‘I think when I work with other people I can let go of all of my ideas and tell them out loud’: The impacts of a Thinking Skills approach upon pupils’ experiences of Maths

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Abstract

This study investigates the impacts of a Thinking Skills based pedagogy upon pupils' experiences of Maths, focusing upon three aspects: progress; self-concept; and the development of metacognition. Literature relating to Thinking Skills suggests that it can have significant impact, with the open nature of tasks and focus upon collaboration providing an alternative to more traditional, de-personalised forms of teaching. The implemented approach ensured increased opportunities for pupils to work collaboratively within mixed-attaining groups. This was combined with a shift from teacher to pupil-led talk, and the use of questions to probe thinking. Key strategies included a visual metaphor to encourage pupils to articulate problem solving strategies and pupils' involvement in formulating learning goals.

The research originates in challenges identified from my own primary classroom and was undertaken between September 2011 and July 2013. It details the shared experiences, of myself, as teacher-researcher, and my pupils - a cohort of 37 Upper Key Stage Two pupils. I have adopted an 'action inquiry' approach, which combines elements of action research and case-study. Research employed mixed methods, including the use of progress and attainment data; a measure of self-concept; and pupil views templates to chart development in pupils' metacognition. This was further supplemented by two embedded case studies following individual children within the focus cohort.

Results show a positive impact, but a complex one. Key findings include an increase in the proportion of pupils making better than expected progress; a positive shift in pupils' self-concept; and pupils' increased focus upon discussions about learning, suggesting the development of metacognition. Overarching these conclusions has been a gradual change in my understanding of the nature of a Thinking Skills approach, becoming synonymous with my beliefs surrounding education in general. In short, Thinking Skills has become my philosophy for education.

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Introduction. The Origins of this Study

During my first seven years as a teacher, I worked at West Side Primary School on the western edge of Newcastle. My first three years were spent happily in a Year 2 classroom, teaching children the basics of constructing sentences, adding two-digit numbers, and about scientific concepts that even I – with only a G.C.S.E. dual award in Science - felt qualified to explain: light and dark, for example, or how to construct an electrical circuit. However, in September 2010, everything changed. I moved to the lofty heights of Upper Key Stage Two. No longer solely faced with supporting children in developing their understanding of simple addition and subtraction, or multiplication and division supported by a number-line, I began to feel uneasy. As a primary school teacher, I have long felt like a 'Jack of all trades, master of none'. I by no means wish to belittle any of the incredibly hard-working colleagues that I have had the privilege of working alongside during my career, yet we all, if we are honest, have our strengths and our areas for development, as, of course, do our pupils.

Prior to completing my P.G.C.E., my background was in languages and literature: I have A Levels in French, Spanish and English Literature. I have a Bachelor's degree in Hispanic Studies. I have a Master of Letters degree in Latin American Literature. My first job following graduation was as a teacher of English as a Foreign Language in Japan. I feel confident in my ability to teach pupils to analyse a text or to discern a subordinate from a main clause (although the reason why this is important quite eludes me). Yet, contrastingly, I have only a G.C.S.E. in Maths. Whilst this does of course, amply qualify me to teach primary school pupils, I am very much aware that my mathematical subject knowledge does not equal that of Reading and Writing. In fact, I can vividly remember my fifteen-year-old self, feeling completely baffled by how on earth I was supposed to find the 'n-th term' (and, if I am quite honest, why it would be useful to do so). I can remember feeling as though I had reached a ceiling in my learning which no amount of explanations from my friends, family or teachers could help me breach. In short, I gave up; I switched off.

I.1 Maths education: developing understanding?

In September 2010, the beginning of my first year in Year 5, Maths teaching was delivered to two ‘ability’ sets. I was, as – lamentably - often seems to be the case with less-experienced teachers, responsible for the lower of the two sets. This consisted of 16 pupils, each of whom was working two or more sub-levels below the age-expected standard. My task was to ‘close the gap’ between these pupils’ current level of attainment, and the expected level, prior to them sitting their Key Stage Two Standard Attainment Tests (S.A.T.s) at the end of Year 6. Upon beginning work with these pupils, I quickly realised that - whilst they were enthusiastic and eager to please - they had little understanding of the ‘why’ in Maths: why did they need to follow specific procedures? Why employ multiplication or division to solve a particular word problem or puzzle?

When responding to a question, the first recourse for many of these pupils was to make a guess, no matter how wild or potentially erroneous. This would then be followed by a swift succession of further guesses; it is my opinion that these pupils had learned to read the faces of their teachers, using these as a gauge by which to ascertain whether they were approaching the correct answer. They could not explain their thinking to me and I believe that this was because they did not themselves understand how to proceed. They did not understand the mathematical activities in which they were engaged, and thus could not reasonably be expected to succeed in them.

This resonated strongly with me, echoing my own bewilderment when faced with certain aspects of the G.C.S.E. syllabus. Even worse, however, I believe that, like me, these pupils had learned to switch off in the face of concepts they perceived challenging. To me, it seemed that they believed in their own inability to understand particular mathematical ideas – finding fractions of amounts, for example - and that this deep-rooted belief became a self-fulfilling prophecy. Consequently, this study originated as a form of professional development, both in terms of developing my own pedagogic knowledge regarding how best to support pupils learning in Maths, and, perhaps, even in terms of developing my own understanding of the subject itself.

I.2 Promoting mathematical reasoning

Having established a lack of basic understanding as a probable cause for pupils' struggle to engage thoughtfully with mathematical concepts, to me, the next step was clear: pupils must be taught to think through Maths to gain deeper understanding of it. Certainly, there is a considerable body of evidence to support this view, evident, for example, in the work of Boaler (2006), Jansen (2008), and Westwood (2011), as well as in Wright and Taverner's (2008) 'Thinking Through Mathematics'. This view has also been supported by the National Centre for Excellence in the Teaching of Mathematics (NCTEM).

As pupils could not explain their thinking, I took this as both my starting point and my goal: through emphasis on the development of pupil-talk and explanations, pupils would be encouraged to engage more actively in mathematical challenges, approaching them as something which could be decoded and understood, rather than as something unfathomable which could only be solved through guess-work and luck. Moreover, the opening of discussions would also allow me, as a teacher, to develop understanding of my pupils' level of mathematical engagement, unpicking misconceptions and, hopefully, thereby developing pedagogic knowledge regarding how best to address these accordingly.

Unfortunately, any investigation into pupils' thinking proposes its own challenges. For example, as McGregor suggests, whilst 'Teachers often say to students 'Let's think about this'' there is 'little agreement about the nature of thinking that teachers expect' (2007: p. 7). Moreover, because thinking is an internal – and therefore largely invisible – process, it is difficult firstly to observe and, consequently, to discern how best to encourage its development. Happily, at this time, I was undertaking a Thinking Skills course at the University of Newcastle, and this seemed to provide a perfect response. A Thinking Skills approach, with its focus upon collaborative working, pupil-talk, and self-reflection, seemed an ideal means of developing the deeper understanding of Maths that I felt my pupils so desperately needed.

I.3 The impacts of Thinking Skills: a preliminary inquiry

As part of a practitioner inquiry undertaken during this particular course, I therefore introduced a series of Thinking Skills activities into lessons, with very positive results. One single week of teaching using this Thinking Skills approach resulted in a marked improvement in assessment results, Moreover, when assessed again at a distance of approximately 10 weeks, pupils appeared to retain these positive effects, suggesting the potential power that an approach of this nature may hold. Nevertheless, it is also fundamental to note that, although, I embarked upon this initial inquiry focused largely upon the impact of a Thinking Skills approach upon attainment, I soon realised that the effects upon pupils were not limited to this, or even fully captured through the use of the standard system of assessment: National Curriculum levels and sub-levels.

When considering my pupils and watching them at work, I felt, almost at a bone-deep level, that, for example, whilst sizeable gains may have been made in terms of pupils' confidence and breadth of repertoire relating to strategies for problem solving or reasoning relating to a particular aspect of Maths, this did not always neatly translate to enough extra highlighted boxes on the A.P.P. to merit a move of a 'point' or sub-level. This is, of course, the complaint of teachers everywhere: our pupils make progress yet this is not always accurately represented by standardised forms of assessment and testing which require very specific responses and evidence.

Yet, this brief foray into practitioner enquiry sparked my interest in the potential of Thinking Skills not only for raising attainment specific to Maths, but also for fostering the independence, curiosity and questioning that I believe is essential for effective learning. I therefore resolved to further investigate the impact of the introduction of a Thinking Skills approach upon pupils' wider experiences of Maths, encompassing not just children's progress and attainment, but also their self-concept and metacognitive development, in an attempt to more fully explore the effects of the prolonged use of a Thinking Skills approach upon pupils' wider perceptions of themselves as Maths learners. To be clear: whilst Maths may provide the context for this particular study, the subject of it is more definitely focused upon the Thinking Skills themselves. It is the development of thinking and the impact of the focus on metacognition which have driven my interest in producing this investigation.

I was particularly struck by the comments of one boy, who wrote that one Thinking Skills activity "helps because it helps your explaining and easy ways to get your answer and it's fun. I think kids learn easier when they're having fun." Aside from the insight into 'metacognitive skillfulness' (Veenman *et al*, 1997) which this remark appears to suggest, it also underscores the impact that pupil engagement and motivation have upon learning. Ma and Kishor (1997), for example, synthesized 113 studies regarding the relationship between attitude towards Maths and achievement, finding that the causal direction was from attitude to the achievement, although they also concluded that this relationship was 'not statistically significant' (p. 35). Clearly, what pupils think impacts upon how well they achieve, suggesting that if we can improve attitudes towards Maths, we may also succeed in improving levels of attainment. Adopting a Thinking Skills approach may be one means by which we can achieve this goal. This research therefore aims to investigate pupils' views of teaching and learning within the context of Maths, and how these are affected by the introduction of a Thinking Skills approach.

I.4 *The structure of this study*

In the course of this research, I believe that it is important to acknowledge that I have not only developed my understanding of the impact of a Thinking Skills approach upon pupils' experiences of Maths, but also, much more generally, I have developed my understanding of myself as both a teacher and researcher. Indeed, my learning in respect to this has become so extensive that it has formed an additional – distinct and yet crucial - element of this investigation. This learning has been multi-faceted, encompassing my understanding of the nature of metacognition, what constitutes 'good' evidence, and the ways in which research should be undertaken. As a result of this professional learning, the research described in this study has undergone a considerable process of evolution, from the rather linear structure envisioned at the outset of research, to the cyclical approach which has ultimately been adopted.

In order to reflect this learning process, I have endeavoured to represent both the original and eventual 'voices' in this thesis, in an attempt to make this learning – this process of evolution – visible. I hoped that, in doing this, I would be able to lend a further layer of validity to this research, conforming to the principle of dialectics by giving space to varying interpretations of the same events, thereby reproducing my thoughts and perspectives at distinct points in the research process and ensuring that they remain 'so genuine and original that the informants can recognize their own thinking in them' (Heikkinen et al, 2012: p. 9). So that these different perspectives can be easily distinguished, later ideas have been italicized and oriented towards the right of the page.

Chapter 1. A Review of the Literature

Having resolved that pupils must be taught to think through Maths to gain deeper understanding, it remains to identify how best to achieve this. The more familiar I have become with research surrounding Maths, the more I have recognised the potential influence that a range of factors – encompassing the cognitive, pedagogic, and emotional - hold upon pupils' experiences of the subject. Perhaps most striking is the strength of feeling that the subject appears to inspire.

The belief that Maths is viewed negatively by many pupils is widespread, with researchers reporting pupils' perceptions of Maths as 'boring' (Brown *et al*, 2007: p. 12), inspiring 'anxiety, feelings of inadequacy and feelings of shame' (Hoyles, 1982: p. 368) and, perhaps most tellingly, of mathematicians as 'authoritarian and threatening' (Picker & Berry, 2001: p. 88). Intriguingly, Hoyles (1982), in her examination of both positive and negative learning experiences found that 'Nearly one-third of all good stories (42 out of the 135 stories) and one-half of all bad stories (72 out of the 146 stories) were, in fact, about mathematics learning' (p. 358). She concludes that this disproportion indicates the strength of reactions which the subject inspires, reasoning that 'pupils would be more likely to recall experiences to which they had reacted strongly than those which had a lesser effect on them' (Hoyles, 1982: p. 359).

1.1 Key concerns surrounding the teaching and learning of Maths

There are various explanations proposed for this sense of dissatisfaction. These appear to fall into three principal categories:

1. attitudes and social influences (Kyriacou and Goulding, 2006; Brown *et al*, 2007)

2. pupils' perception of 'success', together with their ideas of what they are 'capable' of understanding in Maths (Hoyles, 1982)

3. predominant teaching methods (Nardi & Steward, 2003; Brown *et al*, 2007).

These causes are also closely inter-related, with, for example, pupils' attitudes influencing their perceptions of success and ability. This chapter will consider each of these causes to outline a number of areas of concern, or of missed opportunities for the development of teaching and learning. Discussion will then turn to the Thinking Skills approach itself, proposing a definition of this and an evaluation of the extent that the Thinking Skills approach can be expected to counteract these concerns.

1.1.1 *The impact of attitudes towards Maths*

One key explanation proposed in the literature for the prevalent sense of dissatisfaction with the teaching and learning of Maths is that of attitudes towards the subject. Jansen (2008) , for example, suggests that pupils' opinions about learning Maths 'extend beyond their experiences in their current classroom, and are an accumulation of their experiences with learning and doing mathematics both in and out of school' (p. 40). It is also important to note that attitudes towards Maths may just form part of one facet of a larger problem. Certainly, Donaldson (1978) believes that pupils' perceptions of themselves begin at an extremely early age, and are present almost from the point of a child's entry into school, explaining that:

> 'within the educational system at least there is certainly a strong social approval of competence in the more disembedded skills of the mind. So the child who succeeds in coping with these new challenges when he enters school will be highly valued by his teachers – and all too often the one who initially fails will not. In either case the child will quickly discover how he is judged to be doing. That he has often made up his mind about his cognitive competence even before he comes to school is emphasized by Marion Blank, who reports the occurrence of remarks like 'I'm dumb', 'I can't', 'I'm stupid' and 'I don't know how to do things' from certain kindergarten children faced by some cognitive demand' (p. 113).

These feelings of inadequacy and powerlessness are particularly important because self-concept is held by many, including Marsh *et al* (1995), and Wigfield & Karpathian (1991), to be one of the most potent factors for pupil achievement, with research suggesting that 'as much as one-third of the variance in achievement can be accounted for by academic self-concept alone' (McCoach & Siegle, 2003: p. 145). Marsh *et al* (1983) suggest that self-concept is multi-faceted, 'with perceptions moving from inferences about self in subareas (e.g. academic - reading and mathematics), to broader areas (e.g. academic and non-academic), and finally to general self-concept' (p. 334). Furthermore, it is likely that, once formed, pupils' attitudes can be difficult to materially alter. Williams and Ivey (2001), for example, suggest that once a certain stance has been established, this becomes the basis for future action, which can, in turn, form a cycle of repeated reinforcement. Consequently, a pupil, like Bryan - the subject of Williams and Ivey's case-study - who decides he dislikes or is uninterested in Maths, may disengage from the subject and make less effort, leading to lower levels of achievement. As a result, pupils 'can then attribute apparently permanent characteristics either to themselves ('I am not interested in maths') or to the subject ('maths is boring')' (Brown *et al*, 2007: p. 3).

1.1.2 *The importance of 'success' and 'failure'*

The second explanation commonly proposed for disaffection with the teaching and learning of Maths is pupils' 'success' relating to the subject, as well as, crucially, their perceptions of what they are 'capable' of understanding. This is closely linked to attitudes and self-belief, and it seems likely that this plays an extremely influential role in pupils' experiences – and ultimately their levels of achievement – with the work of Marsh *et al* (1995), Sammons *et al* (2008), and McCoach and Siegle (2003) all suggesting the likelihood of a 'reciprocal relationship' (Sammons *et al*, 2008: p. 10) between self-concept and attainment. Similarly, Butler-Por (1993), concluded that 'underachievement in gifted students is closely related to the development of the self-concept' (p. 658), suggesting the potential danger which could result from a poor self-concept, whilst, conversely, 'the realization of potential is enormously enhanced by a child's belief that success is possible' (McLeod & Cropley, 1989: p. 134).

This idea also has firm support in the work of Dweck surrounding mastery- and goal-orientation. Dweck (1986) suggests that these goals are powerfully influenced by children's own ideas about intelligence. For example, 'Children who believe intelligence is a fixed trait tend to orient toward gaining favorable judgments of that trait (performance goals), whereas children who believe intelligence is a malleable quality tend to orient toward developing that quality (learning goals)' (Dweck, 1986: p. 1041). This is important because these beliefs – regardless of the extent to which these may reflect current understanding and attainment - impact upon behaviour for learning, particularly regarding perseverance and determination in confronting challenge. As Dweck explains, pupils with performance goals are prone to ‘interpret negative outcomes in terms of their ability. That is, they attribute errors or failures to a lack of ability […] and view them as predictive of continued failure’ (1986: p. 1042).

It is interesting (yet bleak) to note that Holt suggests this fear is the direct result of education, rather than innate to the pupils themselves, writing that

> ‘We adults destroy most of the intellectual and creative capacity of children by the things we do to them or make them do. We destroy this capacity above all by making them afraid, afraid of not doing what other people want, of not pleasing, of making mistakes, of failing, of being *wrong*. Thus we make them afraid to gamble, afraid to experiment, afraid to try the difficult and the unknown’ (1964: pp. 273 - 274).

The potential impact of this goal-orientated mind-set upon learning is immense. Dweck suggests that, for pupils with performance goals, their choice of task - and particularly the level of challenge they will willingly undertake - is constructed around their concerns surrounding their ability level and how this is perceived. Therefore, ‘if the goal is to obtain a favorable judgment of ability, then children need to be certain their ability is high before displaying it for judgment. Otherwise, they will choose tasks that conceal their ability or protect it from negative evaluation’ (Dweck, 1986: p. 1041). Conversely, pupils with learning goals tended to use these failures as impetus to increase effort or to reconsider the strategies used, varying these where appropriate, resulting in substantial increases in the number of attempts they made to apply new learning, higher test scores, and even a greater volume of work produced, thus suggesting the potential power of pupils’ previously held views and perceptions of themselves, their academic ability, and their capacity to succeed.

This is a phenomenon I have observed with rather surprising regularity as a teacher: the confident child who has a sense of self-belief in their own ability to progress is capable of rapid advancements. I have witnessed this on numerous occasions and, indeed, can instantly name at least three children in the focus cohort alone for whom this was true; who made outstanding progress in Maths, in particular, due to their determination and unshakeable belief in the possibility (almost inevitability) of progress. Conversely – and sadly – I can also name many more pupils for whom a major stumbling-block was confidence; a tendency to second-guess a logical method or line of thinking. All too frequently, these children simply gave up, believing in the futility of even attempting what had become, for them, a task of which they did not believe themselves capable. Often, these pupils had become utterly dependent upon adult support, finding, like Ruth, described some fifty years ago by Holt, 'the situation of not knowing what to do so painful that she prefers to do nothing at all, waiting instead for a time when she can call for help the moment she gets stuck' (1964: p. 17).

Interestingly, Dweck's descriptions of the reactions of pupils with a goal-orientation mind-set are also eerily reminiscent of the images described by Picker and Berry's (2001), featuring 'small children powerless before mathematicians' in addition to images suggesting intimidation and the 'vengeful' nature of mathematicians (both 2001: p. 88). Elliot and Dweck (1988), when investigating the impact of performance versus learning goals combined with pupils' perceived ability level, found that

> 'all of the children in the performance goal-low perceived ability group attributed failure to an uncontrollable cause. None attributed failure to lack of effort, a controllable and modifiable factor. Of the low ability group who made attributional statements, half attributed their failures to themselves. These statements reflected a perceived lack or loss of ability such as "I'm not very good at this" or "I'm confused." The remaining children in this group made statements that fit into various attributional categories including luck ("I accidentally picked the wrong one"), task difficulty ("This is hard and still getting harder"), and experimenter unfairness ("Seems like you're switching on me")' (p. 10).

This further emphasises the seeming 'invisibility' – or certainly lack of comprehension – that some pupils (here, pupils with a goal-orientation mind-set) have when confronted with failure.

To compound this issue, evidence suggests the influence of pupils' self-concept may be stronger in relation to Maths than other aspects of the curriculum. To illustrate: Hoyles (1982) found that pupils 'had strong ideas about what they were capable of doing and what they were capable of understanding in mathematics and their mathematical experiences were dominated by this focus on self and feelings about oneself' (p. 367). Maths can, in some ways, be seen as a rather rigid subject: often there is a specific 'right' answer, in contrast to some other subjects where there are multiple ways of being successful. Certainly, Boaler (2006) recognizes the importance of this, and emphasizes that 'The narrowness by which success is judged means that some students rise to the top of classes, gaining good grades and teacher praise, as others sink to the bottom, with most students knowing where they are in the hierarchy created' (p. 42).

This is all the more important given the apparent fragility of pupils' self-concept in Maths. Hoyles (1982) found that 'when a pupil failed to reach his or her particular goal, whatever it happened to be, that he or she began to doubt his or her ability' (Hoyles, 1982: pp. 367 – 8). Hannula (2002) provides particularly evocative examples of this in her case-study on Rita, a lower-secondary school pupil, whose 'primary reason for not liking mathematics were the unpleasant cognitive emotions she expected to experience. As a consequence of her expectation that she could not learn mathematics, she did not like it either' (p. 33). Intriguingly, and conversely, following more positive experiences with Maths, including doing well in a test, Rita's attitude changed, maintaining that 'Mathematics was "more fun" because she had "been understanding more". […] She more often than before achieved her cognitive goals and therefore her emotional experiences in the class were more pleasurable' (Hannula, 2002: p. 41).

As Hannula explains:

> 'At first glance, her reasoning seems circular: she liked mathematics more because she understood it, and she understood it because she liked it more. However, if we make a distinction between emotions and expectations we can make more sense of her descriptions. She expected to feel good when going to the mathematics class and her initial emotion towards new tasks was interest. In elementary school the initial emotion had been at least occasionally anxiety. Naturally, interest supported learning whilst anxiety had been hindering it' (2002: p. 42).

Nevertheless, whilst the story of Rita is, undoubtedly, a positive tale, conveying a sense of optimism due to the positive shift in Rita's attitude towards Maths, I think that it is extremely important that this shift appears to have taken place as a result of improved performance in the subject. This would appear to be indicative of the very goal-orientation proposed by Dweck (1986), in which pupils pursue performance goals in order to 'measure' their ability.

Whilst Rita feels that she has made progress in her learning – including, notably, her positive performance on a test – she measures well against these goals, however, this does not render her any less vulnerable against further, more negative, shift in attitude as a result of future failure. Instead, Dweck proposes that, in order to increase resilience, it is important to make a larger change – away from this performance-related goal-orientation and towards a learning-related mastery-orientation. As a result, any obstacles encountered in the course of learning 'will not as readily be seen to imply goal failure and will, therefore, not require defensive maneuvers, not as readily generate anxiety, and not detract from the intrinsic rewards shown to derive from involvement and progress on a valued task' (Elliot & Dweck, 1988: p. 6).

1.1.3 *Teaching Methods in Primary Maths*

The final cause of dissatisfaction with the teaching and learning of Maths commonly proposed in the literature is that of prevalent teaching methods. Nardi and Steward (2003), in their investigation into attitudes towards Maths at Key Stage 3, found that the methods commonly associated with the teaching of Maths are often perceived as dull, with too great an emphasis upon individual work and the learning of complex procedures. Similarly, Brown *et al* (2007) maintain that 'Because of league table and performance management targets, teaching strategies are currently focused on training students in procedural skills that are necessary to pass examinations' (p. 11). This suggests that Maths is perceived - whether accurately or not - as monotonous and rigid, requiring pupils to regurgitate learned methods and procedures without room for innovation or creativity.

This is particularly important in light of the evidence provided by several studies (including Biesta, 2007; Sammons *et al*, 2008a; Brown *et al*, 2007; and Hu *et al*, 2010) all of which emphasize the importance of enjoyment in encouraging participation. Sammons *et al* (2008a), for example, found that pupils who were interested in lessons had 'higher levels of

‘Pro-social’ behaviour and ‘Self-regulation’, but also lower levels of ‘Hyperactivity’ and ‘Anti-social’ behaviour’ (p. 6). In short, pupils who are interested are more likely to listen and concentrate, rendering them more likely to learn. It is also possible that this emphasis upon rote learning may have had a rather depressing consequence. For me, from my perspective as a teacher, it is clear that there is a great deal of pressure upon teachers to impart the necessary knowledge required for pupils to achieve well in national tests and examinations. In Maths, this appears to boil down to having the procedural knowledge needed to solve a wide range of calculations, yet does not necessarily entail the conceptual understanding of *why* a particular operation is required.

The implications of this become particularly important in light of research into the psychology of learning Maths, which suggests that the importance of the distinction between instrumental (the ability to apply a series of learned rules) and relational understanding. Fisher (1995) observes that the problem with rules is that ‘they are easily forgotten. Relational understanding implies knowing the reasoning behind the rules and understanding can be gained if the child has though through and can reconstruct the rules for himself. This learning tends to be deeper, more lasting and more easily recalled to memory’ (p. 171). Yet it seems that, in contrast, teachers, ‘in their haste to impart difficult material, make the process of studying mathematics which in actuality can be hard and messy, look so smooth and easy – like magic – that […] pupils are made to feel incompetent when it isn’t as easy for them’ (Picker & Berry, 2001: p. 89).

It also appears likely that any sense of pressure on the part of the teacher may be imparted to pupils through the methods and structure of lessons. Hoyles (1982), for example, found that almost 22% of all negative stories about learning experiences related to Maths ‘contained statements categorized in a sub-category called Teacher Pace, Pressure. All these statements were concerned with the perceived presence or absence of sources of stress imposed by the teacher in the learning process’ (p. 364). This view is strengthened by Picker and Berry’s rather disturbing finding that, in almost all of the five countries considered in their study, pupils produced images of ‘small children powerless before mathematicians. […] Pupils appeared to use experiences of having been intimidated in mathematics classes (*You should know this!)* and their criticisms of teachers for doing this, at times to depict mathematicians in their drawings in a vengeful manner' (2001: p. 88). These findings indicate that 'anxiety, feelings of inadequacy and feelings of shame' (Hoyles, 1982: p. 368) are frequently associated with negative learning experiences in Maths, ultimately confirming the relationship between all three principal causes for dissatisfaction with the teaching and learning of Maths.

Unfortunately, it appears likely that negative perceptions of Maths may be held not only by students, but by teachers themselves. Harper and Daane (1998), for example, found that 'math anxiety still persists in many future elementary classroom teachers. The cause of this anxiety has begun, many times, in elementary school. Often the anxiety has been created by the classroom teacher' (p. 34). I believe it is natural to assume that this anxiety will not only limit teachers' confidence in teaching Maths, but may also limit creativity and experimentation, as teachers stick to what they know because of a fear of mistakes, or perhaps simply an inability to imagine how to impart understanding of concepts which the professionals themselves found challenging during their own education.

This is particularly worrying in light of the link between teacher anxiety and pupil achievement, especially for female teachers and the impact that this has upon girls. Beilock *et al* (2010), for example, found that whilst there was no correlation between teacher anxiety and Maths attainment at the beginning of an academic year, by the end of the year, 'the more anxious teachers were about math, the more likely girls (but not boys) were to endorse the commonly held stereotype that "boys are good at math, and girls are good at reading" and the lower these girls' math achievement' (p. 1860). The potential ramifications of this are huge, not least because, between 2010 and 2013, 87% of teachers[1] in the U.K. were female. Of course, this is not to suggest that all female teachers suffer from Maths anxiety, but, for those teachers who do, it is logical that this could create a negative cycle in which

> 'Negative experiences with formal mathematics instruction led many participants to discontinue their study of the subject, or discouraged them from pursuing formal mathematics instruction beyond that which was necessary to fulfil high school graduation or university admission requirements. This led to

[1] Data from 'The World Bank'. Accessed at http://data.worldbank.org/indicator/SE.PRM.TCHR.FE.ZS on 25.08.2015.

> the perception on the part of many respondents that their mathematics education had not prepared them to teach the subject confidently, a condition that has the potential to be replicated in their students'(Brady & Bowd, 2006: p. 45).

Thus, although teaching methods, self-concept and attitudes may, on the surface, appear to be distinct causes for a sense of disaffection with Maths amongst pupils, these can also be seen to exacerbate each other, creating a negative cycle of deterioration in perceptions of the subject. In short, beliefs about Maths matter and, whilst it may be possible to counteract or even reverse these negative perceptions, it will require a rather radical overhaul not only of teaching methods, but also of the ways in which pupils view themselves as learners of Maths – or perhaps even mathematicians – which could only then begin to influence wider social perceptions.

1.2 Thinking Skills: a potential solution?

I believe that a Thinking Skills approach has the potential to address each of these sources of dissatisfaction with Maths learning. Certainly, such an approach, with its emphasis upon developing metacognition – of reflecting upon thinking and learning – and collaborating with peers to develop shared understanding, has much in common with the learning goals or mastery-orientation mind-set defined by Dweck (1986). Furthermore, there is a wealth of previous research documenting the positive impact of Thinking Skills approaches. Many sources, including Robson (2006) and Hu *et al* (2010), agree with Higgins *et al* (2005) that 'when thinking skills programmes and approaches are used in schools, they are effective in improving pupils' performance on a range of tested outcomes' (p. 3). Others emphasise the importance of explicit teaching of thinking, stating that: 'no curriculum will be regarded as acceptable unless it can be shown to make a contribution to the teaching of thinking' (Nisbet, 1993: p. 284).

For me, it is most important to recognize that the effect of Thinking Skills 'is relatively greater than most other researched educational interventions' (Higgins *et al*, 2005: p. 4), suggesting the remarkable potential of this approach in improving teaching and learning. Nevertheless, there remain many aspects of this decision to more closely determine. Not least of these was to establish what a Thinking Classroom would look like in my particular working context and how, precisely, it could be used to counteract dissatisfaction with Maths learning.

1.2.1 *What do we mean by a 'Thinking Skills approach'?*

Higgins *et al* (2005), in their meta-analysis of the impact of the implementation of Thinking Skills approaches, define Thinking Skills interventions as

> 'approaches or programmes which identify for learners translatable, mental processes and/or which require learners to plan, describe and evaluate their thinking and learning. These can therefore be characterised as approaches or programmes which:
> - require learners to articulate and evaluate specific learning approaches; and/or
> - identify specific cognitive, and related affective or conative processes that are amenable to instruction' (p. 1).

Thus, a Thinking Skills approach entails a shift of focus, away from procedural learning, with pupils following a set of instructions without understanding the justification behind the selection and use of a particular method, towards discussion surrounding the 'why' and 'how' of learning: why does this method work here, why was that mistake made, or how can we improve this particular strategy? It entails an emphasis upon the development of metacognition – reflection about thinking – and in actively engaging pupils in the learning process.

However, from my perspective as a teacher, there are many education professionals in schools who refer to 'doing Thinking Skills', as if they were a set of tasks which, when completed, tick a metaphorical box to say that the Thinking Skills has been 'completed'. I have encountered colleagues who have used, for example, a 'Mapping from Memory' activity - in which pupils work collaboratively to recreate an image or diagram from a shared original which pupils can see only one at a time for a limited period – merely as a novelty. The children enjoy engaging in the activity yet, if they are not encouraged to 'plan, describe and evaluate their thinking and learning' (Higgins *et al*, 2005: p. 1), or, worse, if pupils are unaware of the fundamental importance of doing so, then the opportunity they have been given to develop their thinking skills are minimal.

In contrast, I believe that a Thinking Skills approach is more akin to a philosophy about learning, a set of beliefs about the conditions which best encourage pupils to engage with their learning. Review of the literature relating to Thinking Skills, combined with my own interpretation and understanding of the approach, led me to identify a series of characteristics common to tasks or lessons using this form of approach. A representation of this can be seen in Figure 1.1.

Figure 1.1 Aspects of a Thinking Skills approach

These aspects of a Thinking Skills approach resonate strongly with the work of Wright and Taverner (2008) who suggest there are six essential principles: clear purpose, challenging tasks, articulation, metacognition, opportunities to 'connect the learning', and mediation (p. 111). During the following section, each of the aspects of the Thinking Skills approach will be examined in turn, to gain a better understanding of the importance of each, and to establish whether it is reasonable to expect that the combination of these elements will be successful in counteracting the causes for dissatisfaction with teaching and learning in Maths outlined above.

1.3 The importance of metacognition

A Thinking Skills approach, then, is inextricably linked to metacognition. Yet what exactly is meant by this? It is important to recognise that metacognition sits within a broader field of research into thinking. Indeed, review of the work of Costa (1991) and Presseisen (1991), for example, reveals several additional aspects of thinking including:

- brain functioning;
- epistemic cognition, which relates to the understanding of the 'limits of knowing, as in particular subject matter and the nature of the problems that thinkers can address' (Presseisen, 1991: p. 61);
- and conation, which indicates a desire to think clearly, and to develop approaches and practices which will enhance this.

Yet, what exactly is metacognition, why is it considered to be so important and, perhaps most crucially, how is it to be developed? These issues will be explored in the following section of this chapter.

1.3.1 *What is metacognition?*

Metacognition is defined, most simply as 'thinking about thinking' and is closely linked to effective learning. Schwartz et al (2009), for example, explain that 'Metacognition involves monitoring and regulating thought processes to make sure they are working as effectively as possible' (p. 2). Costa (1991), expands upon this view, adding that metacognition is

> 'a uniquely human ability occurring in the neocortex of the brain. Good problem solvers plan a course of action before they begin a task, monitor themselves while executing that plan, back up or adjust the plan consciously, and evaluate themselves upon completion. Metacognition in the classroom might be characterized by having discussions with students about what is going inside their heads while they're thinking; comparing different students approaches to problem solving and decision making; identifying what is known, what needs to

> be known, and how to produce that knowledge; or having students think aloud while solving problems' (p. 32).

Metacognition, then, is the not only the awareness of the process of learning and effective strategies regarding how this could be achieved, but also the ability to monitor these strategies and to adapt them in order to further enhance learning. However, whilst this initially appears to be relatively straightforward, there is rather less agreement regarding the ways in which different types of metacognition can be further categorized and defined.

Flavell (1979), for example, who first defined metacognition, draws a distinction between metacognitive knowledge and metacognitive experiences, explaining that

> 'Metacognitive knowledge is that segment of your […] stored world knowledge that has to do with people as cognitive creatures and with their diverse cognitive tasks, goals, actions, and experiences. An example would be a child's acquired belief that unlike many of her friends, she is better at arithmetic than at spelling. Metacognitive experiences are any conscious cognitive or effective experiences that accompany and pertain to any intellectual enterprise. An example would be the sudden feeling that you do not understand something another person just said' (p. 906).

Yet it would appear that this issue is still more complex. As a result of more than three decades worth of research into metacognition, the concept has been further divided into numerous sub-categories. These range from discussion regarding the extent to which critical thinking can be considered to relate to metacognition - evident in the work of Flavell (1979), Martinez (2006), and Lai (2011) - to the work of Hennessey (1999), who, through analysis of pupils' metacognitive behaviours, developed six distinct categories to characterize the various levels of metacognition evident in students' discourse. Kuhn (2000) explains that

> 'In the era in which Flavell wrote his 1979 article, almost all the research on metacognitive development was confined to metamemory - the study of what children and adults know about how to remember and about their own memory functions and how such knowledge relates to memory performance. Today, metacognition is conceptualized and studied in a much broader context. Metacognitive and metastrategic functions are being investigated within domains of text comprehension, problem solving, and reasoning, as well as memory. Metacognition in the year 2000, then, is "about" more than it was in 1979' (p. 180).

Nevertheless, whilst acknowledging these different facets of metacognition, I believe that, given the practical context within which this research is conducted, it is important to heed the advice of Lai (2011) who, in her literature review of metacognition, acknowledges that, as metacognition is not typically assessed as part of the regular school curriculum, a large number of the assessments which have been used in an attempt to measure it 'have come from experimental studies where the skills are practiced in a lab environment that is somewhat artificial or contrived, in the sense that it is not connected to school learning' (Lai, 2011: pp. 27 – 28). Thus, I have found that it is most useful to utilize the distinctions drawn by those such as Presseisen (1991), Veenman *et al* (1997), Schraw (1998), and Lai (2011), all of whom highlight two key components of metacognition. Whilst these components are labelled slightly differently, each draws a distinction between metacognition which is rooted in *using* metacognition - for example, by 'monitoring the actual performance of a skill' (Presseisen, 1991: p. 60), thereby demonstrating the ability to reflect upon learning, and an awareness of some of the ways in which pupils learn most effectively – and a type of metacognition which involves regulating this knowledge of the learning process by applying it judiciously to suit different contexts and purposes, and 'includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies' (Lai, 2011: p. 2).

1.3.2 *Why is metacognition important?*

Thankfully, there is rather more agreement regarding why metacognition is deemed to be important. Presseisen (1991) emphasises the potential importance of recognising the difference between, for example, 'a wild guess, an informed guess, a hypothesis, an intuition, and a fact' (p. 61). Adding that assessing the accuracy of particular strategies enables learners to 'apply varying sets of evaluative criteria and to determine if, in fact, the right approach is being employed. The learner has an opportunity to assess the initial selection of strategy, as well as to develop insight into a potentially better choice' (Presseisen, 1991: p. 61). Thus, in becoming metacognitive – in developing understanding of different learning strategies and then reflecting upon the relative success of these – it is likely that learning is enhanced.

It is also encouraging to note that several researchers – including Martinez (2006), Eisenberg (2010), and Lai (2011), Martinez (2006) – highlight the link between metacognition and motivation. Martinez, in particular, stresses the fundamental role that metacognition can play in developing persistence and focus, emphasizing that 'Students can learn to coach themselves: "Stay on track." "Don't give up." "Concentrate." Related to persistence are belief systems that emphasize the role of effort, rather than fixed ability, in ultimate success. The corresponding thought is: "With enough effort I can learn this."' (2006: p. 699). Thus, metacognition can be seen to foster the learning goals or mastery-orientation mind-set which Dweck (1986) suggests encourages pupils to view setbacks in learning as impetus to increase effort or to reconsider the strategies used, varying these where appropriate, resulting in substantial increases in the number of attempts they made to apply new learning, higher test scores, and even a greater volume of work produced.

Nevertheless, given the apparent importance of metacognition, the issue regarding how this can most effectively be developed becomes fundamental, particularly in light of the disagreement surrounding at what age – and to what extent - children may be capable of metacognition. Flavell (1979), for example, has suggested that 'young children are quite limited in their knowledge and cognition about cognitive phenomena, or in their metacognition, and do relatively little monitoring of their own memory, comprehension, and other cognitive enterprises' (p. 906). Indeed, even recent studies maintain that 'accepted wisdom held that children typically do not develop metacognitive skills before 8-10 years of age' (Lai, 2011: p. 15). However, Whitebread *et al* (2009) maintains that this is an 'increasingly untenable position' (p. 64), finding 'evidence of verbal and non-verbal indicators of metacognitive and self-regulatory processes occurring within the 3–5 age group' (Whitebread *et al*, 2009: p. 77).

Yet, whilst this may appear encouraging, it is important to heed Lai's (2011) warning that 'There is at least some evidence, however, that general metacognition does not necessarily increase with age' (p. 19), but 'rather than constituting a single transition from one way of being to another, entails a shifting distribution in the frequencies with which more or less adequate strategies are applied, with the inhibition of inferior strategies as important an achievement as the acquisition of superior ones' (Kuhn, 2000: p. 179). Thus, it seems that, simply because the pupils featured in this study may be considered old enough to be capable of metacognition, it does not necessarily follow that developing metacognitive processes will be a straightforward process. How, then, are pupils' skills in metacognition to be fostered and developed?

1.3.3 *The development of metacognition*

Presseisen (1991) maintains that

> 'One of the most salient characteristics of metacognition is that it involves growing consciousness. One becomes more aware of the thinking processes themselves and their specific procedures, as well as more conscious of oneself as a thinker and performer. As learners acquire understanding of what the various thinking processes are, they can better understand and apply them. Thus, some researchers […] suggest that, initially, thinking skills be taught directly and in relatively content-free situations' (p. 60).

This view is echoed in the work of Lai (2011), as well as Costa (1991), who also adds practical suggestions regarding just what would be must important to teach, including 'learning how to learn; how to study for it test; how to use strategies of question asking […] It might include knowing how you learn best - visually, auditorily, or kinaesthetically and what strategies to use when you find yourself in a situation that does not match your best learning modality' (p. 33).

Part of this training could well take the form of teacher modelling. Schraw (1998), in particular, emphasises the importance of this stressing that 'Too often, teachers discuss and model their cognition (i.e., how to perform a task) without modeling metacognition (i.e., how they think about and monitor their performance)' (p. 119), adding that 'The more explicit this modeling, the more likely it is that students will develop cognitive and metacognitive skills' (Schraw, 1998: p. 118). However, Schraw also advocates use of two separate tools: one for developing metacognitive knowledge, and the other for fostering metacognitive regulation, or skillfulness. The first of these is the Strategy Evaluation Matrix (S.E.M.), which lists a series of strategies, together with information regarding how these should be used and in which circumstances, as well as a brief rationale, suggesting that the use of an S.E.M. promotes 'strategy use (i.e., a cognitive skill), which is known to significantly improve performance' (Schraw, 1998: p. 120), as well as metacognitive awareness, and the ability 'to actively construct knowledge about how, when, and where to use strategies' (Schraw, 1998: p. 120). The second strategy, aimed at increasing metacognitive skillfulness, is a regulatory checklist, which consists of a series of questions which pupils would use as a prompt to consider three main categories of metacognition - planning, monitoring, and evaluating – which Schraw maintains 'enables novice learners to implement a systematic regulatory sequence that helps them control their performance' (1998: p. 120).

Schwartz *et al* (2009) suggest that a further strategy for developing metacognition can be found in asking the pupils themselves to teach and apply metacognition to others, reasoning that 'A strong version of this proposal, consistent with Vygostky (1987), would be that metacognition develops first on the external plane by monitoring others, and then turns inward to self-monitoring.' (Schwartz *et al*, 2009: p. 2). This idea – that in working with others and articulating and explaining reasoning, metacognition may be developed – is linked, albeit loosely, to that of several other researchers including Cross and Paris (1988) and Hennessey (1999), as well as Lai (2011), who describes the benefits of peer interaction in encouraging 'the construction and refinement of metacognitive theories, which are frameworks for integrating cognitive knowledge and cognitive regulation' (p. 25). Indeed, Schraw (1998) believes that pupils may well provide better role models for metacognition than teachers themselves, arguing that 'Frequently, students are better able to model cognitive and metacognitive skills, and provide a powerful rationale for these skills within the student's zone of proximal development, compared to teachers' (p. 118).

Encouragingly, it also appears that working collaboratively – whether to peer-teach or not – may also hold further potential benefits to developing metacognition. In discussing the development of metacognition, Schwartz *et al* (2009) stress the challenges which may be encountered, cautioning that metacognition places a 'dual-task load on working memory. During metacognition, people need (1) to think their problem solving thoughts, and they simultaneously need (2) to monitor and regulate their thinking about those thoughts. When learning or problem solving becomes difficult, there can be less free capacity for metacognition' (p. 2). Schwartz *et al* believe that because 'metacognition takes extra work, people will tend to "get by" if they can, rather than take the extra cognitive effort needed to go beyond "good enough"' (p. 3), and that, as a result, pupils may be discouraged from participating fully in metacognitive talk and thinking. Yet, encouragingly, it appears that peer collaboration could serve to motivate pupils to expend the additional effort required. Certainly, Schwartz *et al* (2009) maintain that 'Working with another [...] can lead to more metacognitive behaviors than completing a task oneself' (p.10), and that, if engaging in peer teaching, the increase in accountability resultant from taking responsibility for the progress and performance of their pupils could also result in increased metacognition, reasoning that this 'may be one reason that tutors learn more when preparing to teach than simply studying for themselves' (Schwartz *et al*, 2009: p. 3).

1.4 Pupils' involvement in the learning process

In attempting to develop pupils' metacognition, it is also important to consider the advice of Lin *et al* (2005), who emphasise the importance of ensuring that both trainer and trainee share common goals. In short: pupils must understand and embrace the purpose for metacognitive development if it is to be successful. The importance of this – of ensuring that pupils appreciate the purposes for engaging in metacognition - is also emphasised by Schraw (1998), who stresses that teachers must 'take the time to discuss the importance of metacognitive knowledge and regulation, including the unique role it plays in self-regulated learning' (pp. 118 – 119). There is much emphasis in the literature upon the importance of clear communication between teacher and pupils, and that pupils engage with the reasons for studying particular skills or concepts. Donaldson (1978), for example, suggests the logic of ascertaining that pupils understand the aims and intended outcomes of learning, explaining that:

> 'You cannot begin the teaching of arithmetic with a lecture on the concept of numerical base. But from the beginning you can be conscious of working towards such an end. And from the beginning you can try to help the child towards some degree of understanding of the general nature of the learning activity that he is about to engage in, so that, before he gets down to the confusion of the detail, he has at least a rudimentary sense of the kind of thing he is attempting' (pp. 99 – 100).

I think that pupils' involvement in the learning process is of particular importance to combat the perception of success in Maths as a 'supernatural' power, which Picker and

Berry (2001) suggest is a consequence of ‘the general invisibility to pupils of the mathematical process, for with the process hidden, mathematical facility looks more like a power than an ability which anyone has the possibility to learn’ (2001: p. 88).

In addition to ensuring that pupils understand what is to be taught and what they must do to become successful, I believe that, to truly involve pupils in the learning process, we must go further, so that pupils also become actively engaged in deciding what they feel their priorities for learning are, and therefore contribute towards designing their own education experience. Certainly, this approach is also advocated by Holt (1964), who rather passionately argues that children should be given the freedom to learn what ‘they most want to know, instead of what we think they ought to know’ (p. 289) and for whom schools should form ‘a great smorgasbord of intellectual, artistic, creative, and athletic activities, from which each child could take whatever he wanted, and as much as he wanted, or as little’ (Holt, 1964: p. 295). This, of course - under our current education system at least – goes too far. Since 1988, the National Curriculum has provided an outline of the basic requirements for teaching and learning and, working within a state-funded school, I am bound to follow it.

Nevertheless, I believe it is possible to involve pupils in the development of the sequence and content of lessons to ensure that learning is personalized – within the boundaries of the various national frameworks and curriculums - to meet the needs of each individual cohort of pupils. This would mark a sharp departure from the de-personalised teaching methods lamented by Nardi and Steward (2003), which are cited as one of the principle causes of dissatisfaction with Maths. Contrastingly, Wright and Taverner (2008) state that involving pupils in this way ‘encourages active participation and intrinsic motivation of students, and at the same time sets up concrete targets for them to achieve’ (p. 111). Furthermore, I believe that emphasizing learning outcomes in this manner would also encourage pupils to adopt the mastery-orientation mind-set described by Dweck (1986). This mind-set is extremely desirable due to the associated behaviours of determination and resilience when faced with challenges in learning. As Elliot and Dweck (1988) illustrate:

> ‘individuals who pursue learning goals are concerned with developing their ability over time and can be seen as posing the question, How can I best

> acquire this skill or master this task? Subsequent events, such as failure outcomes, may then provide information that is relevant to this question, leading individuals to alter their strategies or escalate their efforts. Here, even individuals with poor opinions of their current ability should display the mastery-oriented pattern, because (a) they are not focused on judgments of their current ability, (b) errors are not as indicative of goal failure within a learning goal, and (c) low current ability in a valued area may make skill acquisition even more desirable' (pp. 5 – 6).

This is fundamental because, as Biesta (2007) explains, 'If teaching is to have any effect on learning, it is because […] students interpret and try to make sense of what they are being taught. It is only through processes of (mutual) interpretation that education is possible' (p. 8). This view is grounded in educational theory, and is commensurate with a constructivist view of learning, where teachers 'cannot directly transmit conceptual understanding to learners because such understanding can only develop through an individual's own first hand experiences and cognitive activity' (Westwood, 2011: pp. 6 – 7). Planning and delivering a lesson is simply not enough: teaching must engage pupils, and make them *want* to participate in the learning process. Furthermore, I believe that increasing flexibility and opening up discussions surrounding learning, empowers pupils to take a measure of control – no matter how small - over their own learning, creating a more equitable and democratic classroom community.

The creation of shared learning intentions and success criteria is one of the first steps towards the development of metacognitive talk. The provision of opportunities to develop metacognitive awareness and skillfulness – pupils' understanding of the nature of learning, and how best to achieve this – is essential to the successful establishment of a Thinking Classroom. Metacognition is the act of thinking about thinking, and encompasses planning how to approach learning, monitoring understanding, and evaluating progress. The development of metacognition is a 'vital stepping stone to students becoming autonomous, self-regulating, independent and effective learners' (Nichols, 2006: p. 184), and there is considerable evidence of the relationship between metacognitive awareness and attainment outcomes 'with effect sizes ranging between 0.5 and 0.8' (Wall, 2014: p. 2).

Wright and Taverner (2008) also identify metacognition as one of their principles of teaching thinking, emphasizing the importance of encouraging pupils to 'identify and label the strategies they have used in problem solving, and develop their repertoire of strategies' (p. 112), however I believe that this must be taken further. For me, metacognition is the thread which runs through each of the distinct aspects of a Thinking Skills approach. Metacognitive awareness and skillfulness is, ultimately, the goal of a Thinking Skills approach – in teaching pupils to think, I am asking them to think about thinking; I am asking them to engage in metacognition. Consequently, involving pupils actively in their learning is just one of the means by which we encourage them to do this.

1.5 Classroom environment

As I have previously acknowledged, evidence in the literature suggests that classroom environment – as well as the attitude of both teacher and pupils towards experimentation without fear of failure - is critical to the success of a Thinking Skills approach. Hattie and Timperley (2007), for example, emphasise the importance of a classroom environment where pupils feel safe to make mistakes, writing that 'Errors and disconfirmation are most powerful in climates in which they are seen as leading to future learning, particularly relating to processing and regulation' (p. 100). The potential importance of allowing – and, indeed, encouraging pupils to make mistakes – is not new. Donaldson (1978) acknowledges that it is 'well established that the advent of error can be a sign of progress' (p. 107). However, as Donaldson admits, 'being wrong without knowing it is clearly not of much value! So if we are going to try to put the occurrence of error to good use in education, we must ask […] how we can help to bring them to the critical realization: 'I am wrong!'' (1978: p. 108).

Interestingly, Donaldson cites Socrates, who upon bringing a pupil to a realization of his misconception about geometry, argued that before realizing his mistake, 'there was clearly no hope of change, for he was satisfied with his state. But he cannot be satisfied with a state of ignorance and confusion. He will want to get himself out of it' (1978: p. 109). However, like Donaldson, I am unconvinced by this assertion, particularly if we are to take this as a general principle, to apply to whole classes of children. Holt (1964), for example, writes, with almost unbearable negativity, that

> 'I used to feel that I was guiding and helping my students on a journey that they wanted to take but could not take without my help. I knew the way looked hard, but I assumed they could see the goal almost as clearly as I and that they were almost as eager to reach it. […] I see now that most of my talk to this end was wasted breath. Maybe *I* thought the students in my class because they were eager to learn what I was trying to teach, but they knew better. They were in school because they had to be, and in my class either because they had to be or because otherwise they would have had to be in another class, which might be even worse' (p. 37).

This, I think (with resolute optimism) goes too far. However, reflecting upon my experience as a teacher - and the reactions of the three hundred or so pupils with whom I have worked intimately - I believe that I can identify examples of both.

Whilst I have witnessed examples of tenacity amongst my pupils, I have also worked with those more akin to Holt's example of Emily, for whom fear of failure became so overpowering that it led her to 'act and think in a special way, to adopt strategies different from those of more confident children. […] She makes me think of an animal fleeing danger – go like the wind, don't look back, remember where that danger was, and stay away from it as far as you can' (1964: p. 40). Some children - when they come to expect failure - view mistakes as unavoidable, yet something to fear, and therefore something to avoid at all costs. If we are to ascribe to the patterns identified by Dweck (1986), then the answer to whether the student taught by Socrates would strive to find the correct solution to his geometry problem would lie in his mind-set: whether he had a mastery-orientation mind-set, and was consequently inspired by his initial failure to try, try, try again, or whether he laboured under a performance-focused goal-orientation mind-set, and was discouraged by this setback, and, consequently, resolved to give up his quest for learning, perhaps believing it beyond his reach.

I cannot help but feel that it is crucial to recognise the importance of attitudes towards learning, and particularly of the benefit of encouraging pupils to value learning, as opposed to performance, outcomes. I also wonder whether Socrates, in his teaching of his student, neglected to take these into account. I believe it is likely that many teachers - as graduates who have necessarily been relatively successful in their own academic experiences, and who, presumably, by nature of the profession they have aspired to join, value education and the benefits that it can bring – have a learning-focused, mastery-orientated mind-set and that there is, therefore, a potential danger that they, like Socrates, may make the assumption that all pupils hold similar beliefs regarding the value of learning. Unfortunately however, as Holt (1964) maintains, it is important to recognise the likelihood that, for some children at least, 'the central business of school is not learning, whatever this vague word means; it is getting these daily tasks done, or at least out of the way, with a minimum of effort and unpleasantness' (p. 38).

A potential solution could be found in instilling in children the kind of learning-focused, mastery-orientated mind-set needed to ensure pupils' resilience in the face of challenges to their learning. The role of the teacher is crucial here, in ensuring the creation of an environment where experimentation, hypothesizing and, of course, errors, are embraced as the means by which understanding is developed and enhanced. A Thinking Classroom aims to create 'communities of learners prepared to share thinking and question their own and others assumptions of metacognition in such a way that there was a shared responsibility and engagement with the process of learning' (Wall, 2014: p. 3). Indeed, Wall suggests that the creation of this supportive climate for learning is essential, writing that 'It is through creating an environment and empathetic community that the questioning and hypothesizing about learning experiences can occur' (2014: p. 4).

Wall also asserts that a 'classroom that emphasizes metacognition […] allows time to focus on the learning process, the sharing of thinking about thinking' (2014: p. 3). This resonates strongly with my beliefs regarding the type of classroom environment – or community of learners – which I strive to create with each class I work with. However, this license to slow down, and to prioritise the development of genuine understanding, rather than encouraging pupils to replicate a given procedure before rapidly moving on to the next aspect of learning to be covered – an all too familiar pressure in our current results-driven education system – also provides a possible reprieve for harassed pupils. This links to Hoyles' (1982) finding that more than one fifth of all negative stories about learning in Maths related to teacher pace and the pressure of moving too swiftly through half-considered and understood concepts.

1.6 The role of the teacher

The prerequisites for creating the ‘community of learners’ which is so crucial to the success of a Thinking Skills approach, strongly suggest the vital role of the teacher in the success – or failure – of this endeavour. Ultimately, teachers have considerable control over their individual classrooms, in terms of the lessons they plan, the learning styles they promote, and – crucially – their interactions with their pupils. I am horror-struck, for example, at the image of ‘small children powerless before mathematicians’ (Picker & Berry, 2001: p. 88). In contrast, to create a supportive learning environment in which pupils are free to experiment and make mistakes in order to develop understanding, it is important to shift power away from the teacher, and towards a more equitable division of responsibility.

Like Holt - and many of the most confident and honest of my colleagues, those who can perhaps be seen to relate most easily with their pupils - I have no qualms about replying, when asked a question to which I do not know the answer: ‘I have no idea!’ Relating to this, I am much struck by the words of Wegerif (2010) who also embraces this position of teacher as fellow learner, particularly for the success of the explicit teaching of thinking:

> ‘The first lesson for anyone who wants to teach thinking to others is to make friends with ignorance. It really does not matter that we do not know the answers, what is important is that we keep asking the big questions. That way not only can we stay young and creative forever but also we can help children learn to think for themselves by constantly re-learning how to think things through again with them. For teaching thinking the right answer to every big questions is: ‘I don’t know, let’s investigate it together’ (p. 2).

This is natural to me and, indeed, to many of my colleagues, yet I wonder how much our position as human beings with strengths and weaknesses in our own skill and knowledge-base is visible to our pupils. I hope that teachers have moved on from Holt’s depiction of an inherent dishonesty where teachers ‘present ourselves to children as if we were gods, all-knowing, all-powerful, always rational, always just, always right’ (1964: p. 282). Yet I wonder whether perhaps more might be done to make this fact obvious to our pupils – often small children - who will, perhaps logically, be impressed by our superior skills and the knowledge borne of so many more years of learning than they have yet to experience.

Interestingly, it is possible that sharing my own learning experiences with my pupils may facilitate the creation of this community of learners. Wall and Hall (under review) suggest that 'By being more explicit about their own learning experiences teachers not only model the ups and downs of lifelong learning, but also recognize how the learning process that is inherent in teaching facilitates dispositions that form the bedrock of professional practice' (p. 1). As I engaged in this research, I necessarily opened up discussions about my own learning – including successes and failures – therefore positioning myself alongside my pupils, not as a source of all knowledge, but as a fellow learner. I believe this position enabled me to create a greater sense of equity in the classroom - in our community of learners - but also allowed me to model learning – together with its 'light-bulb moments' as well as its challenges – first-hand for my pupils.

In addition, the evidence suggests that it is necessary to re-consider strategies for teaching themselves. Wright and Taverner (2008) link two of their six principles for the effective teaching of thinking explicitly to the role of the teacher. The first of these is 'connecting the learning', in which the teacher encourages pupils to make links between new and existing learning and between different contexts – both in terms of distinct curriculum areas, as well as learning contexts both inside and outside of school. The second of these principles relates to 'mediation', which Wright and Taverner believe is present – and, indeed, essential to – every stage of a Thinking Skills lesson. During mediation, teachers intervene to 'challenge students' thinking, to help them articulate their thinking, to encourage them to reflect upon their learning and to make links to their existing knowledge' (2008: p. 112).

It is perhaps crucial to recognise that teaching in a Thinking Classroom represents a notable departure from more traditional forms of teaching and learning. It requires a departure 'from seeking the right answer towards recognising the different ways in which pupils think and hence how they achieve understanding' (Gunter *et al*, 2001: p. 28). In contrast to more traditional teaching styles, mediation 'begins with the teacher listening to and observing students at work. This helps the teacher to diagnose and assess how she might best intervene to close learning gaps. The teacher's intervention, therefore, is informed by her diagnosis' (Wright and Taverner, 2008: pp. 112 – 113). This is crucial because 'When teachers are in the habit of introducing their own ideas and information before pupils have a chance to think out theirs, pupils are unlikely to engage in reflection and will probably take the easier route of accepting unthinkingly what their teacher says' (Watson, 2001: pp. 141 – 142).

In such a situation, teachers deprive pupils of the opportunity to construct their own meaning through translation, integration, planning and monitoring, thus preventing them from developing lasting relational understanding. As Holt (1964) explains:

> 'The trouble was that I was asking too many questions. In time I learned to shut up and stop asking questions, stop constantly trying to find out how much people understood. We have to let learners decide when they want to ask questions. It often takes them a long time even to find out what questions they want to ask. It is not the teacher's proper task to be constantly checking the understanding of the learner. That's the learner's task, and only the learner can do it. The teacher's job is to answer questions when learners ask them, or to try to help learners understand better when they ask for that help' (p. 41).

Contrastingly, a 'classroom that emphasizes metacognition […] allows time to focus on the learning process, the sharing of thinking about thinking' (Wall, 2014: p. 3). The role of the teacher therefore becomes more akin to that of facilitator, listening to pupils' responses to gauge their level of perception, and to provide questions which may prompt further - or different - ways of thinking to help develop pupils' understanding. This notion of questions, therefore, takes on a new significance: if we are not to use them, as Holt did, to assess pupils' current level of understanding, but rather to further their thinking and to encourage their own questioning, how exactly should this be achieved?

1.6.1 *Developing questioning*

McGregor and Gunter (2006), in their investigation of how to invigorate pedagogic change through the C.A.S.E. (Cognitive Acceleration through Science Education) professional development programme, emphasise the importance of open-ended questioning, stressing that these 'pose much less 'leading' challenges and thus provide opportunities to develop more diverse cognitive processing' (p. 32). The advice contained in this research is highly specific, and therefore immediately useful to a teacher-researcher, providing, perhaps, one of the clearest outlines to suggest how a Thinking Skills approach can be successfully introduced into the classroom.

McGregor and Gunter emphasise the importance of considering the progression and sequencing of questioning, specifying that questions should be posed one at a time in order to ensure that pupils ‘are not influenced at an early stage by later questions’ (2006: p. 30). They also advocate encouraging pupils to hypothesize and make predictions in the course of their collaborative work, explaining that ‘Questions with the prefix ‘what will happen’ create very open-ended possibilities, with no fettering or constraints on the anticipated response. Frequent use of this type of question engenders a more reasoned ‘open’ culture of offering proposals with justifications’ (McGregor & Gunter, 2006: p. 32), suggesting the necessity of carefully considering the wording of questions and interactions between teacher and pupils to successfully encourage pupils to work in this new and more open manner.

It is important to note, however, that it is not solely the questions asked by teachers themselves which should be considered important. King (1994), for example, suggests that ‘when children use questions that guide them to connect ideas within a lesson together or connect the lesson to their prior knowledge, they engage in complex knowledge construction which, in turn, enhances learning’ (King, 1994: p. 361). Nevertheless, although the importance of asking the right questions appears clear, how best to encourage children to do this is rather more problematic.

Perhaps rather logically, it appears that the modelling of questions is particularly important in developing pupils’ questioning skills, advocated in the work of Biddulph et al (1986), King (1994), and Chin (2004). Suggestions for how best to do this range from Chin’s simplistic recommendations regarding verbal modelling - where, ‘After saying 'What questions can we think of about this?', he or she starts giving examples’ (2004: p. 109), or the priorisitising of displays dedicated to questions within the classroom, and initiatives such as encouraging children ‘to supply 'questions of the week'’ (Chin, 2004: p. 111) – to King’s (1994) rather more complex interventions of guided cooperative questioning. Following this intervention, children are provided with prompt cards containing a variety of question stems such as '"What are the strengths and weaknesses of..?" "What would happen if..?" and "Why is .. important?" to generate their own specific questions on the material being studied. Then in small groups or pairs they pose their questions to each other and answer each other's questions' (King, 1994: p. 340).

I believe that it is also important to recognise, however, that simply encouraging children to generate a wide range of questions may not be sufficient to develop pupils' questioning skills to their full potential. As Chin (2004) observed, there is a vast difference between the types of responses which are prompted by different question types: 'For example, 'What if questions would help students to anticipate scenarios, explore possibilities, consider alternatives, test relationships and predict outcomes, while 'Why' questions would stimulate them to think about cause-and-effect relationships' (p. 109). If children are to question effectively, it is likely that they may require explicit training regarding different categories of question types and the disparate types of thinking which can be elicited with each type of questioning and how these could be used to their full effect.

A further strategy for promoting pupils' questions suggested by Biddulph *et al* (1986) is providing suitable stimuli. This issue of stimuli is intriguing: it resonates with the oft-cited complaint against the dull teaching methods associated with Maths teaching, once again emphasising the fundamental nature of engaging pupils' interest in their learning. Chin (2004) suggests that the manner in which tasks are introduced can be used to foster curiosity and encourage pupils to develop their own skills of questioning. For example, instead of simply instructing pupils on the best strategies for solving a given problem, a teacher could

> 'invite students to first pose questions about the problem. Such questions could help students define the parameters involved (e.g. '*What are the variables involved here?*'), locate missing information (e.g. '*What other information do I need that is not given?*'), invoke prior knowledge (e.g. '*How can I make use of what I already know about things related to this problem?*') and consider alternatives (e.g. '*What are all the things that I could do?*'). In this way, if practised regularly, students may internalise question-asking as a habit of mind whenever they encounter a problem and spontaneously ask such questions, thus steering themselves to untangle the problem and find a solution on their own' (Chin, 2004: p. 109).

The prioritising of pupils' questions in this way marks a clear departure from more passive forms of teaching and learning, in which pupils may simply be expected to absorb new information.

This issue of stimuli is also interesting as I believe it links firmly to the importance of giving pupils a clear purpose for the questioning, whether this comes in the form of the task which provokes these questions, or even in the form of motivation provided by the learning potential offered by engaging simply in the question-asking process itself. King, for example, stresses the importance of making children aware of the potential benefits to learning which could result from engaging in questioning, ensuring that 'Students in both groups were told that asking and answering their own (and others') comprehension and connection questions would help them to understand and remember the material presented in the lessons' (1994: p. 346).

This links firmly to the argument in favour of ensuring that pupils are actively involved in the learning process, and understand, not just what is to be learned, but also why this is important. This is fundamental because, as Chin (2004) remarks, 'All too often, students perform laboratory activities by rote according to given instructions without knowing the aim of the activity' (p. 109). I strongly believe that, by emphasising to pupils the importance of asking and answering their own questions, we greatly increase the likelihood that pupils will do, thereby hopefully generating a positive feedback loop by which pupils' beliefs in the importance of questioning leads to increased numbers of questions asked. This in turn would lead to greater learning, underscoring pupils' beliefs in the importance of questioning.

It is, of course, important to recognise the importance of the teacher's role in establishing this climate in which questions are welcomed. Biddulph *et al* (1986) cite a receptive classroom atmosphere as one of the key strategies for developing pupils' questioning and, indeed, in describing the conditions recommended fostering improvement in pupils' skills in question-asking, it is difficult to see how these could be fulfilled without the whole-hearted support of the teacher. Chin (2004) also emphasises the importance of this, stressing that pupils'

> ‘enquiry skills can develop only when they feel free to ask questions and share their ideas without fear of censure, criticism or ridicule. No matter how silly their questions may appear to be, the teacher should restrain judgmental cues and the questions must be greeted with enthusiasm, a commitment of time and in an unthreatening manner. The key to a questioning climate is the attitude of the teacher toward questions. Are questions viewed as annoyances, digressions, time-wasters to be hurried through, indicators of ignorance, or as tools for thinking and learning, toys for critical and creative minds, a celebration of curiosity?’ (p. 110).

Clearly, then, just as it is crucial for the pupils’ themselves to understand the importance of asking questions for their own learning if we expect them to engage whole-heartedly in developing their questioning skills, it is fundamental that teachers also understand that it is up to us to make it clear that questions are accepted, valued and welcomed within the Thinking Classroom if we are to have any hope of encouraging pupils to use them.

1.7 Open tasks

McGregor and Gunter (2006) emphasise the significance, not just of the nature of tasks used in a Thinking Classroom but also the way these are introduced. Wright and Taverner, for example, propose that these, rather than a series of learning objectives, should begin mathematical learning, stressing the importance of activities which are ‘intrinsically motivating for the student’ (2008: p. 111). The idea of providing inspiring and engaging tasks is also critical in counteracting one of the most common causes of dissatisfaction with Maths learning, the criticism that too many of the teaching methods used are tedious, with over-emphasis on individual work and rote learning (Nardi & Steward, 2003).

Boaler (2006) provides the example of Railside school, where ‘teachers created multidimensional classes by valuing many dimensions of mathematical work’ (p. 42) by using an approach strikingly similar to that of a Thinking Skills curriculum, which involved giving pupils ‘open-ended problems that illustrated important mathematical concepts, allowed for multiple representations, and had several possible solution paths’ (Boaler, 2006: p. 42). Boaler logically maintains that this multidimensional aspect of teaching and learning played a crucial role in the enhanced success of pupils: ‘Put simply, when there are many ways to be successful, many more students are successful. Students are aware of the different practices that are valued and they feel successful because they are able to excel at some of them' (2006: p. 42).

The level of challenge that tasks present for pupils is also highly important. Given the potential risk posed by children's fear of failure and the inhibitive influence this can exert upon their willingness to persevere and engage with learning, Donaldson (1978) suggests that an important element of the teacher's role is to 'guide the child towards tasks where he will be able objectively to do well, but not too easily, not without putting forth some effort, not without difficulties to be mastered, errors to be overcome, creative solutions to be found' (pp. 114 – 115). Similarly, Wright and Taverner (2008) emphasise the importance of tasks which require pupils to work 'at a level above students' current competence, [pushing] students out of their comfort zone' (p. 111), thereby encouraging them to work in Vygotsky's (1978) Zone of Proximal Development. This 'Zone' represents the learning potential a pupil could reach when provided with sufficiently challenging tasks, the support of fellow learners, and - or as well as - mediation from an adult. This is crucial. Too often, differentiation in Maths limits pupils by lowering expectations, particularly for lower- and middle-attaining pupils, thereby limiting their potential achievements as a result of the tasks we allow them to undertake.

This is supported by the work of Chanan (1970), Kelly (1975), Dweck (1986), and, more recently, by Finch and Montambeau (2000) and Ireson and Hallam (2001), all of whom stress the danger of teachers' judgments regarding pupils' capabilities. These can be communicated to pupils in a myriad of different ways – by ability group, setting, streaming, or therefore, by logical extension in my opinion, by teacher directed differentiation within the classroom – with potentially damaging effects upon the pupils themselves. Indeed, Kelly (1975) goes as far as to suggest that 'far from catering from differences of ability, it creates such differences itself' (p. 8). Instead, a Thinking Skills approach, with its focus upon mixed-attaining collaboration, conveys a sense of equality and, because of the focus on the development of metacognition – of learning to learn – expresses confidence in the idea that all learners have the potential to become successful learners, thereby conveying this positive message to pupils.

1.8 Opportunities for collaboration and pupil talk

Collaboration and pupil-talk is central to a Thinking Skills approach, and there is much emphasis of this within the literature. As acknowledged above, collaboration between peers is considered vital for pupils to access the challenging tasks required to access Vygotsky's (1978) Zone of Proximal Development, yet this is just part of a strong tradition emphasizing the importance of talk in developing understanding supported by McGregor and Gunter (2006), and Wright and Taverner (2008). Wright and Taverner (2008) suggest that articulation of reasoning serves two distinct but necessary purposes. The first of these is to make thinking increasingly visible, thereby allowing teachers to 'pick up any misconceptions or gaps in students' learning and subsequently to use these to inform their teaching' (p. 112). Whilst this is logical, it does not explain why a Thinking Skills approach places such emphasis upon pupil collaboration: surely, teachers' identification of misconceptions could be accomplished through conversation between teachers and pupils. I think the true reason why talk is so integral to the success of a Thinking Skills approach lies in the second purpose proposed by Wright and Taverner, that through listening to others' explanations of their thinking, and in the process of attempting to articulate their reasoning themselves, pupils firstly, 'become aware of alternative ways of doing things and ways of learning', and secondly, 'stimulate the realization that there may be gaps in understanding or that the successful articulation has reinforced and clarified learning' (both 2008: p. 112).

Clearly, the dual purpose served by the focus upon collaboration and pupil-talk inherent to a Thinking Skills approach, could also counteract the dissatisfaction felt with more traditional teaching methods. Indeed, the emphasis on collaboration provides a stark contrast to the prevalence of individualistic methods lamented by Nardi and Steward (2003). Furthermore, a focus on the development and articulation of reasoning – a focus which requires pupils to prioritise their understanding of Maths, including why particular strategies are used to obtain specific outcomes - marks a sharp departure from rote or procedural learning and the general invisibility the learning process in Maths, which makes some learners liken skill in the subject to a 'supernatural power' (Picker & Berry: 2001: p. 88).

There is substantial support in the literature for this view. Watson (2001) stresses that ‘it is mainly through the mediation of one or more other people that pupils make intellectual progress’ (p. 143), and this view is supported by the work of several academics, including Leat and Higgins (2002), Ke and Grabowski (2007), Hu *et al* (2010) and McGrane and Lofthouse (2010), all of whom emphasise the importance of talk and collaboration for shared-construction of understanding. It is perhaps unsurprising, then, that a fundamental aspect of a Thinking Skills lesson is the ‘debrief’. Indeed, many, including Nichols (2006), believe that the debrief is essential to the development of metacognition, by which ‘the process of learning (*how* students learn) is accorded a status on a par with the subject content (*what* students learn)’, and stressing that ‘Awareness of, and thinking about thinking […] is a vital stepping stone to students becoming autonomous, self-regulating, independent and effective learners’ (both p. 184).

The importance of talking through the learning process is also emphasised by Jansen (2008) and Boaler (2006), who stresses that ‘There are many good reasons for this — justification and reasoning are intrinsically mathematical practices […] — but these practices also serve an interesting and particular role in the promotion of equity’ (p. 44). Westwood (2011) also highlights the role that high-quality discussion and critique of methods plays in the teaching of Maths in countries with high levels of student performance, such as Japan, adding that ‘It is not unusual for a teacher and class in Japan to take 15 minutes or more to explore a single problem and to critique the methods they have used’ (p. 8).

It also appears that talk itself may be instrumental in raising levels of attainment. This possibility is alluded to by Leat and Higgins (2002), Nichols (2006), Hu *et al* (2010), and McGrane and Lofthouse (2010), all of whom suggest that ‘by verbalizing their reasoning they accept reasoning at a higher level than they start out with’ (Hu *et al*, 2010: p. 5). This is supported by Fisher’s (1995) belief that ‘Even if they have made what seem to be obvious mistakes, children should be given the opportunity to explain them. Providing the answers may not enhance the thinking process; indeed, giving the right answer often puts a stop to the child’s thinking’ (p. 173). Instead, talk becomes ‘a vehicle through which metacognition develops. Metacognitive talk thus generates the potential for a feedback loop, which has the potential to raise attainment’ (McGrane & Lofthouse, 2010: p. 94).

It is important to note that, if teachers are to ensure the high quality of pupils' responses, collaborative work may take time. McGregor and Gunter (2006), for example, emphasise the importance of allowing pupils 'to rehearse with each other in their collaborative groups so that they evaluate others' contributions, prioritize ideas and co-construct resolutions' (p. 33). This is particularly true if we are to emulate the strategy for collaborative work – in the form of mixed-attaining trios – which enjoyed such success during McGregor and Gunter's research relating to the C.A.S.E. professional development programme. Interestingly, a collaborative approach therefore holds potential for remediating the negative associations of many pupils between their experiences of Maths learning and pressure exerted by excessive teacher pace identified by Hoyles (1982) in almost 22% of all negative stories about Maths learning. It is, of course, logical to expect that more time will be given for pupils to discuss their ideas than for pupils to consider an answer independently.

Despite this very positive picture, there is a note of warning in the work of Jansen (2008), who found that pupils are by no means certain to take part in discussions. Indeed, to the contrary, 'Students who perceived a high degree of risk associated with participating appeared to avoid taking advantage of opportunities to participate in reasoning conceptually about mathematics, even in a classroom with many opportunities to do so' (p. 31). For some pupils, participating in conceptual discussions may be an unsettling experience which threatens to affect self-concept and, therefore, their perceptions of the subject and willingness to engage in lessons. Jansen, for example, found that 'Being corrected during classroom discussion felt, for some students, like a personal attack and affected how they felt about themselves and their classmates' (Jansen, 2008: p. 8).

Jansen also maintains that pupils 'who believed participating during mathematics class discussions helped them learn were more likely to talk conceptually about mathematics' (2008: p. 37). Thus, it is to be hoped that, through careful communication of the importance of discussion, pupils may be encouraged to participate more actively. Pupils should also be taught about the value of challenging one another's thinking and the role that this can play in developing mathematical understanding, particularly as, without this intervention, 'Students may instead think that challenging the thinking of others is unkind' (Jansen, 2008: pp. 44 – 45). This is particularly important given Jansen's belief that the notion of helping others may in fact provide additional motivation for pupils to engage in discussions, as some of the seventh-grade students considered in her study ‘who believed participating was threatening said they would participate if they could help their classmates or if they would meet expectations for appropriate behavior’ (2008: p. 37).

As a result of the potential challenges in successfully fostering pupils’ interactions in the classroom, it is encouraging to note the work of McGregor and Gunter (2006) who employed a set of ground rules – first proposed by Mercer (1995) – to develop conversations between teachers to include increased levels of exploratory talk, thereby ‘rendering reasoning more ‘visible’’ (McGregor & Gunter, 2006: p. 29). Under these rules, there is an

> ‘explicit expectation that there should be symmetrical contributions from all participants. When asked a question (or set a task) the partners are each required to describe and explain their view. Each proposal is evaluated, so the group engage critically but constructively with all statements and suggestions. Analysis of their juxtaposed perspectives is encouraged to reach a group ‘consensus’’ (McGregor & Gunter, 2006: p. 29).

Whilst this is a highly formulated – and therefore perhaps restrictive - form of interactions, it is easy to see the benefits of using such a structure - particularly when first introducing collaborative group-work - in providing a clear model for pupils to follow while they become accustomed to this new way of working. Once collaborative work is established, it may then be possible to move away from this format towards a freer form of discussion.

The description of this framework in action is particularly useful for me, as a teacher-researcher, as it provides a clear picture, not just of what successful collaboration may look like in practice, but also of the multiple, somewhat complex, factors to be considered when constructing these groups. For example, McGregor and Gunter outline the wide range of potential group dynamics considered by the teachers involved in the C.A.S.E. professional development programme, who realised that discussion was ‘likely to be richer if pupils changed working partners regularly; […] that boys made quite different contributions to girls [… and] that mixing abilities could augment ZPD development as a result of the complementary increase in discursive exchange of ideas and reasoning’ (2006: pp. 36 –

37). As a teacher, working with pupils on a daily basis, these truths would appear to be self-evident, however I wondered if I, like those teachers on the C.A.S.E. programme, had fully considered their potential influence towards ensuring the success of a Thinking Skills approach. This is clearly an issue that needs serious consideration upon introducing any system of collaboration into the classroom.

1.9 Thinking Skills: effective for all?

Whilst claims of the potential of a Thinking Skills approach to improve levels of attainment in Maths appear well-supported, there is little consensus regarding the pupils for whom it may be successful. Hu *et al* (2010), for example, found that the effects of their 'Learning To Think' initiative 'were concentrated in students in the middle band of initial ability' (p. 1). Similarly, McGuinness (2006) found that 'Children with moderate to high developed abilities benefited most' (p. 3), whilst 'no positive outcomes were identified for children with poorer developed ability' (2006, p. 3). Yet, contrastingly, Higgins *et al* (2004) indicated that 'there may be greater impact on low attaining pupils' (p. 5) and Cardelle-Elawar (1992) found that Thinking Skills enabled low-ability pupils to develop 'as problem solvers in (a) understanding how to approach a problem, (b) identifying the appropriate schema for organizing the information, (c) recognizing there may be more than one right way to solve the problem, and (d) verifying their solutions' (p. 119).

At first glance, this appears rather confusing. Certainly, the findings of Higgins (2004) and Cardelle-Elawar (1992) are more similar to my own discovery – during the research conducted as part of the Thinking Skills module which first inspired me to undertake this study - of an increase of 43.75% in my lower-attaining pupils' understanding of fractions following my own Thinking Skills intervention. It is therefore interesting to note some of the details in the work of both McGuinness (2006) and Hu *et al* (2010), which could begin to explain these discrepancies. For example, lower-attaining children constituted just 20% of the pupils considered in the investigation reported by McGuinness. In addition, McGuinness appears to have measured the impact of the Thinking Skills intervention through 'self-rating measures' (2006: p. 3) suggesting the possibility that those who completed these self-evaluation simply failed to recognise a substantial change. However, crucially, McGuinness also reports that ‘When poorer children were given problems to solve they did show positive changes in their strategies compared to control children, but these specific achievements did not translate into how the children rated themselves more generally’ (2006: p. 3).

There is a similarly positive note in the work of Hu *et al* (2010), who, when examining the effect of the ‘Learning To Think’ initiative upon pupils’ learning strategies and motivation, found that ‘results showed that it had an unapparent effect on low-score students too’ (p. 21). Indeed, Hu *et al* conclude that the lack of positive impact on lower-ability pupils, far from being caused by the intervention, was instead the result of a shortcoming of the curriculum, recommending that ‘the curriculum and or its delivery by teachers needs some attention’ (both p. 21). Clearly, then, a Thinking Skills approach does appear to have the potential to positively influence lower-attaining pupils. Moreover, the evidence stresses that the importance of learning how to think is fundamental, particularly for lower-attaining pupils who ‘have virtually no idea of what they should do when they confront a mathematical problem, and [are often] unable to explain the strategies they use to reach a solution’, in contrast to those higher-ability pupils who will be precisely those who already ‘possess well-developed metacognitive skills’ (both Cardelle-Elawar, 1992: p. 109). Cardelle-Elawar (1992) stresses that ‘the key to a student’s learning lies in his or her own thoughts and actions. To learn, the student must practice thinking and not just apply procedures in a rote fashion’ (p. 119). In my opinion, a Thinking Skills approach is exactly this: an opportunity for pupils to shape their own understanding through talk and collaborative working, taking part, together, in those processes of translation, integration, planning and monitoring and solution execution, which best allow learners to develop skills in mathematical problem solving.

The argument in favour of using Thinking Skills to improve attainment for lower-attaining pupils is further bolstered by the work of Watson (2001), in which she outlines the importance of social-constructivist forms of working. Watson stresses that low-attaining pupils:

> ‘are especially likely to show dependence rather than autonomy and are unlikely to show initiative, that this increases over time, and may be unintentionally

> fostered by the tendency of many teachers to dominate classroom interactions, to be controlling, and in their teaching style to convey low expectations of their pupils' (2001: p. 140).

Watson adds that 'highly prescriptive methods of teaching run the risk of encouraging a passive attitude in pupils with learning difficulties, often with disappointing outcomes in their understanding and generalisation' (2001: p. 140). An argument in favour of Thinking Skills thus becomes almost an argument in favour of a complete overhaul of the roles of both teacher and pupil. Certainly, Hu *et al* (2010) suggest that 'learning to learn means taking over from the teacher the control and management of your own learning and thinking' (p. 7).

Whilst gains in progress and attainment are always an important goal for teachers, the primary focus of this investigation lies in pupils' experiences of Maths. Nevertheless, given the 'reciprocal relationship' (Sammons *et al,* 2008c: p. 10) between attitudes and attainment, it is hoped that, by improving achievement, pupils' opinions of the subject, their concept of themselves as mathematicians, and of Maths itself, will also become increasingly positive. Indeed, this view is supported by Ke and Grabowski (2007), who suggest the importance that collaborative working may hold for pupils' perceptions of Maths, particularly as 'group learning helps to remove students' frustration; it is not only a source for additional help but also offers a support network' (p. 250). Similarly, and perhaps most encouragingly, Hannula (2002) also believes that, whilst 'On the whole class level the efforts to reform teaching to promote desired attitudes have generally been unsuccessful […], recent evidence suggests that collaborative approaches can promote positive attitudes among students' (p. 26).

1.10 Implications

Having considered the evidence outlined in this chapter, it is likely that a Thinking Skills approach may provide an alternative to more traditional forms of Maths teaching, particularly those tedious, superficial and de-personalised methods which Nardi and Steward (2003) found inspired so much dissatisfaction. Nevertheless, despite this very positive picture, a cautionary note can perhaps be found in the work of Hoyles (1982), who indicates that

> ‘pupils in mathematics were particularly fearful and resentful of teachers who seemed to impose additional demands on them. Pupils were appreciative of a secure, encouraging environment in their mathematics lessons and liked teachers to provide a structured logical progression in their work, with plenty of patient explanation, encouragement and friendliness. Pupils, therefore, seemed to want teachers to 'make it easy' or 'tell them the way', perhaps in order to relieve any tension they might feel in their mathematics learning’ (p. 368).

Although it may, from a teacher’s perspective, provide consolation that ‘the provision of too much structure would probably discourage creativity and exploration in the subject and mitigate against pupils taking any responsibility for their own work and progress’, it nevertheless remains that, in Maths, pupils appear to be ‘extremely concerned with the outcome of their work, they wanted to 'do it', 'finish it' and 'get it right', but this very concern could mitigate against involvement in the subject itself’ (both Hoyles, 1982: p. 368).

This could suggest that, for some pupils at least, by taking pupils out of their ‘comfort zone’, and asking them to try something different, pupils’ experiences of Maths could, in fact, be negatively influenced, at least initially, following the introduction of a Thinking Skills approach. Thus, whilst it is to be hoped that, by educating pupils about the potential benefits that engaging in Thinking Skills activities may hold for their mathematical education, they may be encouraged to participate fully, it nevertheless remains to be seen how such a change will impact upon their opinions of Maths.

Chapter 2. Research Rationale

The evidence contained in the literature appears clear: a Thinking Skills approach, together with the increased emphasis upon collaboration, talk, and explicit discussion about learning, could potentially improve pupils' understanding and attainment in Maths. I therefore resolved to investigate this further, in order to more clearly ascertain the impacts of a Thinking Skills approach - with particular focus upon classroom talk and development of metacognitive awareness – upon:

1. progress and attainment in Maths.

2. pupils' opinions of Maths and their ability to succeed (self-concept).

3. pupils' understanding of the ways in which they learn Maths (the development of metacognition).

I believe that, together, these three distinct foci allow me, as teacher-researcher to construct a detailed picture of the potential that a Thinking Skills approach holds for the teaching of Maths in my particular working context. They also link to two of the principal causes proposed for the disaffection of pupils with Maths learning identified from the literature: success in work (Hoyles, 1982); and attitudes towards Maths (Kyriacou and Goulding, 2006; Brown *et al*, 2007).

It may also be important to note that this chapter was originally written in 2011, at the outset of this research. This study was later subject to a process of evolution, a development which I believe to be the natural result of my role as teacher-researcher, as well as a pragmatic acceptance of classroom and school realities. However, a fundamental element of this evolution was my developing understanding of research, evidence, and how this should be represented. Throughout the five years in which I have written this thesis, my understanding of the value of individual voices, and of authentic narrative, has grown significantly. I believe that to remove all traces of the progression of this study would almost amount to an attempt to obscure my learning as a teacher-researcher, and I have therefore maintained elements of this perspective where appropriate, unclouded by my subsequent experience, in order to give an authentic and messy narrative congruent with action enquiry.

2.1 The impact upon progress and attainment

The first facet of the research questions is, perhaps, the aspect of this investigation which will contribute most powerfully towards a judgment regarding the overall 'success' of the Thinking Skills approach. Progress and attainment data is the principal means by which - in our current results and statistics-driven education system - the impact of most educational interventions is measured. Education professionals constantly strive to improve outcomes for pupils in terms of S.A.T.s results and National Curriculum levels. This is the reality of the context in which we work and, as such, it is both natural and important that it is considered carefully in this investigation. Certainly, the research evidence indicates that Thinking Skills programmes 'are effective in improving pupils' performance on a range of tested outcomes' with 'an overall effect size of 0.62' (both Higgins *et al*, 2005: p. 3), Indeed, it is suggested that use of a Thinking Skills approach 'is relatively greater than most other researched educational interventions' (Higgins *et al*, 2005: p. 4), indicating the possible impact of an approach of this nature upon teaching and learning.

I am therefore interested to explore the potential of a Thinking Skills approach within my own classroom. Will the use of a Thinking Skills approach accelerate progress in Maths for my own pupils at West Side School? Will there be an impact upon end of Key Stage Two S.A.T.s scores? Furthermore, if the use of a Thinking Skills approach does impact positively upon attainment, will the effect of this be equal for all pupils, or will it be concentrated upon middle- and higher-attaining pupils - concurring with the findings of Hu *et al* (2010) - with 'no positive outcomes […] identified for children with poorer developed ability' - as found by McGuinness (2006: p. 3)? These questions will be investigated further throughout this study.

2.2 The role of self-concept

I believe that anyone who has spent time in the classroom or, indeed, can remember their own experiences of education, will recognise the importance of pupils' opinions and enjoyment of a particular subject - as well as their perceptions of their own success at it - to participation during lessons. Pupils' view of themselves as learners is commonly termed academic self-concept, and is defined as 'a set of structured self-attitudes that is relatively stable and "characteristic" of an individual' (Demo, 1992: p. 303). As the literature reviewed in the previous chapter demonstrates, there is a wealth of evidence supporting the relationship between self-concept and attainment, including the work of Hoyles (1982), Dweck (1986), Hannula (2002) and Brown *et al* (2007). However, as yet there appears to have been little consideration regarding the affect of a Thinking Skills approach upon pupils' views in general, or opinions of Maths specifically.

This study therefore aims to investigate the impact of a Thinking Skills approach upon self-concept in Maths. Based upon Nichols (2006) assertion that Thinking Skills 'can increase enjoyment and motivation' (p. 181) in Geography lessons, and Watson's (2001) similar claim that relating to pupils' enjoyment of challenges aimed at increasing reflection (p. 144), I hypothesise that a Thinking Skills approach will impact positively upon pupils' experiences of Maths. This hypothesis is bolstered by the stark contrast between the most cited causes of negative views held of Maths teaching and learning – a focus on '*individual* work and *rote learning*' (Brown *et al*, 2007: p. 3); and the 'invisibility to pupils of the mathematical process' (Picker and Berry, 2001: p. 88) – and the Thinking Classroom, with its focus upon collaboration, discussion and exploration of reasoning. Furthermore, the climate of a Thinking Classroom - one in which mistakes are welcomed as evidence of thinking and progress in learning, creating a community in which 'questioning and hypothesizing about learning experiences can occur' (Wall, 2014: pp. 3 – 4) - contrasts heavily with the images explored in Picker and Berry's (2001) study, depicting 'small children powerless before mathematicians' (p. 88).

I believe that a Thinking Skills approach therefore holds considerable potential for altering pupils' views of Maths, overcoming the 'anxiety, feelings of inadequacy and feelings of shame' (Hoyles, 1982: p. 368) which are frequently associated with negative learning experiences in Maths, in turn influencing self-concept. This study therefore aims to explore this question, and will also investigate the possibility of a 'reciprocal relationship' (Sammons *et al*, 2008: p. 10) between self-concept and achievement within my own classroom, in my ultimate aim to improve learning experiences for my pupils.

2.3 Involving pupils in research

Having outlined the purpose of research, it remains to determine how these questions will be investigated; how will I gain insight into the teaching and learning taking place within my classroom, and the impact this has upon pupils. I believe it is important to involve the pupils themselves - the consumers of the education we provide - about the education process. I agree with those such as Freire (1972) who suggests that an effective teacher is 'constantly readjusting his knowledge, who calls forth knowledge from his students. For him, education is a pedagogy of knowing. […] For the educator who experiences the act of knowing together with his students […] dialogue is the seal of the act of knowing' (p. 10). In addition, as a practicing teacher I am acutely aware that pupils are not passive recipients of learning, but rather active participants in the process, and, as a result, 'mutual interpretation' (Biesta, 2007: p. 8) is fundamental.

All too often we, as teachers, see pupils who fail to fulfil their learning potential due to a lack of engagement or motivation. This led Holt (1964) to compare pupils to 'convicts in a chain gang, forced under threat of punishment to move along a rough path leading nobody knew where and down which they could see hardly more than a few steps ahead' (p. 38). Therefore, if I wish to truly transform the teaching and learning of Maths, it is essential that I listen to - and respect - their views, and that they are considered as equal partners in this research process. I must strive to create an environment conducive to exploration, curiosity, and a genuine desire for learning, and I believe that, in order to do so, it is fundamental that I am honest with pupils about my own learning, both past and present, demonstrating that learning is a lifelong journey in which we should all participate, and which should never reach an end-point when we can say that we have learned 'enough'.

In light of these beliefs, I agree with Groundwater-Smith and Mockler (2007) that to employ ‘covert observations’ (p. 204), or to collect data on my pupils without their knowledge or consent would be highly questionable. This research is specifically concerned with the opinions and ideas of the pupils in my class and so, to gather these views without fully informing the children about the purpose for this would serve to undermine the fundamental aims of this research. Furthermore, since the U.N. Convention on the Rights of the Child was ratified in 1991, it is an important aspect of my pupils’ fundamental human rights that any child ‘who is capable of forming his or her own views should have the right to express those views freely in all matters affecting that child’ (U.N.C.R.C., 1991: Article 12). If I truly seek to improve the education experiences of my pupils – to ascertain what they think, value, and the challenges they face - then, surely, what better source of information could there be than to simply ask them?

This investigation deals with pupils’ experiences of learning Maths, and particularly with their metacognition – thinking about thinking. As Wall observes, ‘Metacognition, because of its inwardness, is difficult to observe. […] Even with adults it is difficult to identify and reflect on what metacognition is to them and with pupils this is increased’ (2008: p. 28). It is important to assume nothing, but rather to let the subjects of this investigation, the pupils themselves, to express their experiences in their own words. This belief is reflected in the selection of the data collection tools used to gather and reflect these experiences, as is evident later in this chapter. In addition to the spirit in which this research has been conducted, there was an additional motive which encouraged me to engage the pupils in discussion surrounding their learning of Maths. I believe that by openly discussing my research with the pupils, and by encouraging them to participate actively in the process of improving the teaching and learning of the subject, it would be possible to further develop their understanding of themselves as learners.

This view is supported by the work of Leat and Higgins (2002), Nichols (2006), Hu *et al*. (2010), and McGrane and Lofthouse (2010), all of whom suggest that ‘by verbalizing their reasoning they accept reasoning at a higher level than they start out with’ (Hu *et al.*, 2010: p. 5). In this way, talk ‘thus generates the potential for a feedback loop, which has the potential to raise attainment' (McGrane & Lofthouse, 2010: p. 94). This desire contributed to my use of pupil views templates - a tool designed by Wall and Higgins (2006) to explore pupils' thinking through uncovering evidence of metacognitive knowledge and skillfulness - precisely because these data collection tools provided a means through which pupils would be encouraged to think specifically about their learning of Maths, and, it was to be hoped, therefore develop metacognitive awareness and skilfulness. In this way, the pupil views templates were both a pedagogic tool – facilitating pupils' reflection upon learning – and a research tool – collecting information about pupils' experiences of Maths lessons.

2.4 My position as teacher-researcher

The decision to involve the pupils so openly in research raised important ethical considerations. How was consent to be gained from pupils, as well as parents? How could I ensure that pupils participated freely, rather than feeling obligated to do so because of my role as teacher? How would I ensure that my relationship with the pupils as their teacher would not affect the objectivity I would need to generate unbiased, reliable findings? Whilst these are all important considerations - and will be discussed in greater detail during the Methods chapter of this thesis – these issues are also part of a greater question: is it possible to separate myself from this research? Can I be sure that the findings gained from this investigation are the consequence of the Thinking Skills approach rather than my own involvement in this enquiry?

Quite honestly, I believe that the answer can only be: no. I am inextricably linked to this research in a myriad of ways: in planning the intervention; in teaching, questioning and facilitating learning; in evidence gathering; and in its analysis. Moreover, I believe that, in undertaking this research, I have become what Wall (2014) terms a metacognitive role model. In seeking to develop my understanding of my classroom, and in sharing my intentions with the pupils, I have positioned myself as a fellow learner. Indeed, like Wall, I recognise that 'practitioner enquiry comprises the same reflective and strategic thinking that we are asking student learners in our classrooms to embody' (2014: p. 6), and I believe that the sense of common purpose and of a more equal status may have been instrumental in creating the community of enquirers which I consider essential to the success of a Thinking Skills approach. Furthermore, Wall also explains that the fact that teachers in the Learning to Learn project, for example, were 'undertaking practitioner enquiry through action research projects was influential in supporting the teachers' professional learning and, in many cases, allowing them to open up conversations about learning to include not only the children's perspectives but also their own' (Wall, 2014: p. 5). This suggests that undertaking this research may actually have had the unforeseen advantage of enhancing discussions about learning.

I have now come to consider the impact of my assumption – which was, initially at least, largely unconscious – of the role of metacognitive role model as an additional, yet extremely important, facet of this research. I did not expect that sharing my own learning experiences with pupils would have such a profound impact of this investigation: at the time, this was something that simply came naturally. It made sense, in the course of our discussions, to be open and honest about what I wanted to learn and why. I felt that this was needed to fully inform pupils about the research that we were undertaking together, so that I could be sure that children, as far as possible, understood the purposes and process of research well enough to engage in it as co-researchers. However, I also felt quite strongly about the importance of ensuring that the children understood that learning wasn't just something that took place in school, in a classroom, but was part of a life-long journey. I wanted them to understand that I too had to do 'homework' and that I too sometimes found learning challenging, and that I needed to persevere and be resilient in order to achieve my learning goals. Yet I found, like the teachers featured in Wall's study, that the sharing of my anecdotes and speculations regarding my own learning, also prompted those of my pupils. As I realised this, I believe that I was, rather naturally, encouraged to engage in more frequent conversations of this nature, and that these discussions provided the foundations for our Thinking Classroom, encouraging both the pupils, as well as myself, to more regularly consider teaching and learning and how we could work together to enhance these.

Equally, as this research progressed, and certainly as I became more embroiled in analysing the data gathered and in writing this thesis, it became evident that my position as teacher-researcher held a further implication for this research. This thesis is, of course, primarily concerned with the learning of the children in the focus cohort. However, I have found that the outcomes of my own learning have not been limited to this. Instead, some of the most profound ‘light-bulb moments’ resulted from consideration of my beliefs surrounding education: my understanding of my own influence as a teacher as well as the nature of what constitutes ‘good’ evidence. Furthermore, because this knowledge is not limited to a specific context, but rather relates to me and a clearer understanding of myself and my position - it is amongst the most immediately useful – for me at least -outcomes of this research. The issue of how engaging in this research has affected me as a practitioner and as a teacher-researcher has – unwittingly - become a further element of this study, a hidden, or at least unexpected, research question, and this will therefore also be explored throughout this thesis.

2.5 Research Context

This study focuses upon the Maths learning of Upper Key Stage Two pupils within a primary school situated in a district of Newcastle defined as ‘broadly average in terms of social and economic advantage’ (OFSTED, 2008: p. 3). For the purposes of this thesis, I have termed this school West Side School. In 2011, when this research began, there were approximately 400 pupils attending West Side School, meaning that the school was one of the top 20% largest primary schools in the country[2]. However, in West Side School as a whole, only 13.6% of pupils were eligible for Free School Meals, placing it in the bottom 60% of primary schools nationally, with 3.1% of pupils at School Action Plus or with a Statement of Special Educational Needs, in the lowest 40% of schools. Attendance remained relatively stable between 2011 and 2013: at 94.8% in 2011 in-line with a national average of 94.9%; 95.1% in 2012 in comparison with the national average of 95.6%; and 94.8% in 2013 in comparison with a national average of 95.2%. However, although the attainment data for West Side School was broadly in-line with national averages, the school was placed in the bottom 20% in comparison with primary schools nationally. So, in short, West Side School is large for a primary school, with fewer than average socially

[2] Data and comparisons obtained from the Ofsted School Data Dashboard.

disadvantages pupils or those with Special Educational Needs. West Side nevertheless appeared to be slightly under-performing in terms of standardized attainment.

At the outset of this research, West Side School had a teaching staff of 20, including a senior leadership team (S.L.T.) of eight, comprising of a head-teacher, deputy head-teacher, three phase leaders, and Literacy, Numeracy and Assessment leaders. I taught in Upper Key Stage Two during the two-year research process, teaching in Year 5 in 2011 – 2012 academic year, and in Year 6 in 2012 – 2013. I also held a Teaching and Learning Responsibility (T.L.R.) during the second year of research for developing teaching and learning, a role which was created for me as a result of my involvement in educational research. West Side School was deemed to provide ‘a satisfactory quality of education’ (Ofsted, 2008) during the most recent Ofsted inspection prior to beginning this research, however a further inspection was carried out in May 2012, during which the school received an overall grading of ‘good’ (Ofsted, 2012).

This investigation spanned two academic years, during which the pupils in the focus cohort were aged between 9 and 11, in Years 5 and 6. During the 2011 – 2012 academic year, when this investigation began, the number of children fluctuated between 36 and 37 pupils. Although the year began with 36 pupils, two girls left before October half term. There were also three new admissions to the school during this period: a boy in September 2011, a girl in January 2012, and a further boy in March 2012. These changes to pupil numbers continued during the second year of research: two children (one boy and one girl) left Class 2 in September 2012, whilst another girl joined this same class. These changes in pupil numbers can be seen in the table below.

	September 2011		July 2012		September 2012		July 2013	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Girls	9	11	7	12	7	13	7	12
Boys	8	8	10	8	9	8	9	8
Total	17	19	17	20	16	21	16	20
Cohort total	36		37		37		36	

Table 2.1 Changes to pupil numbers

Class numbers were small because a sizeable number of pupils left West Side Primary to join the middle school system in a neighbouring Local Authority. This was an ongoing trend following the reorganization of a local first school and middle school to form West Side Primary in 2004. This pattern was attributed to parental perceptions of the feeder Secondary school, and thus, despite stability in the school being slightly above national averages, 24 % of Year 4 pupils transferred to a neighbouring Local Authority middle school, meaning that the year group featured in this case-study decreased from 50 pupils in July 2011, to 38 in September 2011, and then to 37 in July 2013.

The changing population of West Side's Year 5 cohort had considerable implications for teaching and learning. Of the twelve pupils who left the school in July 2011, 75% were attaining above national expectations when they left West Side school and were predicted to achieve a National Curriculum Level 5 in Maths at the end of Key Stage Two. Similarly, the two girls who transferred to different schools during October 2011 were also working above national expectations, and were also expected to achieve Level 5 in Maths by the end of Year 6. Of the remaining pupils in Year 5, none had achieved Level 3 at the end of Key Stage One in Maths. The highest-attaining pupils remaining in Year 5 were the higher end of the middle-attaining group in Year 4.

It is also important to note that the low rates of children eligible for Free School Meals, who were working at School Action Plus, or who had a Statement of Special Educational Needs for West Side School as a whole were not necessarily representative of the children who took part in this research. For example, whilst 16.1% of pupils in West Side School as a whole were eligible for Free School Meals, the figure in the focus cohort was somewhat higher: 36.1%, comparable to the top 40% of schools nationally. Similarly, whilst 3.1% of pupils in the school as a whole were working on School Action Plus or had a Statement of Special Educational Needs, the figure for the focus cohort was 19.4%, a figure which would have placed it in the top 20% of schools nationally had it been for the school as a whole[3]. One of these pupils was a boy with severe learning difficulties who was working at Level 1c upon entry to Year 5, significantly below the expected ability range, and, consequently, he received a personalised curriculum for both Literacy and Numeracy,

[3] All data was obtained from Ofsted's School Data Dashboard.

delivered on a one-to-one basis by a Learning Support Assistant (L.S.A.). This boy was therefore exempted from the research described here and, indeed, left the mainstream school system in September 2012 to join a special needs school in the local area, thus for the purposes of this research, the number of pupils in Class 1 is given here as 17 from September 2011.

The percentages of children from each class working at each of the levels of attainment for Maths upon entry to Year 5 can be seen below.

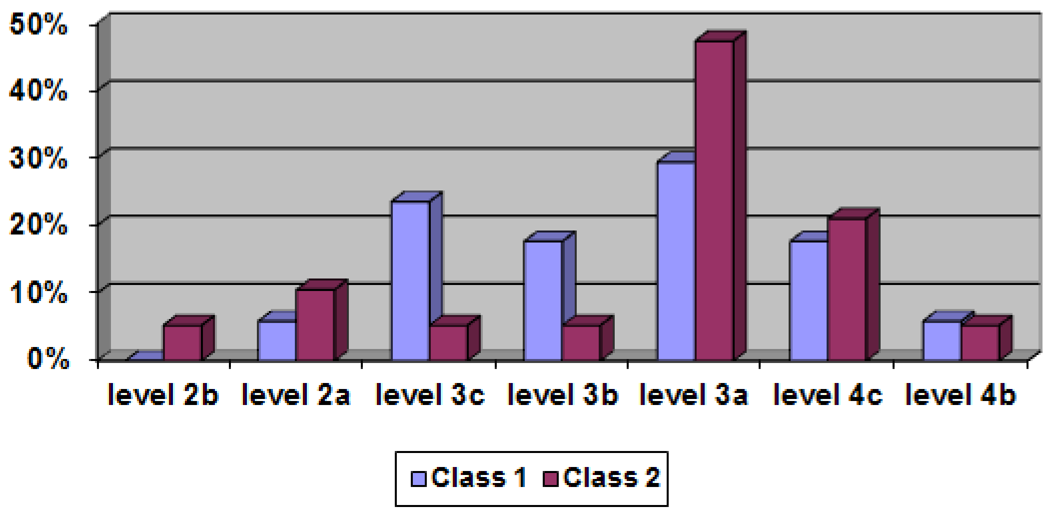


Figure 2.1 Attainment upon entry to Year 5 (September 2011)

Children were taught in their class groups for Maths, a departure from the setting which had been used for the teaching of Maths for several years prior to the beginning of this research. This decision was taken by West Side's Senior Leadership Team as a result of the small class sizes and the relatively narrow attainment range in the two Year 5 classes. However, as the graph indicates, there was a considerable difference in the number of children working above age-expected levels upon entry to Year 5, with 73.68% of Class 2 working at Level 3a or above, compared with just 52.94% of Class 1.

Maths was taught for 70 minutes each day, with each lesson containing both a 10 minutes mental Maths session, as well as the 60 minutes Maths lesson. Learning objectives were taken from the 'Primary Strategy for Mathematics' and generally followed the suggested outline for teaching set out in that document[4]. Additional objectives and information to support the pitch of lessons was obtained from ‘Teaching Children to Calculate Mentally’, and the ‘Assessing Pupils’ Progress’ (A.P.P.) documents. Pupils’ progress in Maths was assessed at regular intervals throughout the academic year. This progress was again measured in National Curriculum levels and sub-levels, and was generally taken from information gathered through use of past S.A.T.s papers, teacher observations, and independent work focused on one or more of the learning objectives described above.

During the first year of research, throughout the 2011 – 2012 academic year, I was responsible for teaching Class 2, as well as the planning of all Maths lessons. A colleague with 10 years of teaching experience taught Maths to Class 1, following the planning which I prepared. Support was provided by one Learning Support Assistant (L.S.A.), and was shared equally between both Year Five classes. During the Spring Term (January to April 2012), one Maths lesson per week was taught by experienced P.P.A. staff[5] who also followed this same planning. A diagram of these teaching arrangements can be found in Figure 2.2.

[4] Examples of planning can be found in Appendix A.
[5] P.P.A. is the planning, preparation and assessment time given to all teachers on a weekly basis. During the Spring Term, Year Five teachers received this time on Wednesday mornings. This P.P.A. time was covered by the same experienced members of staff each week.

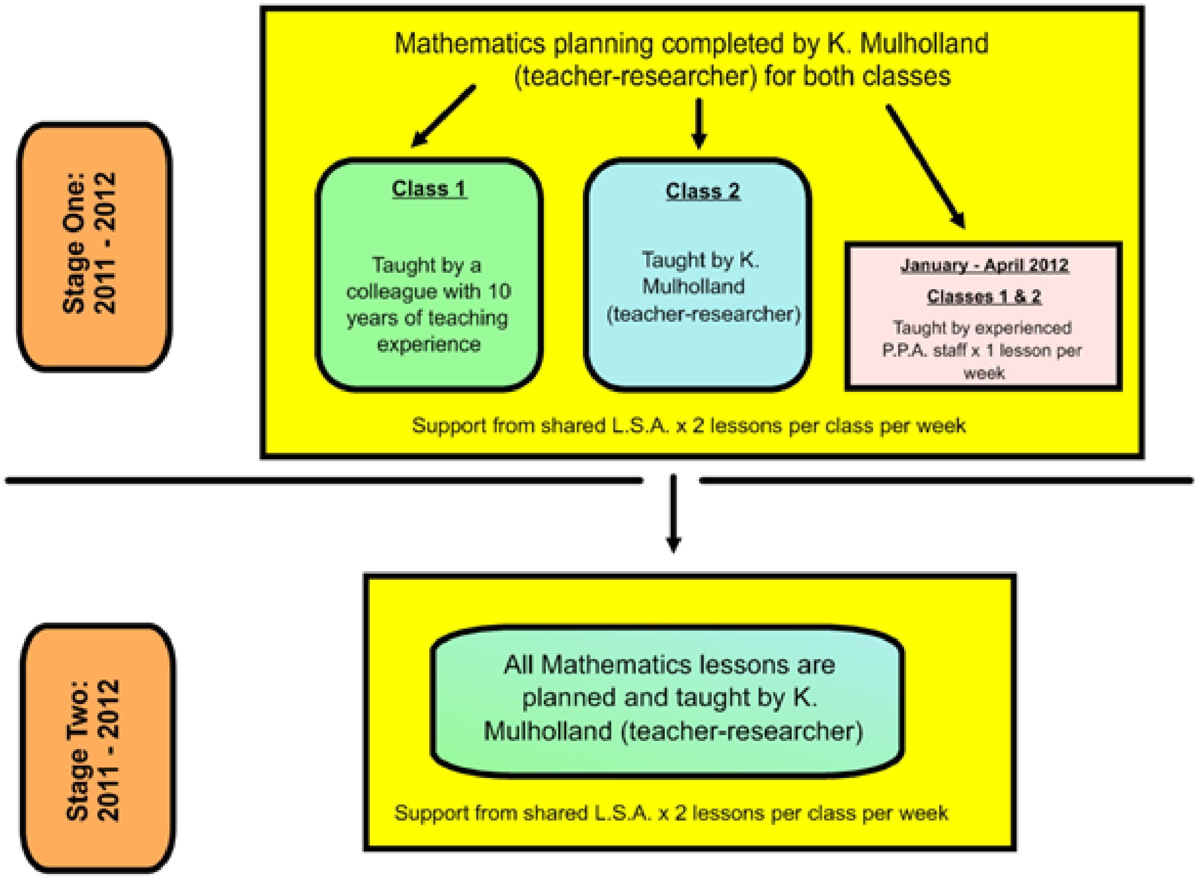


Figure 2.2 Teaching arrangements during the research period

It is also important to note that, for some Maths lessons, both classes were taught together, with members of staff working collaboratively to deliver the chosen objectives. These shared lessons became increasingly common as we progressed through the research, and responded to the growing gap in attainment between the two classes, as well as the opinions and wishes of the pupils themselves. Throughout the second year of research, during the 2012 – 2013 academic year, I moved with the pupils of the focus cohort into Year 6, where I planned, and subsequently taught, all Maths lessons to the pupils in both classes. A colleague - a different year group partner from the 2011 – 2012 academic year - taught all Literacy lessons to both classes of the focus cohort.

2.6 The Thinking Skills approach

The Thinking Skills approach I employed was inspired by the module I studied at Newcastle University during the 2010 – 2011 academic year. At the time, this module was led by Dr Rachel Lofthouse, and drew from the work of those such as Professor David Leat, Professor Steve Higgins, and Professor Carol McGuinness, amongst many others. My interpretation of Thinking Skills characterises it as a guiding principle for teaching rather than a particular set of activities. Prior to adopting a Thinking Skills approach, lessons were loosely based upon the structure outlined in the Numeracy Hour, proposed in 1999 by the DfES. An outline of a lesson of this type can be found below:

Time	Activity	Additional information
10 mins	Mental Maths games	These were focused on objectives taken from the 'Teaching Children to Calculate Mentally' document for the relevant year group. Activities were predominantly game focused, or consisted of rapid recap and practice of a key mental concept. Examples of objectives taught in Year 5 include learning to 'Multiply and divide whole numbers and decimals by 10, 100 or 1000, e.g. 4.3 × 10, 0.75 × 100, 25 ÷ 10, 673 ÷ 100' or 'Multiply or divide by 4 or 8 by repeated doubling or halving'.
15 – 20 mins	Introduction of the focus for the lesson	At this point in the lesson, I would introduce the learning objectives and success criteria for the lesson. Objectives would be taken from the Primary Strategy for Mathematics. I would explain a key concept to the pupils and provide some key example questions which I would model, and then we would work through subsequent examples together until I was satisfied that pupils had sufficient understanding of the concept to undertake the independent task.
25 – 30 mins	Independent task	Children would work (usually on an individual basis) to solve a series of questions related to the learning objective for the lesson. Typically these questions would be differentiated to provide three different levels of challenge for pupils. The level of challenge completed by each child for any given lesson would be pre-determined by the teacher based on previous assessment judgments as well as observations of how different children had grasped the concepts introduced during the introduction to the lesson.
10 – 15 mins	Plenary	Typically, this part of the lesson would provide an opportunity for pupils to apply the skill practiced during the independent part of the lesson in a new context. This could consist of a game or a word problem, or could perhaps extend learning to give pupils insight into the way in which that day's learning would be built upon during the subsequent lesson.

Table 2.2 An example of a typical Maths lesson prior to the introduction of the Thinking Skills approach

It is also important to note that children were largely seated according to their attainment (i.e. with groups of pupils working at a similar academic level) within the classroom, although exceptions were made to account for behavioural needs in order to ensure that pupils requiring additional support had more frequent access to this from either myself, as class teacher, or from our class learning support assistant. Moreover, the 2010 – 2011 Year 5 cohort (the cohort immediately preceding the pupils which featured as the focus cohort for this study), were taught in ability 'sets', further limiting the range of attainment within the classroom.

In contrast, lessons using the Thinking Skills approach which I adopted during this research followed a looser and more flexible format, allowing less time for teacher-led talk or modelling, and more opportunities for pupils to discuss their learning, both in terms of the objectives and learning outcomes, and for comparison and analysis of the strategies and methods used. The explicit planning for increased opportunities pupils to work collaboratively, discussing their thinking and learning and this corresponding decrease in the proportion of time allocated to teacher-led talk was a deliberate attempt to shift the balance of talk from myself, as teacher, to the pupils themselves. Furthermore, I hoped that this increase in collaboration would also serve to facilitate the development of metacognition, following the advice of Schwartz *et al* (2009) who maintain that 'Working with another […] can lead to more metacognitive behaviors than completing a task oneself' (p.10).

In addition to this, I introduced the children to a range of questions to probe thinking, based on Bloom's Revised Taxonomy (Krathwohl, 2002). I hoped that this would enable me to provide the explicit training regarding different question types which Chin (2004) believes necessary to fully developing pupils' understanding of the different categories of question types and the disparate types of thinking which can be elicited using each type. I reasoned that the introduction of these routines would enable pupils to gain that deeper, relational understanding that Fisher (1995) believes can be fostered through a Thinking Skills approach. An outline of a lesson of this type can be found in Table 2.3.

Time	**Activity**	**Additional information**
10 mins	Mental Maths games	These were focused on objectives taken from the 'Teaching Children to Calculate Mentally' document for the relevant year group. Activities were predominantly game focused, or consisted of rapid recap and practice of a key mental concept. Examples of objectives taught in Year 5 include learning to

		'Multiply and divide whole numbers and decimals by 10, 100 or 1000, e.g. 4.3 × 10, 0.75 × 100, 25 ÷ 10, 673 ÷ 100' or 'Multiply or divide by 4 or 8 by repeated doubling or halving'.
2 - 3 mins	Introduction of a problem or task	A problem was shared with pupils – children read this for themselves wherever possible. Children began working towards this with their Maths team (by first reading the problem together and deciding how to proceed).
45 – 50 mins	Group work	Children worked collaboratively to discuss and solve a range of problems. Usually, lessons consisted of a series of tasks which became progressively more difficult, with the vast majority of children beginning at the same starting point and working through the same tasks, rather than being restricted to a set of tasks deemed appropriate by an adult. Children self-managed the pace at which they moved through these tasks – they were readily available in numbered piles within the classroom and children were expected to help themselves to the next problem when this was needed.
Throughout the lesson	Mini-plenaries	Mini-plenaries were used to share key concepts and information with pupils. Typically, the first mini-plenary of any lesson would consist of a brief initial summary of our learning focus for that particular day – what the problem involved and key methods and strategies which would be needed. However, the majority of mini-plenaries were pupil led – allowing pupils the opportunity to share 'breakthroughs', as well as problems commonly encountered by the class as a whole and strategies for overcoming these. Although, as teacher-researcher, I would be responsible for drawing the attention of the class and inviting a particular individual or group to go share an observation or demonstrate a particular method on the class whiteboard, children were encouraged to actually lead these mini-plenaries: they did the majority of the talking, supported by teacher questioning if necessary. These opportunities were used to allow children to share their own views: to ask their own questions; to challenge each other if they heard something they disagreed with; and to explain alternative methods and strategies where appropriate.
8 - 10 mins	Plenary	At this point, the children and I would discuss together what we had learned throughout this lesson, creating a shared list of learning outcomes. These featured both mathematical learning, as well as more general learning which could encompass skills for successful collaboration or relating to other curriculum areas. Children would end each lesson with a reflection, summarising what they had learned and how they felt about their progress during the session, sharing these in discussion with their groups and, sometimes, with the class as a whole, and also recording a written comment in their books.

Table 2.3 An overview of a typical Thinking Skills lesson

I believe that these Thinking Skills lessons marked a sizable departure from the lessons typically used in West Side School in general for several reasons:

1. The nature of tasks used
2. The emphasis placed upon talk
3. The use and organisation of collaborative groups
4. Teacher talk and questioning
5. The emphasis placed upon reflections about learning

Each of these key aspects of the Thinking Skills intervention will be explored in the subsequent sections of this chapter.

2.6.1 *The nature of tasks*

The tasks used as part of the Thinking Skills intervention were subtly different to those I had routinely employed prior to the 2011 – 2012 academic year. Principally, this is because I ‘tweaked’ tasks in order to make them more open in an attempt to counteract the perceived rigidity of Maths. I wished to provide open-ended problems which had various possible solution paths, hoping that, like the teachers at Railside School, I would find that ‘when there are many ways to be successful, many more students are successful’ (Boaler, 2006: p. 42). I also hoped that, by reducing my use of problems with fixed right or wrong answers, I would be able to increase opportunities for children to discuss their work: the strategies they used, solutions they reached, and the concepts they explored. I hoped that, in this way, I would ultimately be able to alter children’s perceptions of Maths itself, increasing their resilience and skills of problem solving, and reducing or removing their fear of challenge in the subject, which Dweck (1986) suggests, for children with performance goals, may affect the level of challenge they will willingly undertake.

As a result of this decision, a key aspect of the Thinking Skills intervention was the dramatic increase in the proportion of lessons dedicated to problem solving. At least one lesson each week focused explicitly on allowing pupils to solve problems in a variety of contexts. These took place each Friday and were taught to both classes of the focus cohort simultaneously. Problems were primarily taken from the ‘Mathematical Challenges for More Able Pupils’ document. Examples of these problems can be found below:

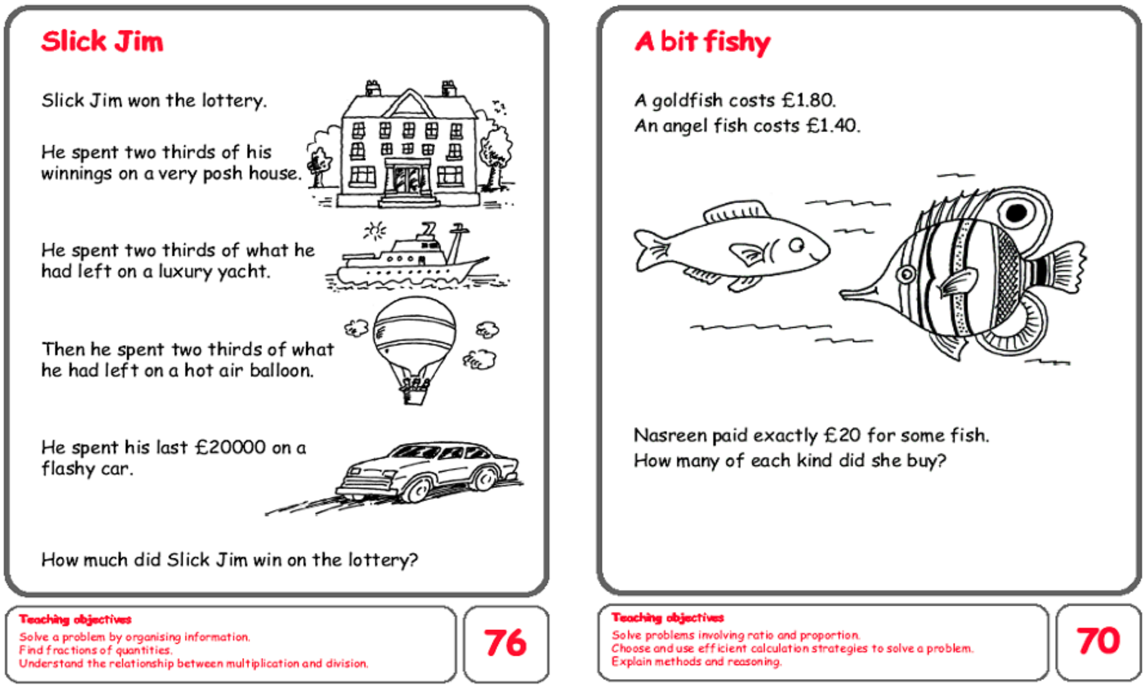


Plate 2.1 Examples of the weekly problem solving tasks

Typically, the Friday problem solving lessons would consist of just one of these problems. Children would work in their Maths teams of three, mixed-attaining pupils to solve these problems. As they did so, they were encouraged to add notes and diagrams to explain their reasoning, record questions they posed themselves as part of their thinking, as well as explanations of any mistakes they made and the reasons why they knew that these initial strategies or answers were incorrect.

In addition, I also developed ways to ensure that additional objectives outlined in the Primary Strategy for Mathematics – which I was obliged to adhere to as a result of West Side School policy – could be delivered in a more open-ended fashion. For example, for a lesson practicing the methods of written, column addition – to meet the Year 5 objective of using efficient written methods to add and subtract whole numbers and decimals with up to two places - rather than a simple list of calculations to solve, children could be presented with the following task:

Can you find a pair of numbers with a total of 50?

22.75	23.82	32.81	17.74
32.06	11.97	14.14	32.62
14.83	41.73	22.39	13.58
26.18	23.8	32.25	17.06

Plate 2.2 An example of a task given to the focus cohort

Rather than simply completing mechanical practice of a written method, this task also encourages pupils to develop skills of perseverance and resilience – because it is necessary to try various combinations of numbers in order to check for the most suitable solution – as well as opening opportunities for discuss of strategies for narrowing the possibilities for finding the pair of numbers closest to 50 – for example through rounding and estimation using mental methods prior to selecting a pair of numbers to add using a formal written method. Similarly, for multiplication, children could be provided with the following prompt:

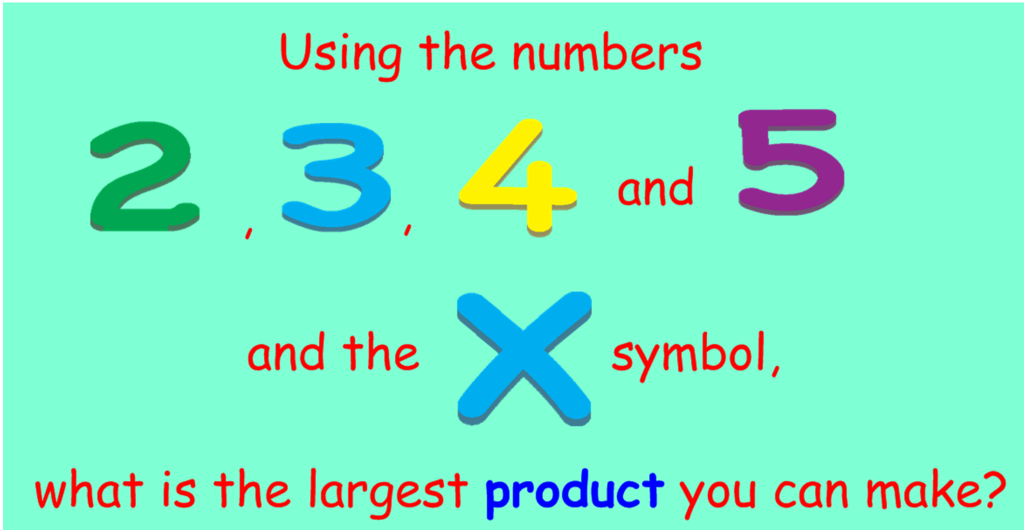


Plate 2.3 An example of a multiplication task given to the focus cohort

Again, this task, whilst still providing pupils with the opportunity to develop a written method for multiplication, moved far beyond the mechanical practice which would have been offered by a simple list of calculations. It created space for an enormous amount of exploration, not just by providing near a source of numerous calculations (when including all of the various 'extension challenges' for this task, such as by altering digits or perhaps using digits more than once), but also by digging deeper into the rules and patterns of multiplication (for example, where to place larger digits for maximum effect, or the multiplication of two two-digit numbers in comparison with a three-digit number and a single digit).

Crucial to this lesson were the questions which accompanied it. These were also displayed on the smartboard for children to discuss whilst working, and were explored during mini-plenaries and the final plenary of the lesson. They include: 'How do you know you've found the largest product?', What calculation did you start with? Why?', 'How did you organise your recording?', 'What was your best strategy?', and 'How can you prove your answer?' These questions also served to model the types of questions that I hoped pupils would incorporate into their discussions, and were particularly important in light of the work of Biddulph *et al* (1986), King (1994), and Chin (2004), all of whom emphasise the importance of teacher modelling in developing pupils' questioning skills. Providing pupils with questions of this nature was also inspired, in part, by the work of Schraw (1998) and description of the regulatory checklist, which consists of a series of questions which pupils would use as a prompt to consider three main categories of metacognition - planning, monitoring, and evaluating – which Schraw maintains 'enables novice learners to implement a systematic regulatory sequence that helps them control their performance' (1998: p. 120).

I believe that it was also extremely important that this task could be accessed at a range of levels – from the multiplication of two single-digits (e.g. 2 x 5), to the multiplication of three-digit numbers and even decimals – allowing the children themselves to select a level of challenge with which they felt comfortable, rather than this being imposed upon them by the differentiated tasks provided by an external assessor (in this case me, as teacher). This was particularly important because of the potentially damaging effects – identified by Chanan (1970) and Kelly (1975) – of teachers' judgments regarding pupils capabilities, with Kelly suggesting that 'far from catering from differences of ability, it creates such differences itself' (1975: p. 8). Instead, during the Thinking Skills intervention, the vast majority of children worked towards the same tasks, although, as I have explained above, the level at which they accessed these tasks could vary. As a result, it was possible for children to progress and substantially develop learning of a specific objective within a task, by initially accessing this task in a rather superficial way, and then progressing to a deeper, more complex understanding of the concept involved. Only children who had vastly different needs – those with Special Educational Needs (S.E.N.) and Individual Education Plans (I.E.P.s) - required different tasks from the remainder of the class, and even these were planned in the same way as the tasks outlined above, although perhaps with, for example, altered numbers to enable pupils to access the task at an appropriate level.

In light of this shift, the level of challenge that tasks presented for pupils became highly important. Donaldson (1978) and Wright and Taverner (2008), for example, suggest the need to ensure that tasks provide children with the opportunity to master difficulties and to overcome mistakes so that they are encouraged to work at a level above their current capability, pushing them out of their comfort zone and into Vygotsky's (1978) Zone of Proximal Development. This is crucial. Too often, differentiation in Maths limits pupils by lowering expectations, particularly for lower- and middle-attaining pupils, thereby limiting their potential achievements as a result of the tasks we allow them to undertake. Instead, tasks used as part of the Thinking Skills approach were deliberately pitched at the highest-attaining pupils in the focus cohort (at the beginning of Year 5, this was Level 4a, with pupils rapidly moving into Level 5). Although this was above the level of current competence of the majority of the focus cohort, differentiation was provided for pupils in the form of the level of support provided by teacher questioning, or, crucially, by the way in which they interacted with their collaborative group. Depending on their current level of understanding and confidence, pupils could take a leading role in explaining and questioning team mates, or could become more of a follower of the instructions given by others, for example, by recording the steps in working needed to solve a given process.

2.6.2 *The importance of talk*

As the literature in the previous chapter demonstrated, opportunities for pupil talk are essential to the success of a Thinking Skills approach. Talk is the means 'through which metacognition develops. Metacognitive talk thus generates the potential for a feedback loop, which has the potential to raise attainment' (McGrane & Lofthouse, 2010: p. 94). Opportunities for talk were planned in various forms. These included the use of talk partners during whole-class sessions, as well as encouraging pupils to work collaboratively in groups during Maths lessons. This increased use of group-work – predominantly in groups of three pupils of mixed gender and attainment following the work of McGregor and Gunter (2006) - represented a considerable departure from previous Maths teaching, where pupils were expected to work individually to allow teachers to gauge the level of understanding of each individual pupil. It is also important to note that even when opportunities for talk were not explicitly detailed in the planning of lessons, pupils were actively encouraged to discuss their learning with others in the course of lessons. This became a fundamental element of our classroom routine, pervading all aspects of the curriculum in addition to Maths lessons.

Initially, I believe that pupils found the increased emphasis upon talk rather confusing. Previously, I believe that they associated talk during lessons with a lack of focus: it was viewed as a negative behaviour, something to be avoided or to undertake surreptitiously as, if it was discovered, it was likely to lead to reprimands or sanctions. Consequently, it was important to outline my expectations, as well as to share my beliefs regarding the benefits of talk for learning. My year group partner and I therefore spent a large portion of one of our earliest lessons together discussing talk and how it could help the children make progress. We briefly discussed brain development and how this can be fuelled by talking about learning. We then wrote our own class slogans (for example, Class 2 selected '2 brains are better than 1, 3 brains are better than 2!’) and displayed these above the smartboard in each classroom as a constant reminder for pupils.

We also created a dedicated section on our Maths ‘working wall’ on which we displayed effective questions - inspired by Chin’s (2004) suggestion of prioritising displays dedicated to questions within the classroom, and initiatives such as encouraging children ‘to supply 'questions of the week'’ (p. 111) - and conversation prompts which could be used during discussions about learning. Following this initial introduction, children were given frequent reminders about the importance of talk and of asking and answering each other’s questions, recapping key benefits, and were also given prompts to remind them to do so as part of the regular instructions given by adults to pupils. Furthermore, West Side School’s regular rewards system of merits was used to help encourage pupils to engage in discussions about learning. For example, my year group partner and I awarded merits for particularly effective group talk, taking care to explain to the rest of the class the type of talk which had been used as well as why this was useful.

2.6.3 *The organisation of collaborative groups*

Because of the importance of increasing the frequency and quality of pupil talk, collaborative groups were incorporated into every single Maths lesson following the introduction of the Thinking Skills approach. Various groupings were used during lessons, varying from informal ‘talk partners’, chosen by the pupils themselves on a lesson-by-lesson basis, as well as more formalised trios chosen by myself as teacher-researcher, taking into account not only the ability of the pupils, but also their behaviour and friendship groups in an attempt to maximise the likelihood that all pupils would participate actively within their individual groups. Mixed-attainment groups were used for collaborative working because of the ‘support network’ (Ke & Grabowski, 2007: p. 250) and opportunity to work with ‘peers who would stimulate their thinking’ (Boaler, 2009: p. 33) that such groups can provide for lower-attaining pupils. This also followed the success that McGregor and Gunter (2006) experienced with similar groups when investigating the impact of the C.A.S.E. professional development programme.

Formalising networks for collaboration was initially seen to be important because of the strong message it conveyed to pupils about the ways in which I was now expecting and encouraging them to work, dispelling any possible misunderstandings that pupils may have about ‘copying’ and the need to complete individual work, which they often perceived should be carried out within a quiet, if not silent, classroom environment. By encouraging pupils to talk to one another about their learning, I aimed not only to create a classroom climate which would promote the talk which I believe essential to improving pupils’ reasoning skills, as well as the articulation of this understanding, but also tap the potential of peer influences upon learning. Hattie (2003), for example, has previously written that ‘the influence of peers is minimal’, concluding that this was the result of the ‘under-utilisation of peers as co-teachers in classrooms, and the dominance of the adult in the room to the diminution of the power of the peer’ (both p. 2). In contrast, I sought to create an atmosphere in which pupils were free to co-construct shared understanding through discussions about learning.

These groups were always chosen by me, as teacher researcher, in conversation with my year group partner and learning support assistant, taking into account the pupils’ friendships, social, emotional and behavioural needs, as well as their current level of attainment. As I have outlined during the previous section, I was explicit about my beliefs regarding the benefits of talk for learning with the focus cohort, and so they were already familiar with my expectations regarding discussions during lessons, and had also come to recognise themselves that ‘2 heads were better than 1, 3 brains are better than 2!’. To remind us all about these groups, we added a Maths Team aspect to our Maths ‘working wall’ display with the names of the different teams. Groups were changed frequently, at least once each half term, to allow pupils opportunities to work with peers with a range of styles of thinking and learning.

Again, I found that it took some time for pupils to truly begin to work together effectively. I found that pupils' habits of producing their own, individual piece of work was ingrained and that, even when asked to work collaboratively, they tended to discuss, in part, the task that they were undertaking, but continued to work largely individually. Interestingly, this resonates with the work of McGregor and Gunter (2006) who report the description of a Science teacher who found that 'the usual expectation in science lessons of pupils having to write everything to be learned was constraining' adding that 'writing limits thinking' (both McGregor & Gunter, 2006: pp. 41 – 42). To counter this, I began giving groups a single piece of paper and a single pen. This simple strategy forced the pupils to work together collaboratively, sharing their ideas much more freely and discussing strategies and methods as they worked. An example of pupils working in this way can be seen in Plate 2.4.

Plate 2.4 Pupils working together towards a shared task

Just visible in this picture is another key scaffold which was given to pupils at the outset of research to support the development of their collaborative work during the introduction of the Thinking Skills approach. This is the multi-coloured question prompt visible underneath the pupils' work, consisting of question prompts based upon Bloom's Revised

Taxonomy (Krathwohl, 2002), which was laminated and attached to pupils' desks to provide a reference tool during discussions. An example of this prompt can be found in Plate 2.5.

Which levels of thinking are you using?

Remembering	What happened after ...?
	Which is the best one?
	How did ... happen?
	What does it mean?
Understanding	What is the main idea of ...?
	How would you explain ... in your own words?
	Which facts or ideas show ...?
	How many examples can you find to ...?
Analyzing	What do you think about ...?
	What is the relationship between ...?
	What evidence can you find to ...?
	What conclusions can you draw ...?
Applying	Which approach would you use to ...?
	What would happen if ...?
	Can you explain why ...?
	How is ... related to ...?
Evaluating	What are the alternatives to ...?
	What do you think about ...?
	Is there a better solution to ...?
	What is the most important aspect of ...?
Creating	How would you test ...?
	Can you improve ...?
	Can you formulate a theory to explain that ...?
	Which changes would you make to solve ...?

Plate 2.5 Question prompt reference tool

This question prompt was considered particularly important as it provided a means of modelling appropriate questions to pupils, following the advice of Biddulph *et al* (1986), King (1994), and Chin (2004). This tool was also intended to follow the process of guided cooperative questioning proposed by King (1994) in which children are provided with prompt cards containing a variety of question stems such as before working in small groups or pairs to pose and respond to each other's questions. In order to ensure that the different types of question – and the distinct responses that these may therefore elicit – were understood by pupils, upon first introducing the focus cohort to this tool, my year group partner and I discussed the different questions with the pupils in order to identify similarities, differences, and to consider situations when each question could be used.

Questions of this nature were also added to the Maths 'working wall' display and, again, West Side School's existing merit system was used to reward groups who used a range of these questions effectively during their collaborative work. Encouraging pupils to use a range of questions of this type was intended to help pupils develop their interactions because, upon beginning to work in collaborative groups, it quickly became apparent that pupils were unsure about how to discuss their learning with their peers. Conversations were rather superficial, asking for answers or perhaps inquiring what a group member was doing, but rarely exploring the reasons behind this. The questions contained in this prompt were particularly useful as they encouraged pupils to vary their discussions, engaging with their learning at different levels of thinking. It was also invaluable in helping children to develop their own questioning skills, and, indeed, pupils became so much more confident in asking a variety of questions that the prompt was no longer needed during the second year of research.

In a further attempt to increase the success of pupils' collaboration, upon the introduction of these groups, one lesson in its entirety was given over to discussion of group work. As a year group, we discussed rules for successful working, creating a shared list for display upon our Maths 'working wall' display. Whilst we did not go as far as following the structure used by McGregor and Gunter (2006), under which each participant describes, in turn, their views, which are then evaluated in order to reach a group consensus, the importance of ensuring that the views of all group members was frequently emphasised. Children were encouraged to consider the 'fairness' of unequal participation in tasks, and agreed on questions that could be used within the group to encourage other members to share their views and participate more actively. These resources remained on display throughout the academic year, and were referred to when necessary. Subsequent discussions surrounding successful group work were also held sporadically throughout the year in response to issues arising during lessons, usually as part of the discussions during mini-plenaries.

One discussion focused on strategies which could be used when the groups were 'stuck' to avoid relying upon adult intervention. Whilst some of the suggestions offered by pupils were firmly rooted in the context of Maths lessons, such as try "Trial and error" or "Use R.U.C.S.A.C."[6],others were indicative of more general reflections such as "Ignore any distractions" or "Try again!"[7]. These suggestions were recorded in one shared list and were added to the Maths 'working wall' display as a prompt for the groups. In addition to this, I also introduced a 'C3B4Me' ('See three before me') mnemonic to encourage pupils to first try to resolve their own difficulties before appealing to an adult. This was particularly important because of the challenging nature of the tasks used by the children; in order to ensure that pupils were working in the Zone of Proximal Development proposed by Vygotsky (1978), pupils were provided with challenges that required them to work at a higher level of understanding than they were accustomed to. As a result, many children were tempted to seek help or to give up in the belief that they were incapable of successfully completing the task, and it was therefore important to encourage pupils to persevere within their groups to develop their understanding.

Pupils within each group were also loosely assigned roles to fulfil. This technique was based upon a strategy for developing effective group work in which pupils are each given a card[8] which requires them to act as 'leader', 'questioner', 'scribe', or 'summariser', amongst other defined roles. To help scaffold interactions, lower-attaining pupils were initially asked to act as the group's 'scribe', requiring them to pay close attention to any discussions. This also ensured that these pupils completed any necessary calculations, with the support and guidance of the other members of their group, providing them with additional opportunities to practise the mechanics of Maths whilst simultaneously using these in context or problem-solving activities. However, as time went on, particularly as the second cycle of research progressed, I found that pupils became more familiar with

[6] A mnemonic for remembering the steps in solving word problems: **R**ead, **U**nderstand, **C**hoose a calculation, **S**olve, **A**nswer, **C**heck.

[7] The full list of these suggestions can be found in Appendix B.

[8] This is a technique commonly included in Thinking Skills training. It can also be found in resources created and shared by teachers on forums such as the Times Educational Supplement (T.E.S.) website, such as the cards produced by makesensetraining, which can be accessed at www.tes.co.uk/teaching-resource/group-work-role-cards-6047778.

collaborating successfully as a group, and interacted more freely with each other, without requiring the allocation of specific roles within the group.

2.6.4 *Teacher talk and questioning*

As a result of the shift from individual to collaborative working, relying upon pupils to work together to construct shared understanding of mathematical concepts, the role of the teacher must undergo a substantial overhaul. Thus, instead of relying on more traditional lesson structures - in which concepts are introduced by the teacher and practised by the class as a whole, before individuals complete practice exercises related to this teaching - the teacher becomes a facilitator or guide, helping pupils to further their own thinking through the use of questions and discussion of strategies. This shift is fundamental in the development of a Thinking Classroom as ‘When teachers are in the habit of introducing their own ideas and information before pupils have a chance to think out theirs, pupils are unlikely to engage in reflection and will probably take the easier route of accepting unthinkingly what their teacher says’ (Watson, 2001: pp. 141 – 142). Consequently, during the 2011 – 2012 academic year, wherever possible, tasks were introduced through whole-class or group discussion, rather than teacher-modelling and instructions.

This strategy was, in part, inspired by the advice of Chin (2004) who suggested that, instead of simply instructing pupils on the best strategies for solving a given problem, a teacher could ‘invite students to first pose questions about the problem’ (p. 109) in the hope that, if practised regularly, pupils ‘may internalise question-asking as a habit of mind whenever they encounter a problem and spontaneously ask such questions, thus steering themselves to untangle the problem and find a solution on their own’ (Chin, 2004: p. 109). Indeed, during Thinking Skills lessons, teacher-talk consisted primarily of guiding whole-class and group discussions surrounding individual problems, as well as the strategies used to solve them. In addition, a large proportion of lesson time was devoted to reflections upon learning, usually during mini-plenaries, at times determined by the pupils’ response to the task at hand, rather than being predetermined by the teacher. This was inspired by the teaching model provided by Japanese teachers of Maths, for whom it is normal to spend considerable proportions of class time in the discussion of strategies pupils have used in problem solving, and the critique of methods (see Westwood, 2011: p. 8).

This focus upon the strategies pupils use to tackle mathematical tasks or concepts has been central to my development of a Thinking Classroom. Encouraging pupils to explain their reasoning was key to the success of this approach therefore, at the very beginning of the Thinking Skills intervention, pupils were introduced to the very simple phrases: ‘I think … because’ and ‘I know … because’. These phrases were displayed prominently on our classroom Maths display, serving as a constant prompt to the pupils - and indeed to myself as teacher-researcher - of the importance of understanding Maths more deeply. Furthermore, this provided an opportunity for pupils to contrast methods, opening up discussions, and focusing on strategies and the learning process, rather than simply upon ‘answers’. I believe that this was fundamental in shifting emphasis away from a determination to get the right solution to a problem, and towards a focus on developing understanding. This change in focus was crucial to encourage pupils to adopt the learning-focused, mastery-orientated mind-set which, Dweck (1986) suggests leads pupils to ‘choose challenging tasks that foster learning’ (p. 1042) even when their current level of attainment is low.

Whilst teaching, I found that one of the most useful methods for encouraging children to engage in these discussions was a visual metaphor that the pupils and I developed together, and called simply ‘the river’. We discussed the question and its answer as being on opposite river banks, and the need to develop ‘stepping stones’ to create a bridge between the two. Plate 2.6 features a photograph of the class as a whole working on a shared mathematical problem around this ‘river’.

Plate 2.6 The 'River': a visual metaphor

Initially, it was fundamental to give pupils the answers to the questions I posed. I found that this enabled us to shift the focus away from simply finding the correct answer towards an emphasis on learning and understanding. Groups worked together to 'bridge the gap' between the question and solution and having this answer was instrumental in allowing pupils to gain both independence – as a means of checking their answer and readjusting or analysing their work if their solution did not match the answer given – and the confidence to experiment and explore without the pressure of having to solve a specified number of calculations within a set period of time. Once pupils began to find the necessary steps, individual groups were invited to explain their reasoning to the rest of the class. An example of this can be seen in Plate 2.7.

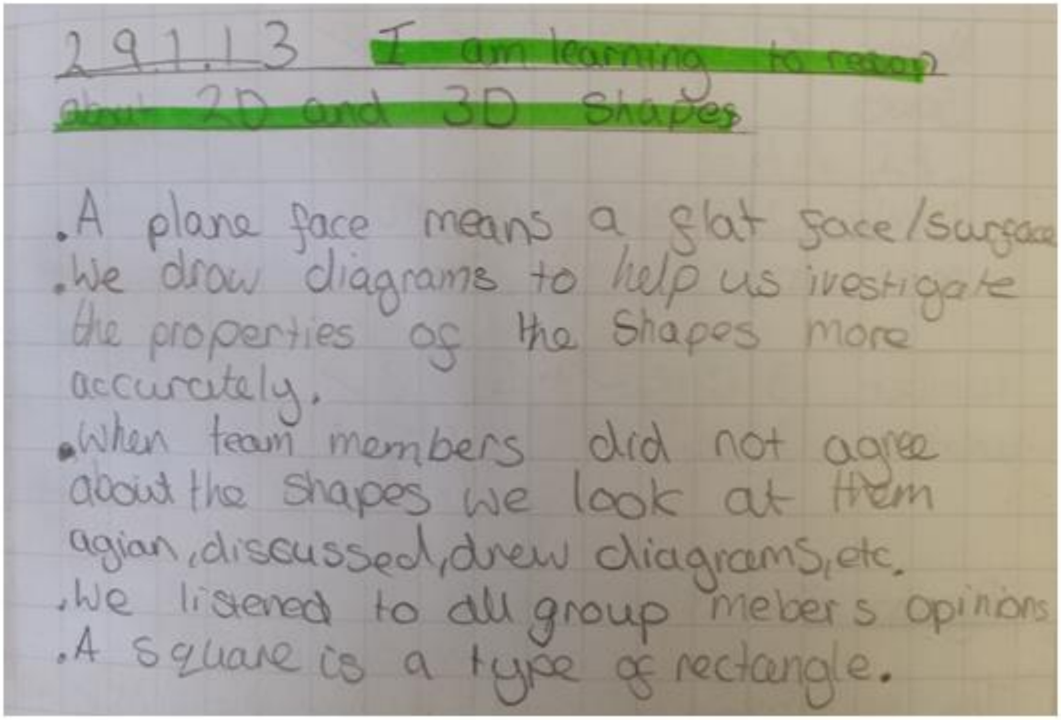
Plate 2.7 The 'River' in use during a lesson on fractions

Groups were encouraged to question and challenge each other, presenting contrasting methods, and opening up discussions of efficiency. This allowed pupils to recognise that there are multiple ways of reaching the same solution, granting them the freedom to select whichever they felt most comfortable with. This also conformed to one of Hattie and Timperley's suggestions for effective feedback, in which 'students can seek better strategies to complete the task or be taught them, or they can obtain more information from which they can then solve problems or use their self-regulatory proficiencies' (Hattie & Timperley, 2007: p. 86).

2.6.5 *Encouraging reflection upon learning*

In addition, pupils were encouraged to actively consider the learning process by making the focus for each lesson explicit. This was achieved by using the learning objective for each lesson as the title recorded by pupils in their Maths books. At first, these titles were given by me. I would explain the learning for each lesson to the pupils, modelling thinking about the learning we would undertake (or had undertaken – as it was often simpler to encourage pupils to reflect upon what they had learned during each lesson after they had completed it and could more easily recognise what this looked like). Furthermore, whilst West Side School policy specified the use of titles beginning 'I can', Year 5 pupils instead used titles beginning 'I am learning to'. Thus a typical title may read 'I am learning to find percentages of amounts' or 'I am learning to solve word problems involving measurement'. I believe this was important because, semantically, whilst 'I can' suggests that pupils have already achieved a particular learning focus, possibly leading to a sense of failure if pupils then find this challenging, 'I am learning to' focuses pupils on the learning process, perhaps making them aware of the steps they undertake to improve their understanding.

As pupils became more aware of the planned nature of learning objectives, we began to create titles together as a class. At the beginning of the lesson – once I had explained the task or focus for the lesson - we would discuss what the children thought the learning focus was, and would use this to create a shared title. An example of one such title can be seen in Plate 2.8, followed by a list of learning outcomes – determined by each individual or group of pupils – for that particular lesson.

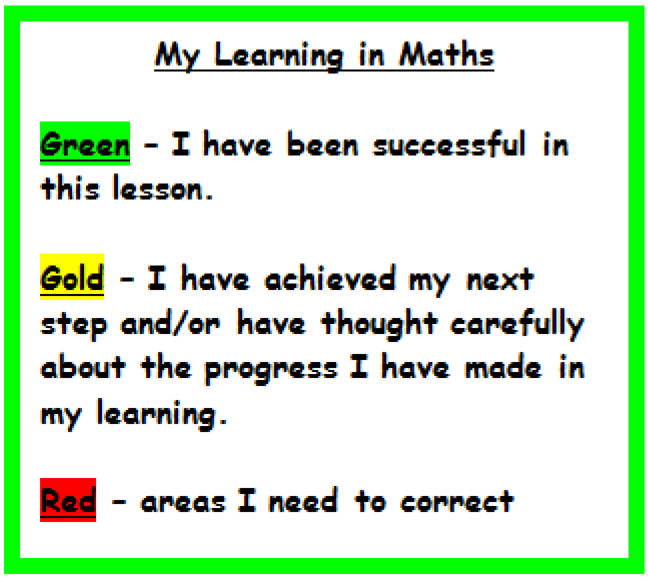

29.1.13 I am learning to reason about 2D and 3D Shapes

- A plane face means a flat face/surface
- We draw diagrams to help us investigate the properties of the shapes more accurately.
- When team members did not agree about the shapes we look at them agian, discussed, drew diagrams, etc.
- We listened to all group mebers opinions
- A square is a type of rectangle.

Plate 2.8 An 'I am learning to…' title, discussed and developed with the focus cohort

This shared understanding of the learning focus and intended outcomes was important as it links to the conditions that Hattie and Timperley (2007) consider essential to effective feedback, explaining that 'goals without clarity as to when and how a student (and teacher) would know they were successful are often too vague to serve the purpose of enhancing learning' (p. 88). During more complex lessons, pupils were also asked to do this retrospectively, recording a title of 'I have been learning to:' at the beginning of the lesson, and then returning to this during the plenary at the end of the lesson, when pupils were given the opportunity to discuss their learning and record a list of skills they had developed, or knowledge that they had gained in the course of the lesson.

In addition, children were engaged more actively in self-assessment of both individual tasks and progress in their learning. Wherever possible, children self- or peer-marked work during lessons. This was achieved through a range of strategies including the use of calculators, 'answer sheets', peer-evaluation, and class discussions. This was instrumental in continuing to move emphasis away from 'answers' and towards progress in learning, and the corresponding shift from a goal-orientation mind-set, towards a focus on the development of learning and that 'mastery' determined by Dweck (1986). To facilitate this, a new marking code was developed and shared with the pupils to ensure clarity of understanding. This was crucial, particularly in light of Hattie and Timperley's (2007) highly sensible suggestion that feedback can only impact positively if it is fully understood by pupils, and if they recognise its importance, encouraging active engagement with it. This marking code was stuck into pupils' exercise books, ensuring that it could be referred to as needed. A copy can be found in Plate 2.9.



My Learning in Maths

Green - I have been successful in this lesson.

Gold - I have achieved my next step and/or have thought carefully about the progress I have made in my learning.

Red - areas I need to correct

Plate 2.9 The marking code for Maths at West Side School

Hattie and Timperley (2007) maintain that feedback has the 'greatest effect when a learner expects a response to be correct and it turns out to be wrong' (p. 95). Indeed, Hattie believes that tolerating pupil errors is one of the key characteristics in creating 'optimal classroom climates for learning', explaining that this creates an environment where pupil 'error is welcomed, where student questioning is high, where engagement is the norm, and where students can gain reputations as effective learners' (both 2003: p. 7). As a result, where children had made an error, they were required to repeat their working using a different coloured pen to identify and address mistakes. Children thus gained immediate feedback on their learning, and were able to address any misconceptions rather than risking these being ingrained and 'learned' through repeated application of incorrect methods, either by identifying for themselves the source of any difficulty, or by appealing to a peer or teacher, thus developing their understanding.

I believe that this feedback – provided both by me, resources, and, crucially, the pupils themselves - was instrumental in encouraging my pupils to become more independent learners. Certainly, Hattie and Timperley (2007) believe that feedback of this nature allows pupils to ‘develop effective error detection skills, which lead to their own self-feedback aimed at reaching a goal. Such error detection can be very powerful, provided students have some modicum of knowledge and understanding about the task on which to strategize and regulate’ (p. 86). To further this, I also strongly encouraged pupils to provide verbal or written explanations to clarify why mistakes had been made, allowing both myself and my pupils considerable insight into their understanding of their work as well as progress in understanding. An example of this can be seen in Plate 2.10.

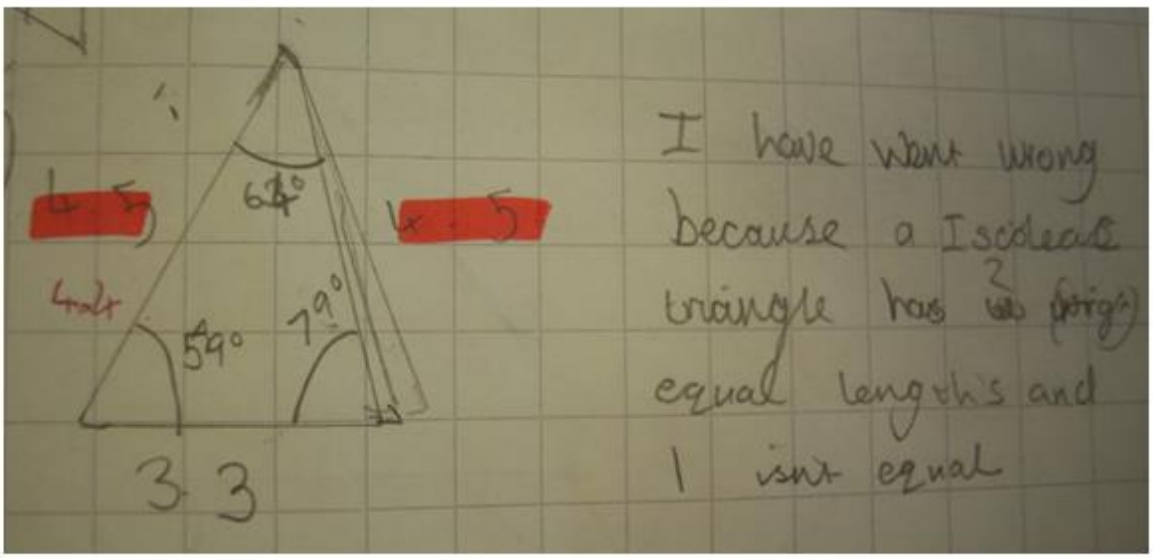


Plate 2.10 A pupils’ explanation of why his first answer was incorrect

Pupils were further encouraged to reflect upon lessons by writing a comment upon their learning at the end of each lesson. Whilst this often consisted solely of a rather brief comment such as “I made progress today”, some pupils - such as Harry[9], a boy in Class 2 - demonstrated deeper reflection, commenting on the strategies and mathematical methods which helped them achieve their learning objective. Such comments include “I now understand how to use my protractor accurately because I was measuring the wrong way and my protractor had different angles measured” and “I feel working as a team and

[9] Please note that the names Harry and Grace are both pseudonyms, used to preserve the anonymity of the children featured in this study.

learning things on the carpet helped me learn today". An example of a comment of this type can be seen in Plate 2.11.

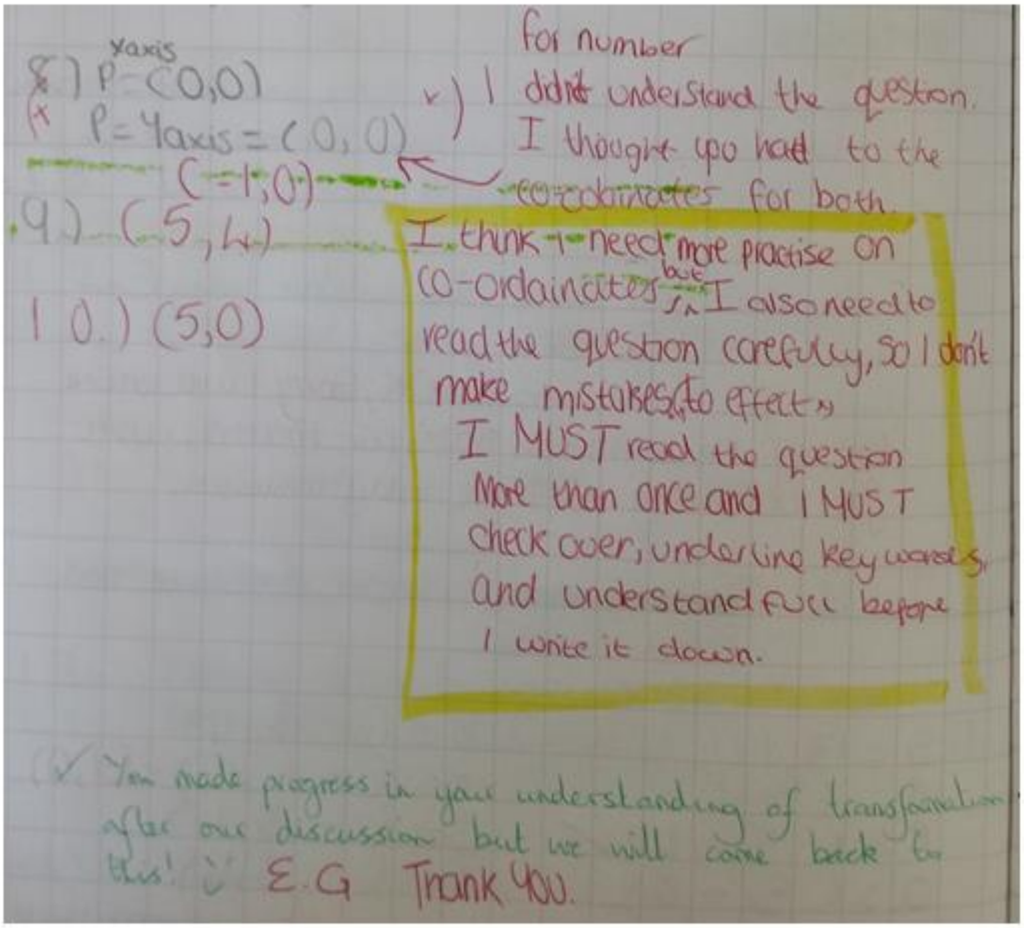


Plate 2.11 A pupil's reflection upon learning

Initially, pupils found it challenging to understand exactly what type of reflections upon their learning I expected. I believe that this was largely because their previous reflections upon their learning were typically very simplistic – describing learning as either 'easy' or 'hard', and often even both! – and they thus had limited experience of analysing what they had learned, how they had learned it, and the progress that they had made. It was therefore important to dedicate a specific portion of lesson time (the 8 – 10 minutes of the plenary element of Thinking Skills lessons outlined in Table 2.3 above) to discussing this as a class in order to model thinking of this nature, share ideas, and to develop pupils' understanding of just how to reflect effectively upon a lesson. The comments that pupils ultimately recorded were extremely interesting as they indicated - as was logically to be expected -

that some children reflected in notably greater depth than their peers, therefore raising the question of whether these pupils were also more significantly affected in other areas of interest, such as attainment, progress and self-concept relating to Maths. Consequently, I resolved to study these cases more closely; the case-studies of both Harry and Grace, also from Class 2, are therefore included as part of the Findings chapter of this thesis.

Again, these reflections were given in a different pen to that they customarily used during Maths lessons. I decided to give children a red pen to use specifically for thinking of this type in an attempt to emphasise to children that these reflections were distinct from children's ordinary work in Maths, and that I was expecting something rather different to be written using this pen. This choice was made, in part, because, whilst teachers at West Side School mark in a green pen, children's work in Maths books is completed in pencil. By giving pupils a pen, I hoped to symbolically transfer power from the adults within school to the pupils themselves, helping them to understand that they were being given shared responsibility for developing their learning through reflecting upon their work, identifying and correcting errors, as well as identifying avenues and strategies for future improvement. The use of a pen was also useful because it helped my year group partner and I and the pupils to distinguish between initial and subsequent ideas: it made progress in understanding more visible, therefore helping pupils to recognise their learning and how this developed throughout the course of individual lessons and larger blocks of learning.

Thus, through the increased focus upon problem-solving and open-ended tasks, as well as greater emphasis upon pupil talk and collaboration, questioning, and reflections upon learning, the introduction of the Thinking Skills methods were designed to influence the development of pupils' awareness of themselves as learners of Maths; their opinions and self-concept; as well as their progress and attainment in the subject. Consequently, this intervention was both the direct result – in terms of the strategies adopted and the manner in which they were introduced to the classroom – of the existing literature surrounding Thinking Skills, and an extension of the current body of research in this field – in terms of my aim of pinning down in a more tangible, reliable form, the impact of a Thinking Skills approach upon those measures which must, in our current results-driven education system, be of great significance to practitioners such as myself – progress and attainment. The following chapter of this thesis will give further information regarding the methods used to record and analyze the impact of the Thinking Skills approach within my own classroom.

Chapter 3. Research Design and Methods

As a teacher-researcher, I am inextricably involved in this investigation; responsible for the planning, delivery and analysis of the Thinking Skills approach. As a practising teacher, my views are firmly influenced by my position. I believe that education research must aim to improve learning and the efficacy of classroom practice. This is concurrent with the views of many researchers, including Stenhouse (1979, 1983), and Bassey (1995), who believe that education research should ‘directly inform the concrete activities of education’ (Elliott, 2001: p. 569). I therefore agree with the distinction, made by those such as Elliot (2001) and Whitty (2006), between *educational* research – ‘research concerned in one way or another with improving policy and practice’ – and *education* research – a term which ‘should be used more broadly to characterize the whole field’ (both Christie & Menter, 2009: p. 338).

Thus, practical, practitioner knowledge is valuable ‘precisely because it develops in response to specific problems of practice’ (Hiebert *et al*., 2002: p. 6) and, certainly, this can be applied to this particular investigation, which aims to address an area for development identified from within my own classroom: an aspect of my children’s Maths learning which I felt – and, indeed, still feel - strongly about, and which is, in my opinion, crucial to pupils’ confidence, determination, and, ultimately, their success, as learners in this subject. In subscribing to this view, I am also aligning myself with Carr (2007), and his views of educational research

> as a mode of inquiry that would be simultaneously ‘scientific’, ‘practical’ and ‘educational’. It would be ‘scientific’ in that it critically and systematically develops the body of knowledge that structures the interpretations of educational practitioners and hence structures education itself; ‘practical’ in that it recognises that this knowledge always arises from, and must always relate back to practice; and ‘educational’ in that it self-consciously promotes the ethical ends that are constitutive of a practice as an educational practice and justify its description in these terms’ (p. 283).

In contrast, I believe that the notion of research as a ‘basis’ for practice, proposed by those such as Hargreaves (1996, 1997), is rather like putting the cart before the horse: practice must always be our starting point. Issues may arise that we wish to investigate or counteract, but practice must always be the primary focus, the realities of which, alone, must dictate our response. Indeed, Carr, in linking educational research to Aristotelian philosophy, emphasises 'its embeddedness in practice and its inseparability from the concrete situation in which it is applied — [which] means that it cannot be developed by a 'theoretical science' that yields generalisable or theoretical knowledge that can be applied universally and unconditionally' (2007: p. 280).

I believe that this point is highly important, with profound implications for the relationship between research and practice. Although, I have cited Hargreaves, and my belief in the importance of positioning practice as the primary focus of research, there is yet more to consider. Hammersley (2003), for example, in further examining this idea of education research as a practical science, argues that, as a result, it Aristotle 'must be practical rather than theoretical in nature. This means that it must be concerned not with producing knowledge but rather with determining what is the right course of action in particular situations' (p. 7). Hammersley argues that, consequently, research of this nature must be termed as informative, rather than educative, suggesting that

> 'educative action is aimed at changing people in some respect, and is specifically designed to do this; informative action is aimed solely at providing people with information that could be relevant to their concerns. In the latter case, there is no obligation, or right, to try to control the way in which people derive practical or policy implications from the knowledge provided, or to try to control what people do on the basis of it. The only obligation and right, in this context, is to seek to correct any misrepresentation of the knowledge supplied' (2003: p. 18).

3.1 Teacher as researcher

In light of this view, I believe that the involvement of teachers in the research process is essential. Teachers are at the front line of our education system, responsible for the everyday teaching and learning of the pupils in our care. It is *our* understanding of our individual learning environments which enables us to identify suitable teaching approaches for our pupils. This notion that teachers should not only be involved in research, but also have control over it, is not a radical one: this view is evident in the work of numerous academics, including Carr (2007), and his work on Aristotelian practical philosophy, as well as Sachs (2000) and Groundwater-Smith & Mockler (2007). Elliott (2001), for example, stresses that for educational research 'teachers need to be involved in prioritising their educational aims […], in defining what is to count as relevant evidence […] and interpreting its practical significance for them' (Elliott, 2001: p. 565). Similarly, Hall likens challenges in the classroom to 'the grit in the oyster that motivates teachers to undertake enquiry and the pursuit of greater understanding becomes part of professional practice and identity' (2009: p. 672).

It is also interesting to note that Rudduck (1985) claims that because classroom research is undertaken by teachers 'the research act must be educationally justifiable: at no time can research curiosities subvert educational principles' (p. 124). Whilst I believe that this idea is perhaps naïve, I agree that the undertaking of research is a fundamental element of the teacher's role. Indeed, Rudduck argues that

> 'it is the child in the everyday world of the classroom, where the pattern of teaching and learning remains unexamined, that is at risk because he or she is subject to constant unmonitored and unreflected-on action. Not to examine one's practice is irresponsible: to regard teaching as an experiment and to monitor one's performance is a responsible professional act' (1985: p. 124).

I would also argue that teachers are ideally placed to understand the realities of their own working context. They alone are immersed in their individual classrooms, are fully able to understand the intentions and impact of their own teaching, and therefore it must surely be acknowledged that they are in a unique position to first identify an area worthy of further research and, once this has been accomplished, to interpret the resultant findings. I believe that I am not alone in holding this view. Indeed, Lytle and Cochran-Smith (1992) write that:

> 'because teaching requires simultaneous attention to many agendas and because it provides the opportunity for constant observation of particular phenomena, such as children's drawing or writing, teacher researchers' analytic frameworks are extraordinarily rich and complex. What we mean here is that when teacher researchers turn their attention to children's drawing, for example, they bring a historical framework based on a thousand other drawings and what these drawings meant for particular children at particular times and places. Hence, they ask questions that other researchers may not ask, and they see patterns that others may not be able to see' (p. 465).

Yet whilst I agree whole-heartedly that research is a key element of a teacher's role, and that a teacher's role within the classroom enables a unique insight into the complex dynamics which influence teaching and learning, I believe that, in West Side School and, indeed, in our current education system in general, the potential for learning and development is unfulfilled. For example, Hall (2009) observes that the 'discourse in the UK of 'research-informed' practice positions the teacher as an observer of the research process and a consumer of research products' (p. 678). Like Hall, I am concerned with the 'passivity' (2009: p. 678) this may create, together with a failure to recognize that it is *our* understanding of our individual learning environments which enables us to identify suitable teaching approaches for our pupils. Instead, I agree with Furlong and Oancea (2005) that there is no clear division between the realms of research, policy and practice, but instead these are 'integrated activities that borrow from each other, inform each other and support each other' (p. 8).

It is important to note that this stance holds profound implications for this research. I have positioned myself at the very centre of this research, and this leads to several potential complications. For example, in light of my role as teacher-researcher, it was important to consider issues surrounding consent from both pupils and parents, whilst avoiding engendering any sense of obligation to engage in this research. Furthermore, it was essential to carefully consider how it would be possible to avoid, as far possible, any bias resultant from my relationship with pupils. Nevertheless, whilst these are undoubtedly highly important issues, issues which I had foreseen at the outset of research and which will be addressed throughout the course of this chapter, I believe that this position also had consequences which extended far beyond this, and which only became apparent as research progressed.

These consequences predominantly concerned the ways in which my beliefs influenced the ways in which methods were selected; research was adapted to suit the needs of the pupils, becoming more cyclical to take into account areas of interest arising from the data and in an attempt to improve educational outcomes; and even a significant shift in the very evidence which I was willing to include and acknowledge, from an initial, subconscious quantitative bias towards a final embracing of qualitative evidence. This investigation was *substantially altered over the course of research as a result of my changing understanding of myself, reflecting my evolving - and increasingly confident - understanding of myself as a teacher-researcher, ultimately becoming a hidden, or unexpected, facet of research which emerged throughout the course of this investigation. I understood, from the outset of research, that, as a teacher-researcher investigating my own classroom, I would, of course, be inextricably linked to this research, yet I believe that, even so, I underestimated the extent of this. I hate to sound egotistical, but, ultimately, this research really did become all about me, my teaching practice, and my professional learning as a teacher-researcher.*

This conclusion is, I believe, further evidence that this research is related to practical science which also places the practitioner at the centre of research by enabling them 'reflectively to expose and critically revise the presuppositions inherent in their practice enables them to reconstruct their knowledge and understanding of how its internal 'good' is to be more appropriately pursued' (Carr, 2007: p. 280). Therefore, practical science can be seen as a means by which practitioners – teacher-researchers – may consider and explore practice in order to acquire self-knowledge – knowledge about themselves, together with the beliefs and assumptions which underpin their individual practice – and, in the process of doing so, allows them to 'evaluate their practice on the basis of a coherent and clearly articulated educational point of view. In this sense, it is a form of educational research that allows practitioners to reconstruct their practice as an educational practice in a rational and reflective way' (Carr, 2007: p. 282).

3.2 Children as co-researchers?

The argument that teachers are ideally situated to understand the realities of their own working context naturally raises questions regarding the extent to which the pupils themselves should be involved in research. Those such as Kellet (2005) and Lundy *et al* (2011) argue vehemently in support of involving pupils actively as participants in, rather than simply the subjects of, research. Kellet suggests that the importance of this relates strongly to issues of power and emancipation: just as I believe that practitioner-research empowers teachers to take increasing control over their own classrooms, child-led research could 'redress some of the balance of an adult dominated research world. Such ideology critique would challenge the legitimacy of research into children's worlds and children's lived experiences where the research is conceived wholly from an adult perspective' (2005: p. 7). Indeed, Lundy *et al* (2011) go further, emphasizing the link between children's involvement in research and the U.N. Convention on the Rights of the Child (1991), stressing that this participation is 'essential if children's rights and best interests are to be duly respected' (p. 716).

The very process of engaging in research – of seeking the pupils' opinions – conveys a powerful message regarding the extent to which children's perspectives are valued. I believe that this is crucial to the creation of the Thinking Classroom in which adults and children together form 'communities of learners prepared to share thinking and question their own and others assumptions of metacognition in such a way that there was a shared responsibility and engagement with the process of learning' (Wall, 2014: p. 3). Furthermore, it is important to consider the additional benefits that may result from encouraging pupils to participate in research. For example, taking part in the process of education research may hold the potential to increase pupils' metacognitive knowledge and skillfulness. By engaging in education research, children necessarily consider teaching and learning and how these can be improved and developed: they exercise metacognition. Furthermore, Kellet (2005) suggests that participating in research may also lead to wider benefits, forming a 'virtuous circle of increased confidence and raised self esteem resulting in more active participation by children in other aspects affecting their lives' (p. 11).

In addition to the considerable benefits that involving pupils in research may hold both for the establishment of a Thinking Classroom as well as for the pupils themselves, it is important to note that involving pupils in research has the potential to increase validity and reliability through incorporating their perspectives upon teaching and learning. As Kellet observes,

> 'Children observe with different eyes, ask different questions – they ask questions that adults do not even think of -, have different concerns and have immediate access to peer culture where adults are outsiders. The research agendas children prioritise, the research questions they frame and the way in which they collect data are substantially different from adults and all of this can offer valuable insights and original contributions to knowledge' (2005: p. 9).

Although, of course, it could be argued that all adults, having once - no matter how long ago – been children, Kellet maintains that it would be ‘unwise to try and apply principles of a childhood from a generation ago to a contemporary childhood. Above all we need to be able to learn and understand about the lived experiences of children of today’ (2005: p. 9). Similarly, whilst both Kellet (2005) and Lundy *et al* (2011) describe age and maturity as an oft-cited prohibiting factor in involving children in research as co-researchers, I do not subscribe to this view. Having worked extremely closely with children in various year groups of primary school, I have regularly been fascinated and extremely impressed by pupils’ capacity for insight and sophisticated understanding. Therefore, like Kellet, I must conclude that children’s competency ‘is ‘different from’ not ‘lesser than’ adults’ competence […]. Undoubtedly adults have greater knowledge than children in many areas of life but with regard to childhood itself - in the sense of what it is like to be a child - it is children who have the expert knowledge’ (Kellet, 2005: p. 10). Thus, the pupils themselves have a unique perspective to offer research in terms of their experiences of the teaching and learning ongoing in our shared classroom. To ignore this perspective would amount to a dismissal of an incredibly valuable source of information - the opportunity to view, through the children’s eyes, what it is like to be a part of the Thinking Classroom – a perspective which would otherwise be lost to this research.

Whilst the benefits of gaining pupils’ perspectives upon research appear self-evident, it is important to consider to what extent children should be involved in research. Should involvement extend to consulting the pupils regarding their opinions surrounding existing research, or go still further, to involve them in the posing of questions, selection of methods and even data analysis? Kellet, for example, criticizes the ‘unequal power-relations and the adult focus of such research. It is the adults who frame the research questions, choose the methods and control the analysis. For the most part, children are unequal partners’ (2005: p. 6). Lundy *et al* support this view, suggesting that ‘In an ideal children’s rights-based approach, the children would have been involved in the discussion before the questions were set’ (2011: p. 723). However, I believe that it is important to maintain focus upon the purpose and aims of any given research.

For example, although this research aims to investigate pupils' experiences of Maths, its ultimate aim is to improve teaching and learning. As I have previously stated, it arises from genuine concerns regarding my own practice. Therefore, although it directly concerns the children of the focus cohort, it is not instigated by them. This, I believe, is a crucial distinction. Just as adults do not have experience of being children today, pupils do not have experience of being teachers. Consequently, I believe that children would not be able to steer this research because they do not have the pedagogic knowledge or previous experience necessary, firstly to identify an area for development in this particular aspect of their learning, and, secondly, to explore the impact of the Thinking Skills approach to learning.

This is not to deny the importance of the pupils' perspectives altogether. Lundy *et al* (2011), for example, suggest that children can play a key role in 'identifying ways in which their peers can participate effectively in research projects as participants, and helping to give meaning to the findings' (p. 719). Certainly, I have found children's contributions in these areas to be extremely useful, and the remainder of this chapter will describe some of the ways in which this research has been influenced by pupils' ideas and feedback, predominantly in the form of the 'Feedback Station' and in the tray system – proposed by the children themselves - used by the focus cohort to indicate whether or not they wished their views to be included in research.

Whilst children may not have led each and every facet of this research, they have certainly been consulted. Indeed, I believe that this research fulfills each of the four fundamental concepts which Lundy et al (2011) believe underpin participation rights outlined by the U.N.C.R.C.: '(a) space—children must be given the opportunity to express a view in a space that is safe and inclusive, (b) voice—children must be facilitated to express their views, (c) audience — the view must be listened to, and (d) influence—the view must be acted upon as appropriate' (Lundy et al, 2011: p. 717). I believe that, in this, it is my own attitudes towards any contributions that the pupils may make which is key: 'If the children are seen as rights holders (which entails recognition of their competence, agency, and entitlement to influence decisions affecting them), then it follows that their view will be treated seriously and acted upon wherever possible' (Lundy *et al*, 2011: p. 733).

3.3 The transferability of knowledge

This study has arisen from the realities of my own class, from a genuine area for development identified both by myself, as class teacher, and by my school's Senior Leadership Team. It is grounded in the everyday reality of my own classroom practice, placing this study very firmly within the field of practitioner research. However, this investigation is also a description of a very specific and localized case of just 37 Upper Key Stage Two pupils from my own Primary school in Newcastle. This forms a contrast to the continued prevalence, identified by Groundwater-Smith and Mockler, amongst many others, of 'treating educational problems as technical, and thus able to be resolved objectively through a rational assessment of evidence gathered within a positivist research paradigm' (2007: p. 200).

In much of the literature on educational research there is wide-spread lamentation – evident, for example, in the work of Carr (1996), Pring (2000), and Elliott (2001) amongst numerous others - of the current bias towards scientific methods and generalizable knowledge. Biesta (2007) summarizes that 'there are those who think that research will be able to give us ''the truth,'' that ''the truth'' can be translated into rules for action, and that the only thing practitioners need to do is to follow these rules without any further reflection on or consideration of the concrete situation they are in' (p. 11). Gorard and Cook (2007) echo this view, claiming that because randomised control-groups 'are initially identical on expectations, any final difference between them must be due to whatever intervention one group has had that the other (or others) did not' (p. 312).

Instead, I agree with Elliott (2001) that randomised controlled trials 'abstract practices and their outcomes from the contexts in which they are situated' (p. 564), as well as with Stenhouse (1988) that 'The variability of educational situations is grossly underestimated' (p. 44) and that, as a result, knowledge is always heavily dependent upon its context. Indeed, Stenhouse expresses almost a sense of futility in attempting to draw generalisable principles when dealing with education research, writing that 'in human affairs what the scientists tell us does not take us too far. 'Other things being equal...' they begin, but other things never are' (1979: p. 5). For me, as for Stenhouse, education research deals with people - participants rather than subjects. Human responses to particular conditions often vary widely and are difficult to predict, therefore what may work in one school or, indeed, with one pupil, may produce a very different impact upon another.

This view is also supported by proponents of practical philosophy, as the 'imprecise nature of praxis unavoidably entails that practical philosophy is an 'inexact' science which yields a form of knowledge that cannot be applied universally and unconditionally' (Carr, 2006: p. 427). This, I believe, is the compromise which must be accepted when one has the aim, as in this study, of conducting practical research specifically concerned with the generation of knowledge of direct use in practical, and often context-dependent, situations. Hammersley (2003), for example, explains that because

> 'decisions have to be made at particular points in time, in order to be useful the findings must be available when they are needed; and this places significant constraints on the research process. There are two aspects to this. One is that while some kinds of knowledge are within the reach of practical research, others are not. Unavailable, in particular, are those that can only be achieved through long-term investigation of the kind allowed by scientific research. However, the second aspect of the trade-off involved in practical research partly compensates for this limit on the questions which practical research can answer. Practical researchers will usually take as valid much of what practitioners believe to be true about the field in which they operate. Indeed, this is a requirement if the knowledge produced is to be found directly relevant. And it makes possible the answering of many questions that would not be currently answerable on a scientific basis (albeit with a greater risk, though not always a high risk, that the answers will be false)' (pp. 15 – 16).

Several risks are implied here. One regards the limitations which Hammersley believes are imposed upon the scope of investigation by engaging in practical research. Whilst this may be true, I believe that – despite my personal views regarding the type of research best suited for this investigation, or which I find most useful as a practitioner - it is important to recognise that there are many different forms that research can take. Long term investigations – the type of research given by Hammersley as an example here of the restrictions of practical research – would, I believe, be impractical as a teacher-researcher, for whom the needs of each individual class may be distinct and incompatible with longitudinal research of this nature. However, as a pragmatist, I must then argue that this simply suggests that research of this form would be unsuitable to meet the aims of the proposed investigation, and that, therefore, a more suitable methodology should be utilized. In short: simply because Hammersley considers that practical research is not appropriate for *all* forms of education research does not signify that it may not be deemed the most suitable for *many* of these.

I also believe that it is implied that, because the kind of knowledge generated from practical science is so dependent upon its context, findings may not be 'available when they are needed' (Hammersley, 2003: p. 15). However, I believe that, to argue this point, it is important to recognise that 'uniqueness in one respect does not entail uniqueness in every respect' (Pring, 2000: p. 258). Indeed, as Wolcott (1994) points out, 'there must be a capacity for generalization; otherwise there would be no point to giving such careful attention to the single case' (p. 113). Although pupils and classrooms are undoubtedly different, there will be similarities which may enable the application of aspects of knowledge to a new context. Instead, 'Reaching toward the truth through education is a matter of situational professional judgment […] Prescriptions will vary according to cases' (Stenhouse, 1988: p. 44).

This issue, relating to the context-dependent nature of knowledge as well as my developing understanding and acceptance of the ways in which practitioners use the findings generated from educational research, has come to be extraordinarily important to me. This is the hidden research question that I discovered as my own beliefs regarding both research and practice crystallised in the course of undertaking this research. Although, at the outset of research, I already acknowledged the uniqueness of educational settings – and even, of each individual class within every single one of these settings – I believe that I nevertheless fell into the trap recognised by Stenhouse (1988), who stresses that 'The variability of educational situations is grossly underestimated' (p. 44).

Another risk implied by Hammersley is that of validity, suggesting that practical researchers may blindly accept much of what 'practitioners believe to be true about the field in which they operate' (2003: pp. 15 - 16) with the consequence that although many more questions may, in this way, become answerable, there is a correspondingly 'greater risk, though not always a high risk, that the answers will be false' (Hammersley, 2003: p.

16). This suggests that, in accepting a greater range of evidence – presumably in the form of the qualitative, anecdotal evidence that is regularly and informally exchanged between practitioners – there is a risk that the findings of research will be less reliable than other, more objective forms of data. Here, again, I believe that it is important to consider how research is to be used. Stenhouse explains that:

> 'Good teachers are necessarily autonomous in professional judgment. They do not need to be told what to do. They are not professionally the dependents of researchers or superintendents; of innovators or supervisors. This does not mean that they do not welcome access to ideas created by other people in other places or at other times. Nor do they reject advice, consultancy or support. But they do know that ideas and people are not of much real use until they are digested to the point where they are subject to the teacher's own judgment' (1988: p. 45).

This view is further supported by Biesta (2007), who emphasises that 'in reflective problem solving we do not use 'old' knowledge to tell us what we should do; we use 'old' knowledge to guide us first in our attempts to understand what the problem might be and then in the intelligent selection of possible lines of action' (p. 16). It also links to the distinction drawn by Hammersley (2003) between informative and educative research. Whilst educative research aims to bring about a specific change upon the audience – for example relating to understanding, attitudes or behaviour - Hammersley clarifies that informative research aims only to provide information which could be relevant for the audience, without any sense of responsibility, or even the right, to attempt to 'control the way in which people derive practical or policy implications from the knowledge provided, or to try to control what people do on the basis of it. The only obligation and right […] is to seek to correct any misrepresentation of the knowledge supplied' (p. 18).

I therefore propose that the research contained in this thesis should act, not as a 'truth' – or with educative intent - but should instead aim to be informative, providing a means of furthering the thinking of practitioners, prompting their own action inquiry research in their own classrooms. This would enable practitioners to use practice as a basis for research, prioritising the needs of their particular context, without running 'the risk of re-inventing the wheel' (Hall, 2009: p. 672). It is also in keeping with Stenhouse's conception of comparative education, which is 'less concerned with predictions and possibilities than with that which is accepted as actuality occurring in time and space. […] It is descriptive rather than experimental. It deals in insight rather than law as a basis for understanding' (1979: p. 5). Thus, research, rather than providing an instruction manual to be followed to the letter, instead supplies possible avenues for exploration by describing approaches which may be suitable, together with their successes and probable limitations. Rather than serving as a means of looking backwards – at something which has previously been achieved and attempting to replicate this – it provides a means of using existing knowledge to inform future action, making it possible to assimilate, adapt and build upon previous work, learning from past mistakes, in order to further enhance practice.

To accomplish this, I believe that the aim of this research should be - simply and straightforwardly – to investigate my specific context in as much detail as possible to gain insight into pupils' experiences of learning Maths, encompassing both pupils' awareness of themselves as learners of Maths, their opinions and self-concept, as well as their progress and attainment in the subject. For this, I take a rather pragmatic stance, following Fielzer's (2010) assertion that 'Pragmatism does not require a particular method or methods mix and does not exclude others. It does not expect to find unvarying causal links or truths but aims to interrogate a particular question, theory, or phenomenon with the most appropriate research method' (p. 13). Indeed, I believe that to adhere blindly to a preferred method or form of data is restrictive. Instead, I agree that 'The acknowledgement of the unpredictable human element forces pragmatic researchers to be flexible and open to the emergence of unexpected data. This means that […] pragmatism reminds researchers of their ''duty'' to be curious and adaptable' (Fielzer, 2010: p. 14).

In short, I do not agree that there is a particular data-collection tool which renders our research more likely to be reliable or valid. Instead, I whole-heartedly agree that:

> 'By choosing one, exclusive way of describing the world, it cannot capture the richness which is present in that non-technical everyday experience of understanding of experience which, no matter how hard we try to ignore it for the purposes of science or theoretical sophistication, cannot dispense with what Ryle refers to as 'the world of real life' or 'the world of common sense' ' (Pring, 2000: p. 248).

I believe that multiple methods, each with their own advantages and perspectives, will always produce more comprehensive data than a single method alone, allowing for the comparison and the identification of trends and patterns between data. Indeed, researchers such as Symonds and Gorard (2010), as well as Groundwater-Smith and Mockler (2007) consider this process of contrast and comparison essential to the generation of reliable findings. Mixed-methods research thus forms a 'cycle of complementary phases and activities' (Gorard & Cook, 2007: p. 316), with both quantitative and qualitative methods serving to enhance and verify the data obtained from the other. Viewed in this way, mixed methods is simply a means by which we may consider 'multiple ways of seeing and hearing, multiple ways of making sense of the social world, and multiple standpoints on what is important and to be valued and cherished' (Greene, 2008: p. 20).

3.3.1 *What can be considered 'good' evidence?*

It is important to note that, whilst I have understood – and passionately embraced - this stance theoretically for some time, in conducting this research I discovered a subconscious bias towards - and preoccupation with - 'proof'. This came as something of a surprise to me: I would always choose to use research in the way outlined above, prizing anecdotal and qualitative evidence as valuable representations of situations which I could perhaps adapt and attempt to emulate, rather than as ideals of which I could attempt to create carbon copies. Yet, conversely, I found that, in conducting my own research, I felt the need to generate proof in the form of quantitative evidence and statistic, as if this were 'proper' or 'real' research; the only evidence which could possibly be of value! Without previously realizing it, my objective, reasoned views were at stark contrast with my instincts as a researcher.

Upon reflection, I believe that this may have stemmed from a sense of insecurity. Quantitative evidence is less open to interpretation; it is also perhaps more familiar to me. Somewhat worryingly, I have come to realise that, as a practicing teacher within our results-driven system, I have become used to dealing in the facts and figures associated with attainment and progress – how many children will reach the age expected level, how many steps of progress each child has made in the course of each academic year. I have also come to associate success with statistics of this nature: regular practice at West Side School, my new working context, and, I am sure, schools throughout the country, link *teachers' annual performance management targets to ever-increasing proportions of children reaching, or exceeding, national expectations, and this has, I believe, caused me to prioritise outcomes of this nature with the success of the teaching and learning ongoing in my classroom.*

Accepting evidence of this nature – data in the form of numbers and statistics – seemed comfortable and reliable. I felt that it was more likely to be trusted by others reading my research. In contrast, data which relied heavily upon my interpretation of it – impressionistic accounts of my experiences within the classroom, or my interpretations of the pupil views templates – seemed more risky. After all, why on earth would anyone trust my interpretation of this information? It took some time before I truly accepted that, in my own practice, the evidence most likely to inspire me to adopt a new approach or to try something different, was not statistical, but was instead the accounts of practitioners whose opinion I valued. It was not lists of progress and attainment data, but rather anecdotes of the reactions of pupils to a particular teaching and learning strategy. This shift in thinking had a profound impact upon this research. From an initial research design which was predominantly quantitative – searching for 'proof' – albeit within a wider context of a mixed methods approach, over the course of research this position shifted, ultimately becoming more interpretative – and cyclical, responding and adapting according to findings as they emerged – as the research progressed.

In adapting and responding in this manner to findings and areas of interest from this study as they emerged, I believe that this research can once again be seen as related to the notion of practical science, defined by Carr (2007), as it arises from recognition of the nature of education – rather than of research – and, as a result, would 'not seek to improve the rationality of education by infusing practice with knowledge it had itself methodically produced but by enabling practitioners to rationally examine their practice on the basis of their own reflective inquiries' (p. 282). Therefore, rather than seeking to produce knowledge about education, this research seeks to cultivate the ' kind of self-knowledge that enables practitioners to identify the unquestioned assumptions and irrational beliefs sustaining their practice and, by so doing, enables them to evaluate their practice on the basis of a coherent and clearly articulated educational point of view' (Carr, 2007: p. 282).

3.4 An obligation to participate?

My position as teacher-researcher, whilst it may allow me insights into the everyday realities of my classroom which may be inaccessible to external researchers, nevertheless posed its own challenges. For example, it was important to carefully consider the notion of consent, both from parents, school leadership, and, of course, the pupils themselves. As a practising teacher-researcher, it was important to both inform my Head Teacher about the proposed research, and gain her permission to proceed, in light of her role as 'ethical guardian' (Jones & Stanley, 2010: p. 158) of the pupils in my care. In addition, I sought appropriate parental consent, as suggested in articles 10, 11 and 16 of B.E.R.A.'s Revised Ethical Guidelines for Educational Research (2004). To do this, a letter detailing the proposed research was sent out to all parents, encouraging them to discuss this research with their children, and allowing them to opt out of the research on their children's behalf if they so wished[10]. The response to these letters was extremely positive, and indeed 100% of parents chose to allow their children to contribute their views for the purposes of this research.

It was also necessary to ensure that each of the data collection tools utilized in this research - namely the assessment and attainment data, S.D.Q., and pupil views templates - were used in a manner which avoided, as far as possible, any bias resultant from my role – as both teacher and researcher - in this investigation. In addition to teaching both classes during both their time in Year 5, during the 2011 – 2012 academic year, and in Year 6, during the 2012 – 2013 academic year, I had also previously taught all of the children involved in this research during their time in Year 2 during the 2008 – 2009 academic year. Although I felt that this familiarity will help to ensure that pupils feel at ease during the research process, in compliance with article 18 of the research guidelines (B.E.R.A., 2004: pp. 7 – 8), I was also concerned about the obligation that pupils may have felt to contribute their views for the purpose of this research. One of the aims of the discussions which I held with pupils in order to ensure that they were fully informed about the research process was to ensure that pupils' recognised the voluntary nature of participation. Therefore, throughout research, and in particular during each of the data collection periods, pupils were reassured that there

[10] A copy of this letter of consent can be found in Appendix D.

were no right or wrong answers. They were also assured that their identities would remain anonymous, and that pupils should feel free to give their honest opinions, without fear that these would be shared with others.

Pupils were also fully informed about the purpose of each of the activities, and were given the opportunity to discuss these, together with any questions they had. Furthermore, in an attempt to dispel any further anxiety or sense of pressure to provide answers aimed to please me, as teacher-researcher, I decided that pupils should complete the pupil views templates and S.D.Q. in large groups – for example, with the whole year group or, in the case of the S.D.Q. and because of restrictions caused by the limited number of computers upon which to complete the online version of the questionnaire, with each class – completing these data collection tools simultaneously[11]. This was done in an attempt to ensure that as many children as possible completed the research tools at the same time: I hoped that the reassuring presence of their peers would help pupils to give their views honestly, without feeling the pressure to conform to a pre-conceived notion of a 'correct' response.

In light of Dockett and Perry's (2007) views about the notion of ownership surrounding any artefacts (drawings, pupil views templates[12], completed questionnaires, etc.) produced by the pupils it was also stressed that these were the property of the children themselves – distinct from schoolwork produced in class. In order to convey this distinction, at the outset of research, and then subsequently, each time a data collection tool was completed, the children, my year group partner and I discussed the tool which was to be used: what form it would take, what it was for, and how it would be used, together with any questions or concerns the children raised. We stressed the optional nature of submitting completed data collection tools for analysis, emphasising that their views were private and important, and that they had control over whether or not they chose to share them. Particular care was taken to ensure that children understood that research tools were not work to be marked: the children were free to express their views honestly, without fear of being 'told off' if they

[11] Please note that, for the comparative groups from across Key Stage 2, children from all year groups completed the data collection tools simultaneously in order to give as large a group size as possible.
[12] Pupil views templates are a research tool devised by Wall and Higgins (2006) to explore pupils' thinking through uncovering evidence of metacognitive knowledge and skillfulness. A full description of this particular tool can be found later in this chapter.

recorded a negative view or opinion. On the contrary, I stressed to children that I wanted them to be as honest as possible – that if there was something that they did not like, or that annoyed them, this was an ideal opportunity to say so, as my aim in asking them for their views was to improve their experiences of teaching and learning in Maths and so it was important for me to know what they enjoyed and found beneficial, and, perhaps even more usefully, what they did not.

Lundy *et al* (2011) suggest that asking pupils to participate in research ‘in their familiar school environment can be problematic because children may consider the activities to be class work. This can be addressed in part by keeping the engagement as informal as possible and by using the least conventional or school-like spaces available’ (p. 719). However, because all pupils in the focus cohort completed the data collection tools simultaneously, the limitations of available spaces within West Side School meant that unfortunately it was not possible to use a less conventional setting. However, every attempt was made to create a distinct and informal atmosphere in order to help children differentiate between engaging in research and regular class work. For example, to emphasise the different nature of the pupil views templates, children were provided with a wide range of materials with which to record their views.

Typically, in Maths books, children were expected to use pencils, drawing any lines neatly with rulers. When writing, children used ink handwriting pens provided by school, and were expected to use neat, joined writing in-line with West Side School’s general expectations regarding the presentation of children’s exercise books. In contrast, when completing the pupil views templates, I emphasise to children that they were free to use their own pens, brought from home, coloured pencils, biros and felt-tipped pens. Whilst this change was relatively minor, I believe that it supported the important message that the pupil views templates were unlike the work children routinely completed in class and, furthermore, I hoped that allowing pupils increased freedom in recording their ideas would in turn enhance freedom of expression.

To allow pupils the freedom to opt out of submitting any responses that they did not wish to share, I routinely used two trays during each data collection period. This method of opting in or out was decided upon in discussion with the children themselves. At the outset of research, having discussed the optional nature of including their responses in research, the children and I deliberated how best to achieve this. It was during this discussion that some of the children proposed the system of using two trays, one labelled simply 'Yes', and the other 'No'. They suggested that 'Yes' could be used to indicate that pupils were happy for me to include their responses in the research into teaching and learning in Maths, and that 'No' would show that they wished to opt out of submitting their views, instead choosing to keep them private. In the course of our discussion, this was quickly agreed by the focus cohort to be the most straightforward means of sorting responses to include and exclude from research. Because the children themselves suggested this method, I felt confident that they understood it, and had a certain degree of ownership over it. I also feel that it is important to note that giving pupils the opportunity to share their own ideas regarding this aspect of the research process also allowed me to engage them, even in a very small way, as the kind of co-researchers described by Lundy *et al* (2011), in which children 'have a key role to play in identifying questions, identifying ways in which their peers can participate effectively in research projects as participants' (p. 719).

Each time these trays were used, their use was recapped and explained to the pupils, and they had the opportunity ask any necessary questions. Again, before children were asked to decide in which tray to place their data collection tool, it was stressed that their views were private and important, and that pupils had total control over whether or not they chose to submit these for use in this research. Furthermore, in an attempt to minimise any pressure which children may have felt to submit their views against their inclination, these trays were not monitored by an adult, so pupils were able to choose which tray in which to place their completed data collection tool without feeling as though they were being watched or monitored as they did so.

The majority of pupils were willing - even enthusiastic – to share their views about teaching and learning in Maths. Throughout research, many children expressed very positive responses to the discussions we had about our teaching and learning. Perhaps unsurprisingly, they appeared to enjoy being consulted! When asked how they felt about sharing their views using the pupil views templates, for example, 84.84% of pupils indicated that they enjoyed using the template. Furthermore, spontaneously and without prompting, 45.45% of pupils cited the opportunity that these templates provided to share their ideas about learning Maths as the reason for their enjoyment. A typical response explained that “I like doing this because it is fun and I like to share my ideas”[13]. I believe that comments of this nature suggest the pleasure that pupils felt in being offered the opportunity to share their views surrounding teaching and learning – in other words, to share their reflections; their metacognition – and, as a result, to influence the teaching they experienced. I believe that this could also perhaps be seen as evidence of the ‘virtuous circle of increased confidence and raised self esteem resulting in more active participation by children in other aspects affecting their lives’ (Kellet, 2005: p. 11) which Kellet believes results from involving pupils actively in research – here, by sharing their views about the teaching and learning of Maths. Not only did this confirm my personal views regarding the importance of consulting pupils regarding their own education, but it also emphasised the suitability of the data collection tools chosen in providing the means for them to do so. The data gathered using the pupil views templates can be found in the Findings chapter of this thesis.

3.5 Research Design

In this study, evidence of pupils’ experiences of Maths is collected through the use of a range of data collection tools, encompassing both quantitative and qualitative data across the whole cohort. This has been further supplemented by the use of two case-studies following two individual children within the focus cohort. This decision has resulted in a multi-faceted research design which encompasses several distinct elements. It is important to stress that, as a teacher-researcher, I am bound to act in the best interest of my pupils, as they appear to me in each given moment. This means that, whilst as a researcher I may wish to adhere to a planned intervention or structure, as a teacher I must, above all else, follow the dictates of the classroom and the needs of my pupils. I accept this as one of the realities of research in the classroom, rather than a laboratory. Indeed, willingness towards flexibility is an essential characteristic of the pragmatic researcher, who must be ‘flexible and open to the emergence of unexpected data. This means that […] pragmatism reminds

[13] Further examples of the pupils’ responses to the pupil views templates can be found in Appendix E.

researchers of their ‘‘duty’’ to be curious and adaptable’ (Fielzer, 2010: p. 14). Furthermore, my belief that the reader of research is responsible for determining its relevance alleviates some of the consequent inconvenience: as long as there is transparency in my account of this case, it will still be possible to learn from it.

It would be disingenuous to suggest that this was the planned research design for this study from the outset of this investigation. As this investigation progressed, along with my understanding of my priorities as a teacher-researcher, initial findings from data analysis (which, in turn, suggested further avenues for exploration), as well as my beliefs surrounding the nature of evidence, so too did the research design. Ultimately, I believe that the research design for this study can be best summarised in the following diagram:

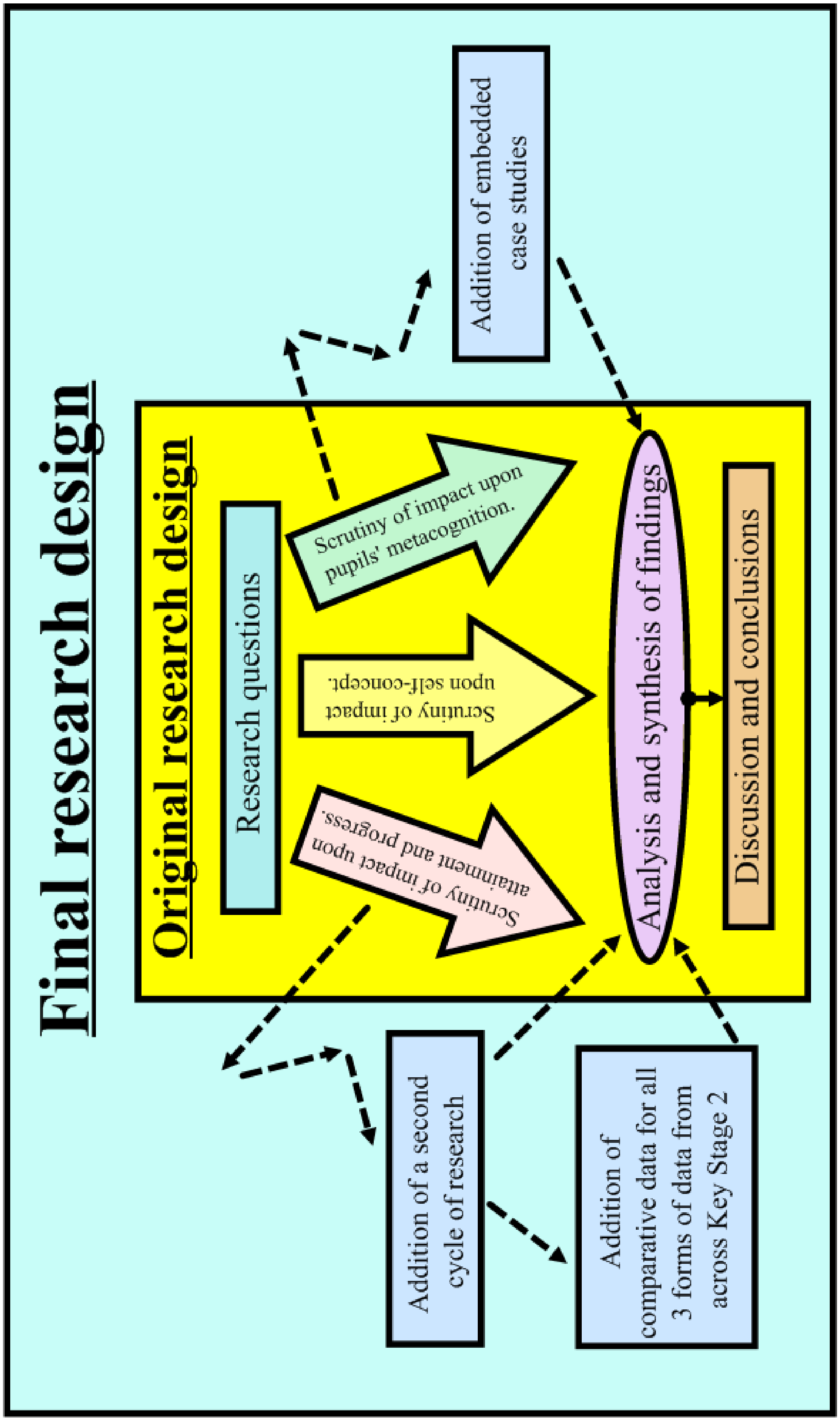


Figure 3.1 Research design

This diagram shows that, although originally intended to be relatively straight forward and linear, this research ultimately became rather messy as a result of my attempts to fulfil my 'duty' as a pragmatic researcher of following my curiosity surrounding the realities of the Thinking Classroom the focus cohort and I succeeded in creating together, as well as adapting to circumstances and findings as they emerged.

For the purposes of this research, I propose to draw upon the work of Bell (1985) by adopting an 'action inquiry' approach, which combines elements of action research and case-study. A diagram of the ways in which these different approaches combine to form the action inquiry approach can be found in Figure 3.2.

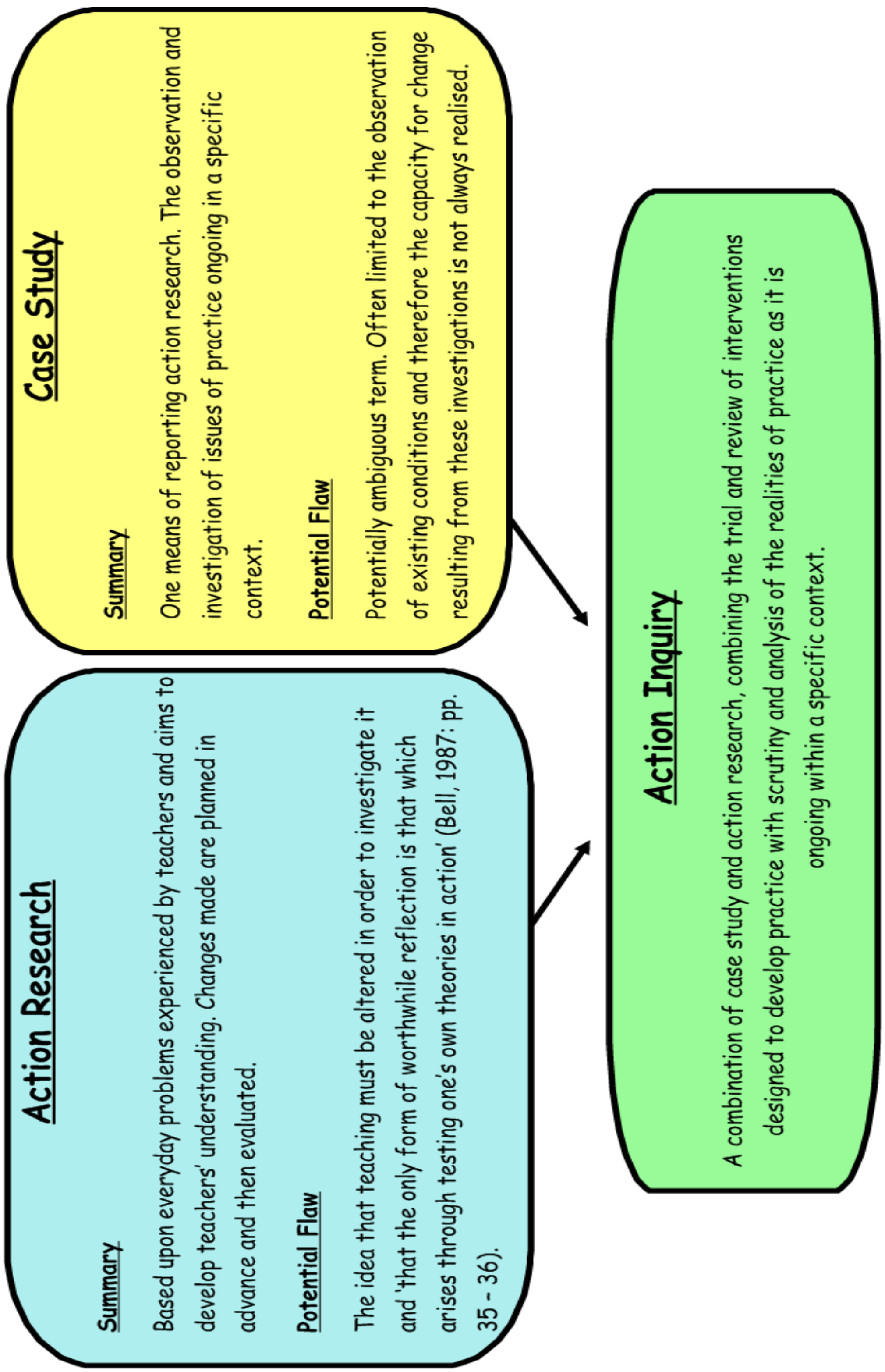


Figure 3.2 Combining action research and case-study in action inquiry (drawing on Bell 1987: pp. 35 - 37)

The action inquiry methodology appears to be ideally suited to this investigation as it allows the introduction and evaluation of a planned change (in this case the introduction of a Thinking Skills approach), which is then captured and described by drawing upon case-study methodology, and then finally 'diagnosing and validating the treatment' (Bell, 1985: p. 182), as it is manifest in this particular working context, through engagement in action learning. The multi-faceted nature of action inquiry tallies with my beliefs about the complexity of the learning process, as well as the uniqueness of each classroom and pupil. Equally resonant is the realistic acknowledgement that

> 'action researchers cannot know in advance what it is prudent to do. Its central point is that through interventions, facts and theories can be tested in order to develop more intelligent practice. By contrast, case study avoids the snare of being imprudent by leaving everything as it is, but in so doing strengthens judgment and not practice. Action inquiry, by combining these elements tests judgment in the practice of the case' (Bell, 1985: p. 183).

In this way, research following an action enquiry approach is free to form 'a self-reflective spiral of planning, acting, observing, reflecting and re-planning' (McNiff, 2015). This is extremely fitting for the type of research which I believe is most ethical within the classroom: that which instantly adapts to suit the needs of the pupils, rather than to doggedly persevere in a set way of working after a means of possible improvement becomes apparent. This is also in keeping with the notion of reflexivity, another of the principles for validation in action research described by Heikkinen *et al* (2007), in which

> 'development is based on previous actions. Reflection also serves as the momentum that triggers the next cycle of reflection. Based on reflective evaluation of previous action, new insights emerge as to how to plan new practices of action and new practices of research. New prospects will open up both in action and in the research approach. Development is not merely development of actions, but also development of research methods, ways of thinking and theoretical formulations. A research project may occasionally give rise to a completely new research question or even a new project' (p. 12).

Thus, I view this research, rather than as the rigid 'testing' of a particular intervention, to be the descriptive account of an exploratory process; one that originated in response to an area for development within my own classroom. A representation of this process can be found in Figure 3.3.

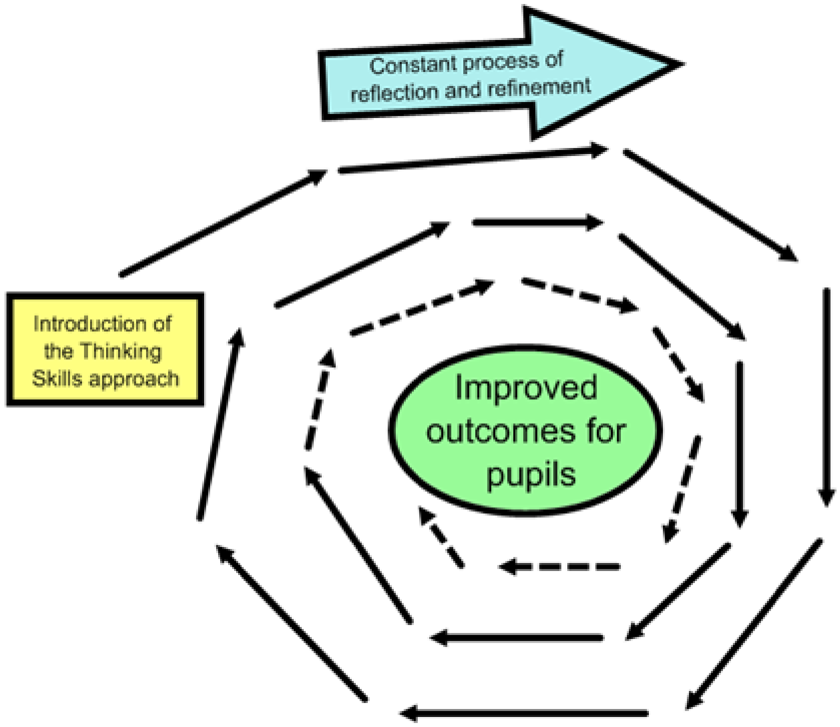


Figure 3.3 The spiral nature of the development of the Thinking Skills intervention

3.5.1 *The use of case-studies*

The stories of Harry and Grace form 'embedded case studies' (Yin, 2009: p. 50) as they consist of multiple units of analysis, again encompassing both qualitative and quantitative data. They are intended to enrich the evidence collected throughout this research, offering further insight into the experiences of the children in the focus cohort. This is an aspect of this account that I have come to feel quite strongly about: I believe the analysis of data – and in particular the use of 'averages' – can lead to an abstraction of this information from the pupils themselves. The children of the focus cohort and I worked together closely during the 2011 – 2012 and 2012 – 2013 academic years, spending five days each week together as teacher and pupils. The Thinking Classroom that was developed during the course of this research was very much a shared venture, and I feel that, by telling the story of these two very special pupils, this thesis more readily reflects the spirit of this research: aiming to tell the story of two years in the life of a particular classroom and the individuals working within it, rather than simply to provide clinical detail of data obtained from research participants.

The eventual inclusion of these case studies also marks a considerable shift in my understanding of myself as a teacher-researcher and the types of evidence which I consider to be of most value. These case studies are intended to describe my own interpretations of the children's experiences as they are documented in their pupil views templates*. As such, they are subject to my own interpretations, and constitute a substantial departure from my previous unconscious bias towards quantitative methods. As such, the use of these case studies is not only important in terms of the information they provide regarding the impact of the Thinking Skills approach upon pupils' experiences of Maths, but is also perhaps the most obvious evidence of my own learning about myself as a teacher-researcher.*

The link between teacher research and case-study methodology is well established: Flyvbjerg (2004) asserts that 'more discoveries [stem] from the type of intense observation made possible by the case study than from statistics applied to large groups' (p. 429), and there are even those, such as Lytle and Cochran-Smith (1992) who maintain that 'Almost by definition, teacher research is case study — the unit of analysis is typically the individual child, the classroom, or the school' (p. 466). Nevertheless, it is important to recognise that, if research is to provide a 'basis for judgement about the action that individual teachers might take in their own settings' (Rudduck, 1985: p. 123), the task of generalization is shifted from the researcher to the reader. In other words, the reader is responsible for determining whether or not the research is relevant to their own situation. Although this shift in responsibility follows logically from the belief that knowledge is largely reliant upon its context, it had profound implications for this study. Larsson (2009), for example, argues that by granting responsibility for determining whether or not research is relevant to the reader, 'the description of the context of the interpretations is given this new function: to communicate a context to an audience, which has the role of judging whether some context they know about is similar to the researched context' (pp. 32 – 33). The description of the case thus becomes fundamental, and it becomes the job of the researcher to describe this as objectively - as openly and honestly - as possible.

Although this may appear straightforward, it is not without complications. Rudduck (1985) writes that the

> 'eyes of teachers have two weaknesses: because of the dominance of habit and routine, teachers are only selectively attentive to the phenomena of their classrooms. In a sense they are constantly reconstructing the world they are familiar with in order to maintain regularities and routines. Secondly, because of their busyness, their eyes tend only to transcribe the surface realities of classroom interaction. The aim in teacher research is for the teacher to attain the eyes of the artist, for it is art that teaches the sensitivity of being attentive to significances that normally remain uncelebrated' (p. 125).

This issue of objectivity strongly influenced my choice of data collection tools. As Stenhouse (1979) explains, 'it is clear that any description […] rests upon the judgment of him who observes and describes, both in respect of what he selects as worthy of notice and in respect of interpretative perception' (p. 8). Whilst I believe that, to make this research useful to me as a teacher, it is necessary to interpret the findings using my own judgment, I also recognize that, to be relevant for other practitioners, the data used to support my conclusions about my own specific context must be allowed to speak for itself. Indeed, Freire warns of the danger of assuming that 'the obvious is clearly understood' (1972: p. 5), emphasizing that all educational practice suggests some form of theoretical standpoint on the part of the teacher: it is the result of a personal interpretation of the world around us. Freire maintains that, most of all, it is the 'possibility of the act of knowing through his praxis, by which man transforms reality. For man, this process of orientation in the world can be understood neither as a purely subjective event, nor as an objective or mechanistic one, but only as an event in which subjectivity and objectivity are united' (1972: p. 5).

Thus, observations made by those on the outside may be influenced by previously held beliefs, or run the risk of being misinterpreted. This is particularly true when the subject of investigation is an internal process, and not easily visible to external observers. Therefore, to ensure that the data collected here is reliable, I have selected data collection tools which, as far as possible, allow the pupils of West Side Primary to express their own opinions and descriptions of their learning experiences, in their own words. This allowed me to recount the underlying story of this research in a logical sequence, thereby ensuring historical continuity, one of the five validation principles for action research defined by Heikkinen *et al* (2012), who believe that it 'is important to show the causal relations underlying the story, which are also considered important in the Galilean tradition, and simultaneously to emphasize the intentionality and teleology of human actions, which represent the Aristotelian logic of action' (p. 8).

This decision was strengthened by the work of Pascal and Bertram, who, drawing upon the 'mosaic' metaphor proposed by Clark, McQuail and Moss (2003), advocate the use of multiple data collection tools when collecting the views of children, stressing that 'listening to young children is an active process of receiving, interpreting and responding to their communications. 'Listening' includes using all the senses and emotions and accessing children's range of communication is clearly not limited to the spoken word' (2009: p. 255). As a result, I determined to use data collection tools which recorded pupils' perceptions in their own words, such as the pupil views templates, so that the data given in support of my findings is not just given in my own words, but in those of my pupils, the subjects and fellow participants in this research. This was particularly important in light of my beliefs regarding the importance of involving pupils actively in research, as well Article 12 of the UN Convention on the Rights of the Child (1991). However, this also served to further enhance the validity of this research by adhering to another of the principles described by Heikkinen *et al* – the principle of dialectics – by aiming to 'reproduce the voices of different people as authentically as possible - and to keep them so genuine and original that the informants can recognize their own thinking in them' (2012: p. 9).

3.5.2 *The implications of working as a teacher-researcher*

The desire to involve pupils actively in the research process was not without complications. One potential concern involves the trustworthiness of data and that 'children will tell researchers what they want to hear, or that their responses change often' (Dockett & Perry, 2007: p. 51). As I have outlined above, I was careful, when selecting data collection tools for this research, to choose methods which would allow the pupils to express themselves in their own words, thereby reducing confusion or the incorrect interpretation of pupils' opinions, feelings or perceptions. These research tools were also largely used as pedagogical tools, providing feedback upon the children's experiences of the Thinking Skills approach, enabling me, as teacher-researcher, to develop teaching and learning to best suit the needs of the focus cohort. However, with regard to the 'trustworthiness' of the children themselves, I find this notion to be somewhat patronizing, suggesting that pupils are not sufficiently self-aware for their views to be considered valid or relevant, or that their opinions are less important, or less to be considered than that of older research participants.

Working with children daily, I know that even very young children have strong opinions and, whilst I may not always agree with these – just as I do not agree with all adults – these opinions nevertheless colour the experiences of these pupils at these particular points in time, and whether or not these views subsequently change does not alter their importance at the time these views were given. Instead, it seems practical to accept the logical assumption that 'children, as adults, may have many different perspectives on the same issue, and that these are reflective of their context/s' (Dockett & Perry, 2007: p. 49). This research, like that conducted by Dockett and Perry (2007), does not aim to demonstrate that there is 'one accurate interpretation of data and the generalizability of results' or indeed that 'all children in all contexts have the same views, or even that the same children have the same view all the time' (both p. 49). Rather, the aim of this thesis is to describe this research, together with my own interpretation of my findings, in a transparent manner, leaving other researchers free to make their own interpretations.

Thus, the focus of this thesis, rather than describing a concrete 'truth' is instead the accurate and honest representation of this research. This relates to Hammersley's (2003) distinction between informative and educative research, and his view that, because education research is practical, as opposed to theoretical, in nature, it must not be concerned 'with producing knowledge but rather with determining what is the right course of action in particular situations' (p. 7). I agree with Hammersley that this research is inextricably linked to its context and thus can only ever aim to be informative by providing readers with information that could be relevant to their own classroom practice. Thus, I believe that I have neither the duty, nor the right to 'control the way in which people derive practical or policy implications from the knowledge provided, or to try to control what people do on the basis of it. The only obligation and right, in this context, is to seek to correct any misrepresentation of the knowledge supplied' (2003: p. 18).

It was important to me – in light of my beliefs regarding the importance of the establishment of a community of learners within our classroom – to consider how the pupils themselves should be encouraged to engage with this research. I believe that, when initially designing this study, the notion of power was important. As Dockett and Perry (2007) observe, ‘Determining what is researched is a critical part of negotiating the research space. Researchers, by necessity, develop a plan to investigate particular elements of experience. The opportunities for children to engage with these plans, to change and redirect them are important to consider’ (p. 59). In this research, it was therefore important to consider who determined the direction of research and how the Thinking Skills approach was to proceed following its introduction into the classroom. In taking this approach, I very firmly followed Dockett and Perry (2007) in refusing to view my pupils as the passive subjects of educational research, but instead strove to ‘promote children’s involvement in ways that recognize the competence of children and emphasize the importance of the perspectives of those living the experience’ (p. 48).

Of course, I was ultimately responsible, as teacher-researcher, for identifying the areas of interest and specific research questions for this study. Nevertheless, whilst I do not believe that a classroom can be truly democratic – with all participants on a completely equal footing – it is possible to more evenly balance the scales. At the outset of research, all children were informed about research during an informal discussion, and had the opportunity to ask questions and gain further information. I was particularly careful to establish a culture of openness and honesty regarding this research: in undertaking this investigation it became clear to me that the issue of willing participation is not merely one of consenting to become involved in an educational initiative, but is instead a more complex matter inextricably related to the power dynamics of the classroom. Consequently, it was important to ensure that children understood when research was taking place.

In some respects, this was relatively straightforward: the focus cohort and I discussed each data collection tool as it was used and pupils also had the opportunity to choose whether or not to submit the completed tools for consideration in this research. I am thus confident that, each time the data collection tools were used, pupils both understood that research was taking place, and were able to choose whether or not they wished their views to be included at each individual point in the data collection process. However, particularly as research – and my beliefs as a teacher-researcher - shifted and solidified from a quantitative bias towards a more interpretivist approach, relying more heavily upon my everyday observations and upon anecdotal evidence, it was important to recognise that research was actually ongoing or continuous: it was our daily Maths lessons and thus, whenever we were engaged in a Maths lesson, we were simultaneously engaging in research.

This was rather more challenging to convey to pupils as it was necessary for them to keep in mind that each of our lessons could now become the focus of scrutiny in order to ensure that they remained well-informed regarding the research that was undertaken, and to try to ensure that observations did not become covert; committed without the pupils' knowledge or consent and, therefore, something that was done *to* them rather than *with* them. In order to achieve this, I reminded the pupils regularly about my research – at least weekly – whether this was through discussions which were carried out when the various data collection tools were used; through updates regarding progress and findings; or even just in conversation. The creation of our Thinking Classroom was also essential. The day-to-day sharing of our thinking about Maths – both in terms of mathematical concepts, and discussions of effective strategies for teaching and learning – needed to be embedded in our classroom routines in order to ensure that this new way of working was familiar to children and that they knew this was of profound interest to me, thus ensuring that they shared their views and ideas with me readily during the course of lessons rather than waiting to share views at a pre-determined time, potentially limiting the extent to which pupils shared their opinions and ideas.

I also felt that it was fundamental that pupils were informed about the progress made throughout the course of research, together with information regarding any findings. To do this, I created a 'Feedback Station' next to the 'working wall' display for Maths. This included information about their responses, and also provided a further opportunity for the pupils to vote to say whether they agreed, or to comment on these, adding further information. I believe that this provided a means of involving the pupils of the focus cohort in the process of data interpretation as co-researchers, thereby 'ensuring that findings are grounded in the perspectives and experiences of children themselves as opposed to reflecting adult interpretations of children’s perspectives’ (Lundy *et al*, 2011: p. 725). Topics for discussion included on the ‘Feedback Station’ included “Sam thought about what helps him when he gets stuck. He uses our Maths working wall, RUCSAC and talking with people on his table. This made me think – what do the rest of you do when you find something difficult? What can you do to help yourself?” or “Jane thinks that having targets for Writing helps her know what she needs to do to improve. She thinks it might be a good idea to have targets for Maths too. What do you think?”[14] This display was changed each half term, to provide feedback on the latest data collected, and so provided a means for pupils to continue to develop their thinking about the ways in which they learned Maths. A photograph on the ‘Feedback Station’ can be found in Plate 3.1.

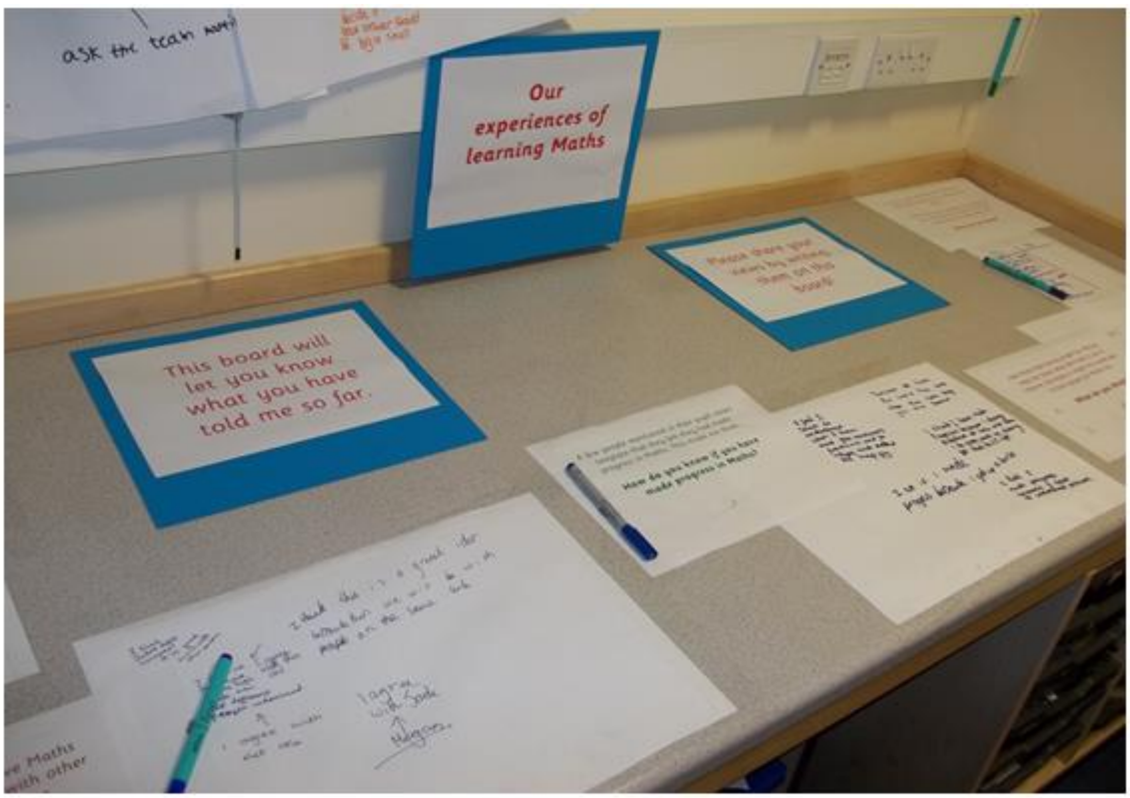


Plate 3.1 The ‘Feedback Station’

The ‘Feedback Station’ was particularly interesting because of the role it played in steering the direction of research. It allowed us, as a class, to further explore some of the ideas and issues emergent from the pupil views templates and provided the opportunity for pupils to influence classroom policy. For example, according to the outcome of discussion of the

[14] Please note that all names have been changed to preserve anonymity.

topics included in the 'Feedback Station' display, classroom practice was altered to incorporate some of the suggestions made by the children themselves. This led directly to the introduction of targets for Maths, the increased use of particular types of activities, and a range of classroom management techniques ranging from the grouping of tables within the classroom, to the use of talk partners at particular points during lessons.

I believe that the 'Feedback Station' was crucial as it ensured that the pupils felt that the Thinking Classroom was a joint venture – something that we developed together – rather than something which was imposed upon them, as it was regularly adapted and evolved to incorporate ideas which they had suggested, and that they believed would benefit their learning, or ideas which had been generated during shared discussion. Consequently, the children were able to see that their contributions were both highly valued and formed the basis for future action, and I believe that this contributed greatly not only to children's motivation in engaging in the reflective process, but also prompted them to more actively consider their learning and how best this could be developed. As a result, the Feedback Station became not only a means of developing shared understanding of the outcomes of the introduction of the Thinking Skills approach, but also a further element of the Thinking Skills intervention itself by guiding pupils to engage in metacognition by inviting them to carefully consider their thinking when reflecting upon their learning experience.

3.6 The research process

This study was subject to substantial evolution as it progressed, and eventually incorporated two distinct phases of research. The first was conducted whilst the focus pupils were in Year 5, during the 2011 – 2012 academic year. Following initial analysis, it became clear that the attainment data collected to answer the first of my research questions – what is the impact of the Thinking Skills approach upon pupil progress and attainment - was inconclusive. As a result, I decided to introduce a second cycle of research. I make no apology for this departure from my original intentions. On the contrary, under pragmatism it is the ''duty'' of researchers 'to be curious and adaptable' (Feilzer, 2010: p. 14), and this adaptability is also in keeping with the notion of reflexivity, one of the principles for validation in action research described by Heikkinen *et al* (2007). I believe that this flexibility is necessary to take full advantage of any opportunities which may arise from unforeseen circumstances or the emergence of unexpected data, in order to understand the realities of the classroom.

Because of the uncertain nature of the impact of the Thinking Skills approach upon progress and attainment – and thus my inability, at this point in research, to respond decisively to the first of my research questions - I decided to make this the focus of the second phase of research. Consequently, this cycle of research focused predominantly upon attainment, complementing the priorities of West Side School, and my own new role as Year 6 teacher. Like it or not, the success of the teaching and learning ongoing in schools is largely determined by the Key Stage Two S.A.T.s results, and thus progress and attainment are foremost in the mind of almost every Year 6 teacher!

3.6.1 *A Mixed Methods approach*

During this research, I employed several data collection tools to capture the complexities of my classroom reality. This encompassed both quantitative and qualitative forms of data, each designed to capture information relating to a specific aspect of my enquiry. The use of multiple data collection tools provided a means of comparing - and therefore supporting or contradicting - the information gathered, significantly reducing the risk of bias. Mixed methods research is considered by many - including researchers such as Symonds and Gorard (2010), as well as Groundwater-Smith and Mockler (2007) - to be essential to the generation of reliable findings. Multiple methods, each with their own advantages and perspectives, will always produce more comprehensive data than a single method alone, facilitating capture of what Pring describes as 'the richness which is present in that non-technical everyday understanding of experience' (2000: p. 248).

The idea that qualitative and quantitative methods combine to allow greater insight links to the concept of synergy in which 'two or more options interact so that their combined effect is greater than the sum of their individual effects' (Hall & Howard, 2008: p. 251). Indeed, I believe that this study can be classified as synergistic mixed methods research because I am 'less interested in highlighting the similarities between methods of a mixed methods study but more interested in using methods that inherently contribute multiple points of view on the topic of interest' (Hall & Howard, 2008: p. 252). Consequently, I believe that the use of these multiple forms of data allows me to more accurately reflect the reality of the Thinking Classroom that the focus cohort and I created together, and that this, in turn, allows me to present a form of education research which serves the informative purpose outlined by Hammersley (2003) in that it does not seek 'to control the way in which people derive practical or policy implications from the knowledge provided, or to try to control what people do on the basis of it' (p. 18) but rather attempts only to provide practitioners with information which may be relevant to the development of their own classroom practice. Therefore, the 'only obligation and right, in this context, is to seek to correct any misrepresentation of the knowledge supplied' (Hammersley, 2003: p. 18): in other words, it is the duty of the researcher to represent findings as fully and honestly as possible.

The data collection tools thus included quantitative methods, such as attainment data – which aimed to address the research question relating to the impact of the Thinking Skills approach upon pupils' progress and attainment - and the Self Description Questionnaire (Marsh, Smith and Barnes, 1983) – which aimed to gather data to address the research question relating to the impact upon pupils' self-concept relating to Maths. In addition, more qualitative methods were also used, such as pupil views templates, which aimed to address the research question relating to the impact of the Thinking Skills approach upon pupils' metacognition. These tools were specifically chosen to encompass multiple learning styles, as well as both paper and I.C.T. based formats, to provide a wide range of means by which I, as teacher-researcher, could 'listen' to pupils' experiences of Maths. It is also important to note that these distinct data collection tools, together with the different forms of data they collected, were considered equally valuable. This again corresponds to a synergistic approach to mixed methods research, in which neither a qualitative nor quantitative approach 'inherently overrides the other because researchers value the contributing epistemologies, theories, and methodologies equally all the time despite necessary fluctuations in the use of either quantitative or qualitative methods throughout the research process' (Hall & Howard, 2008: pp. 251 – 252).

It is interesting, with hindsight, to reflect upon my thinking here, particularly with regard to the lengths that I go to here to emphasise my beliefs surrounding the equal value that must *be places upon quantitative and qualitative evidence. This chapter was initially written whilst the data collection process, as well as the subsequent analysis, was still underway. Moreover, it was written at a time when my thinking about my own research as well as my beliefs about myself as a teacher-researcher were still very much in development. Consequently, it was written at a point before I had fully recognised my subconscious bias towards quantitative methods and fully embraced the shift towards a more interpretivist approach. Yet, I think it is important, in reading the above, to acknowledge the previous discrepancy between my acknowledged beliefs and the realities of my practice as a teacher-researcher. I hope that, through the adaptation of this research – in particular the eventual inclusion of the embedded case studies – I have ultimately succeeded in bridging the gap between my beliefs and practice.*

Further detail of the different formats of these data collection tools and the information they collect can be found in Table 3.1.

Data collection tool	Information gathered	Format	Form of data
Pupil views template	Pupils' experiences of Mathematics learning	Drawing and short written notes	Quantitative and qualitative
Self-Description Questionnaire	Pupils' academic self-concept relating to Mathematics	Multiple choice questionnaire	Quantitative
Scrutiny of attainment evidence	Pupils' progress in Mathematics	Teacher-only analysis of attainment data	Quantitative

Table 3.1 Information gathered by data collection tools

The tools used during the first phase of research formed part of a 'cycle of complementary phases and activities' (Gorard & Cook, 2007: p. 316), with quantitative and qualitative methods serving to enhance and verify the data obtained from the other. Figure 3.5 contains a representation of the data collection tools used during the first cycle of research, highlighting the way that the data gathered formed part of the feedback loop.

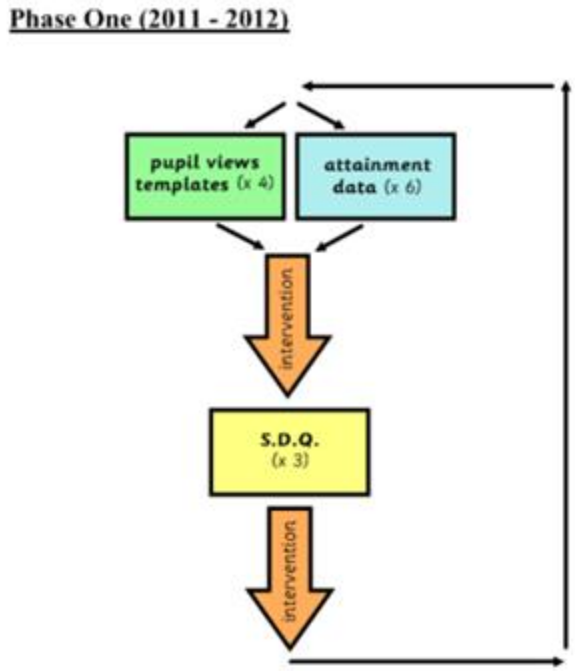


Figure 3.4 Cycle 1 data collection

As the diagram illustrates, the cycle of research was repeated throughout the academic year. The S.D.Q. – or Self-Description questionnaire, developed by Marsh, Smith and Barnes (1983) to analyse self-concept in preadolescents and adolescents - for example, was completed three times during the data collection process, whilst the pupil views templates were completed on four separate occasions. This was a conscious decision, ensuring that the information collected by each data collection tool was compared with that produced by the others, as well as by the data collected at each of the stages of the data collection process, thereby facilitating the identification of patterns and anomalies.

It is also important to note the impact that the repeated use of these data collection tools had upon the validity of this research. These tools formed an integral part of the Thinking Classroom: because each tool was specifically chosen to allow, and even encourage pupils to reflect upon their experiences of Maths, it is logical to expect that repeated use also helped pupils to develop their ability to do so. The repeated use of these distinct data collection tools can thus be seen to have served to enhance both research – in terms of providing a means of comparing different data sets in order to identify patterns and anomalies, ultimately combining through use of a mosaic approach to capture the richness of our classroom reality - and pedagogy – in terms of providing pupils with frequent opportunities to reflect upon their learning and Maths, thereby presumably developing the familiarity and skill with which they did so.

The second cycle of research focused more closely upon the impact of the Thinking Skills approach upon progress and attainment and, as a result, the data collected primarily related to this aspect of pupils' experiences of Maths. However, it is important to note that this second cycle of research also included the collection of comparative pupil views templates and S.D.Q. data from pupils across Key Stage Two, as well as a final set of S.D.Q. data in July 2013 and, consequently, the mixed methods approach extended for the duration of the research process. A representation of the data collection tools used during this second phase of research can be found in Figure 3.5.

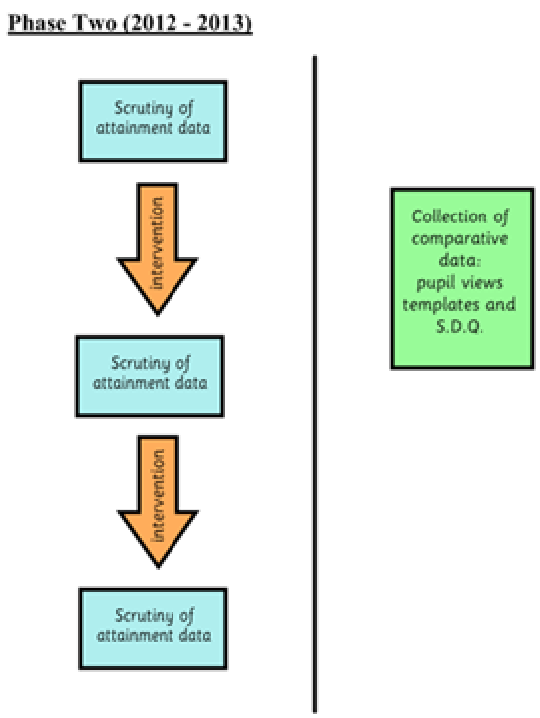


Figure 3.5 Cycle 2 data collection

The adoption of these two distinct cycles of research meant that the data collection process for this investigation as a whole was complex, with multiple forms of data collected at several different points in the research process. As a result, the final research design is testament to my beliefs regarding the importance of pragmatism – in terms of flexibility and the willingness to adapt research in order to meet the needs of my pupils – as well as my belief in the importance of the use of mixed methods research. Table 3.2 contains a brief timetable outlining when the different forms of data were collected.

Cycle 1	Term 1 2011	Baseline attainment data (September 2011) S.D.Q. baseline assessment (October 2011) Pupil views template 1 (December 2011) Attainment data for Term 1 (December 2011)
	Term 2 2012	S.D.Q. (January 2012) Pupil views template 2 (February 2012) Attainment data for Term 2a (February 2012) Pupil views template 3 (March 2012) Attainment data for Term 2b (March 2012)
	Term 3 2012	Pupil views template 4 (May 2012) Attainment data for Term 3a (May 2012) S.D.Q. (June 2012) Attainment data for Term 3b (July 2012)
Cycle 2	Term 1 2012	Baseline attainment data (September 2012) Attainment data for Term 1a (October 2012) Attainment data for Term 1b (December 2012)
	Term 2 2013	Attainment data for Term 2a (February 2013) Comparative S.D.Q. data – Years 3 – 6 (March 2013) Attainment data for Term 2b (March 2013)
	Term 3 2013	**Attainment data for Term 3a (May 2013)** **Attainment data for Term 3b (July 2013)** S.D.Q. (July 2013)

Table 3.2 Timetable outlining the collection of each different form of data

3.6.2 *The selection of case-studies*

Initial analysis of the pupil views templates did not reveal any consistent trends across the whole cohort. This contrasted strongly with my intuition; impressionistically, as teacher-researcher, I felt that there had been a considerable shift in pupils' thinking, reflection and engagement with Maths. Consequently, to further explore the ways in which pupils' thinking had been affected by the increased focus on thinking and the development of metacognition, I decided to more closely scrutinise the views recorded by those pupils whose daily work, verbal and written feedback suggested that they had been most strongly influenced by the Thinking Skills approach.

In this rather pragmatic stance, I followed the guidance of Pettigrew (1988), who suggests that considering the limited number of cases which can usually be studied, it is logical to select extreme situations in which the process of interest is 'transparently observable' (p. 275). Consequently, I chose to further consider the experiences of Harry and Grace during the research process precisely because they intrigued me: I wanted to learn more about them because their comments in their books, their contributions to discussions, and their attitudes towards Maths indicated that a notable change had taken place. The selection of these children can thus also be seen to follow the advice of Flyvbjerg (2006), who argues that, when attempting to maximise insight into a given phenomenon, the selection of random or representative cases may not be the most 'may not be the most appropriate strategy. This is because the typical or average case is often not the richest in information' (2006: p.13). Harry in particular gave frequent comments to explain his reasoning. Examples these can be found in Plates 3.2[15] and 3.3.

I also believe that my decision to follow what, ultimately, amounted to a hunch, based upon my impressions as teacher-researcher, is an important indication of the shift of my thinking, away from an initial reliance upon quantitative methods, and towards increasing confidence in the qualitative: encompassing my interpretations and understanding of the realities of our shared context, gathered through my daily immersion in our Thinking Classroom. Harry and Grace stood out because I could see - from my perspective as teacher-researcher, and in the course of my daily interactions with them, even without consulting the data relating to their progress and attainment, self-concept and metacognition - that the Thinking Skills approach was having a positive effect upon their learning of Maths. Thus, I believe that, in addition to the justification provided above in the form of my references to the work of Pettigrew (1988) and Flyvbjerg (2006), the selection of these pupils as the focus of the embedded case studies can also be seen to follow my own interpretations which, I have eventually come to believe, themselves constitute a sampling frame.

[15] This photograph has been altered to preserve the Harry's anonymity. Please note: the handwriting in red at the bottom of this photograph also belongs to Harry. As part of the Thinking Skills intervention, children were expected to respond to all comments made in their books.

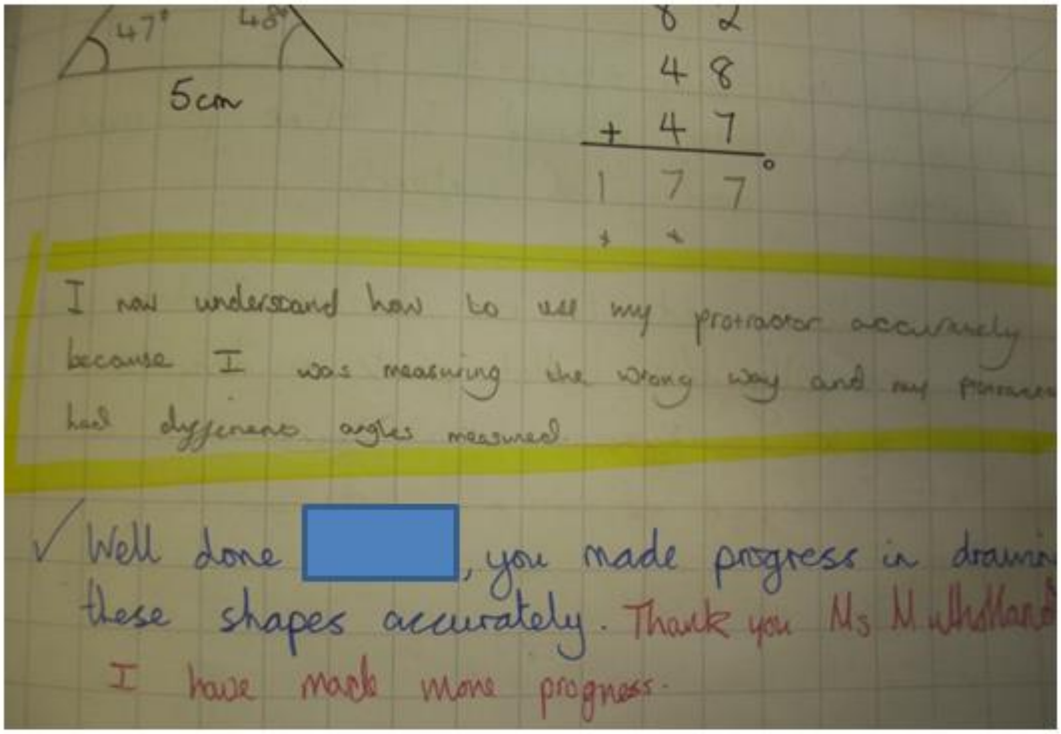


Plate 3.2 An example of Harry's explanations relating to progress

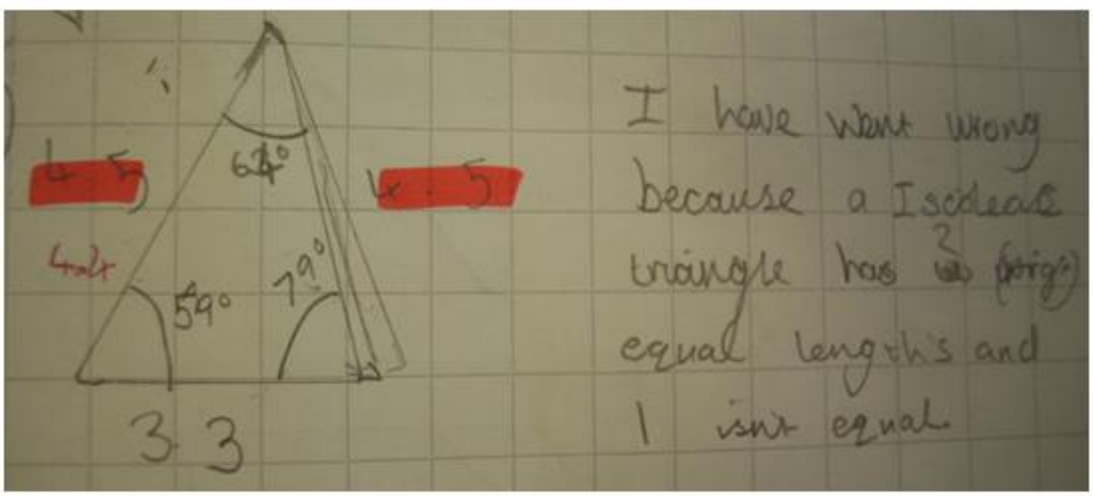


Plate 3.3 An example of Harry's explanation of his mistakes

Unfortunately, this decision was made towards the end of the second year of research, too late to collect further pupil views templates which may have documented further changes in pupils' thinking and metacognition about Maths learning throughout the 2012 – 2013 academic year. Nevertheless, this focus upon just two individual pupils within the focus cohort did allow me to synthesise evidence gathered from all data collection tools, in an attempt to better ascertain how pupils' experiences of Maths learning had been affected by the introduction of the Thinking Skills approach. As a result, the analysis of the data collected during this research also took several forms. This is illustrated in Figure 3.6.

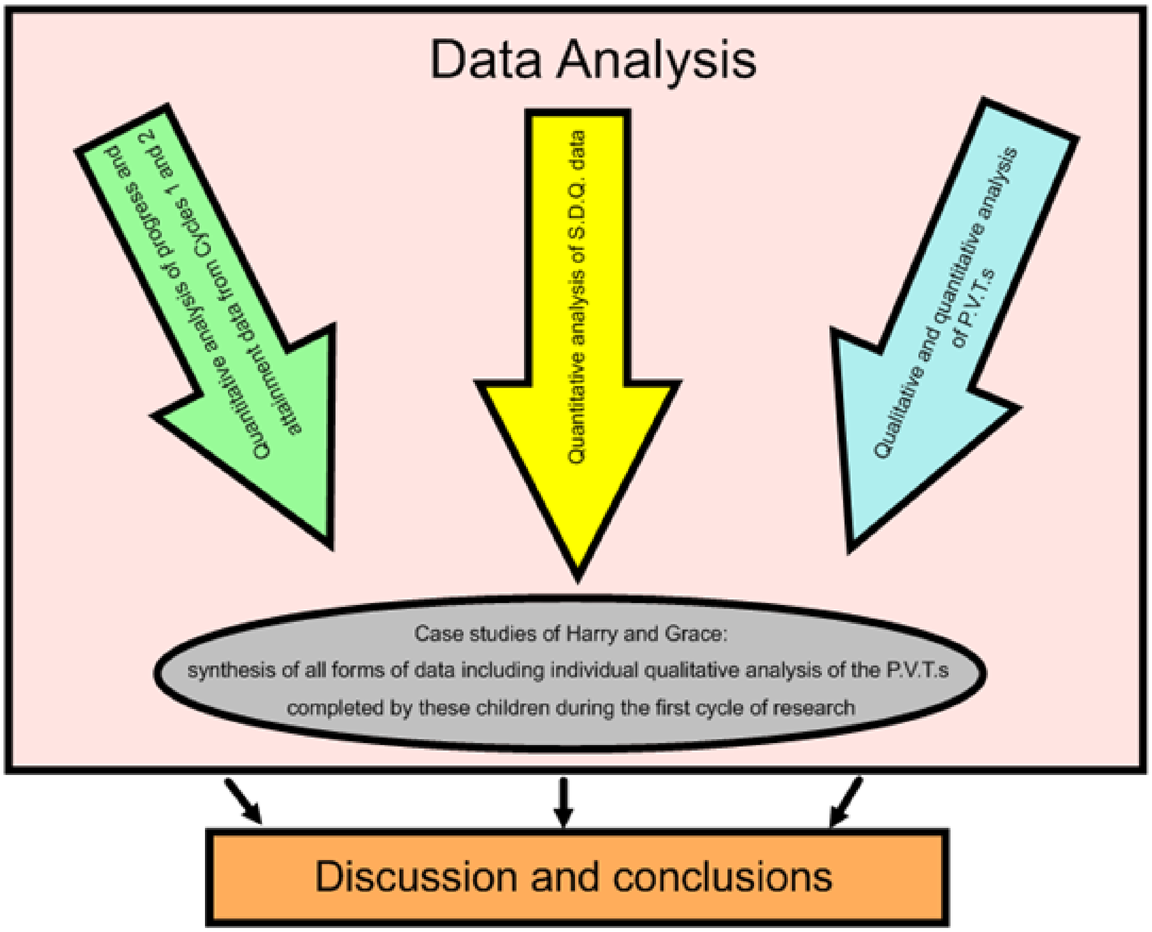


Figure 3.6 Different forms of data

As this figure suggests, the case-studies permitted in-depth analysis of all of the data – including data relating to progress and attainment, self-concept data from the S.D.Q. and responses recorded using the pupil views templates - collected from these two individual children. The substantial reduction in the quantity of data to be considered allowed me to scrutinize each form of information in turn in order to simply learn from it, to seek out what patterns or anomalies may emerge from it, rather than attempting to carve out links, however tenuous, to preconceived ideas. It also allowed me to more easily compare and contrast the findings emergent from these distinct forms of data, thereby gaining a more holistic picture of how Harry and Grace were affected by the introduction of the Thinking Skills approach.

These case-studies thus provided a means of constructing a more coherent narrative surrounding the learning experiences of specific children, deepening understanding of the realities of teaching and learning within our Thinking Classroom. However, it is important to recognise that this does not imply an assumption that there is an objective reality which can be uncovered through the combination of varying, multiple perspectives but rather that the process 'of examining a research context in different ways, from different perspectives is important in our attempts to describe and understand the social worlds being investigated' (Dockett & Perry, 2007: p. 53). This process of contrast and comparison thus becomes a process of enriching understanding of the impact resultant from the introduction of the Thinking Skills approach rather than as a means of determining a single 'truth' about the experiences of 37 distinct individuals, each with their own personal perceptions.

3.7 Methods of data collection

Having described the overall research process, it remains to describe the individual methods that were used for data collection. An outline of the design of these methods, together with a rationale for their selection, and further detail regarding the analysis of the information collected, can be found in the remaining section of this chapter.

3.7.1 *The role of attainment evidence*

Attainment evidence was used to answer the first of my research questions: what is the effect of the Thinking Skills approach on pupils' progress in Maths? This was important because - whether we like it or not - schools, teachers, and educational interventions are primarily judged by their effectiveness upon pupils' progress and attainment and thus I believe that to overlook this facet of pupils' experience of teaching and learning would be almost incredible in this age of accountability. This data is quantitative and arguably constitutes the most concrete, objective evidence of pupils' learning in Maths throughout the research period.

Having decided to include attainment data in this study, it was logical to make use of the teacher assessment data – given in National Curriculum levels - routinely submitted each half term to West Side Primary's Senior Leadership Team. National Curriculum levels are the primary means of comparison used by bodies such as Ofsted to assess pupils' progress, and to compare schools in the government-produced league tables. Indeed, assessment, in terms of these National Curriculum levels, is one of the key elements of my role as a teacher, and thus it was a very straight-forward and pragmatic decision to make use of this data – data that I am contractually obliged to generate regardless of any additional research that I may or may not be undertaking – rather than seeking to re-invent the wheel by constructing some new and personal form of assessment which would also prevent comparison with previous cohorts or with similar groups of pupils nationally.

West Side School policy requires that teacher assessments for each individual pupil should be determined using the 'Assessing Pupils' Progress', or A.P.P., document. Typically, a range of independent work, including tasks completed in pupils' books, weekly mental Maths tests, end of term or post-unit assessments, and practice S.A.T.s papers, were used to determine to what extent pupils' had fulfilled the various assessment criteria for each National Curriculum level. An example of a completed A.P.P. document can be seen in Plate 3.4.

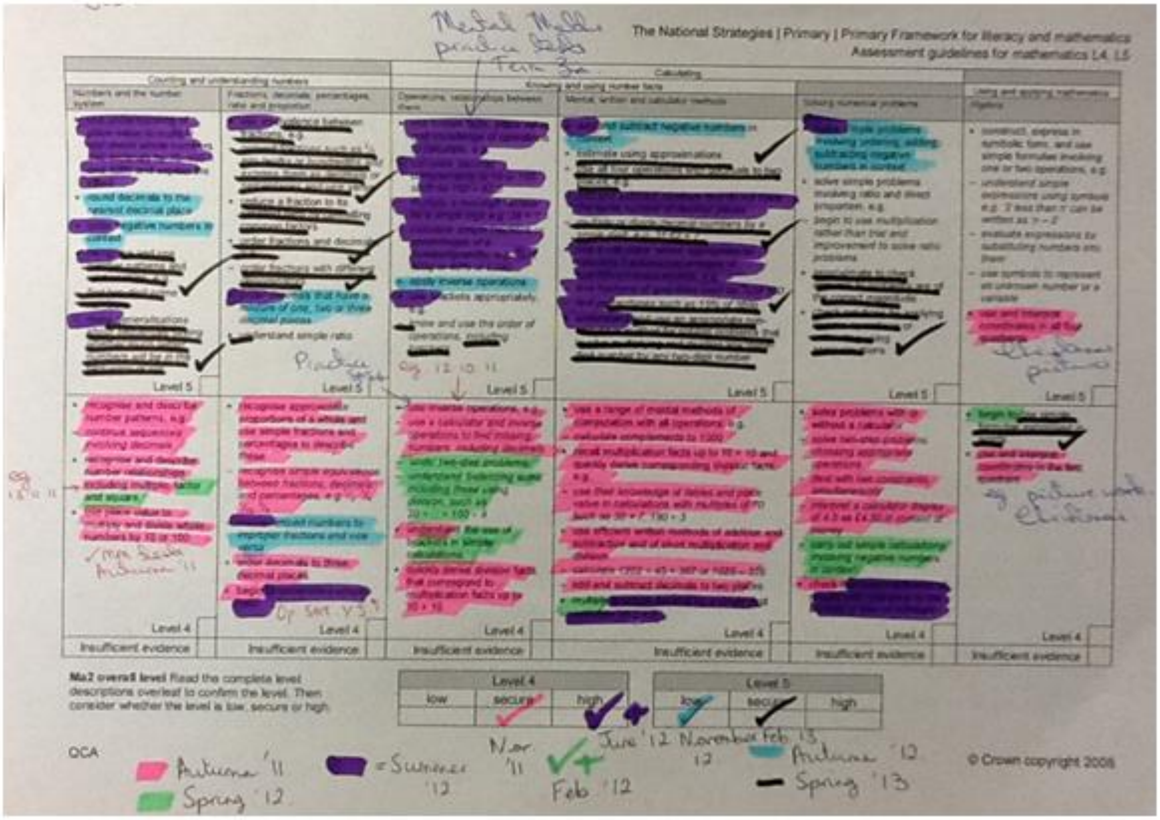


Plate 3.4 A completed A.P.P. document

The various annotations refer to the dates when pupils demonstrated their ability to complete the Maths described in each assessment focus. Usually, two or three pieces of evidence were referenced before a pupil could be considered to have mastered each aspect of Maths. Substantial guidance has been produced to advise teachers on the proper use of A.P.P. to successfully 'level' pupils' work, thus enhancing the reliability of judgements made using this particular system. In addition, over the course of the several years since the A.P.P. was introduced West Side School developed a system for moderating teachers' judgements, further increasing reliability. Further detail regarding this moderation process can be found later in this chapter.

Whilst, as teacher-researcher, the advantages of the use of this existing progress and attainment data – in terms of the relative ease of collection and subsequent validation – were immediately apparent, there were also a number of drawbacks. For example, during the 2011 – 2012 academic year, there was a small yet potentially important change in the ways in which teacher assessment data was submitted to West Side School's Senior

Leadership Team. At this time, a new assessment system was introduced, measuring progress not just in whole sub-levels, but also in half sub-levels or 'points', thus dividing each National Curriculum level into six, rather than three. This allowed teachers to more accurately describe pupils who were on the cusp just before reaching a new level, or who were consolidating their current sub-level, so that this progress could be reflected in the data routinely submitted to West Side School's S.L.T. without having to account for what may previously have appeared as pupils stagnating, or failing to move sub-levels for prolonged periods of time. The 2011 – 2012 academic year also marked the beginning of this research, and this subtle shift in assessment system meant that the data collected from the focus cohort could not always be compared directly with previous cohorts who had been assessed using the previous system, and whose progress was measured in the larger sub-levels rather than according to the narrower 'points' system.

Nevertheless, even when using this more precise system, I still felt, upon occasion, that the development of my pupils was not always truly captured, so that, for example, whilst sizeable gains may have been made in terms of pupils' confidence and breadth of repertoire relating to strategies for problem solving or reasoning relating to a particular aspect of Maths, this did not always neatly translate to enough extra highlighted boxes on the A.P.P. to merit a move of a 'point' or sublevel. This is, of course, the complaint of teachers everywhere: our pupils make progress yet this is not always accurately represented by standardised forms of assessment and testing which require very specific responses and evidence. Yet, whilst this assessment system is not perfect, I appreciate the need to have some form of standardisation and perhaps also, particularly as a result of this research, acknowledge the difficulties inherent to charting the development of true understanding. Therefore, with all of its flaws, this remains, for me, the most appropriate means of attempting to measure gains in attainment and progress.

Once gathered, this quantitative data was used to compare the progress and attainment of the focus pupils, not only against that expected nationally, but also against previous cohorts in the same school. This allowed comparison both with the progress and attainment of the one hundred or so pupils working within a similar context – that of West Side School, albeit for pupils within a previous cohort – and with the national expectation, a standard used in primary schools across England. In this way, I hoped it would be possible to judge whether the focus year group were representative of other pupils at West Side School, or whether their progress and attainment could be attributed to the Thinking Skills approach. This was done in several distinct stages:

1. average number of sub-levels of progress made during Year 5
2. levels of attainment at the end of Year 5
3. average number of sub-levels of progress made during Year 6
4. levels of attainment at the end of Year 6

The data was analysed using these particular stages primarily for pragmatic reasons, particularly as a result of the evolution of the research process. At the outset of research, for example, I originally intended for this research to span a single academic year. At this time, I did not know that I would have the opportunity to teach the focus cohort as they moved into Year 6. Nor, in all honesty, did I expect the Thinking Skills approach to have so slight an impact upon progress and attainment during the first year following its introduction, although, upon reflection, it would have been logical to do so given the findings of Boaler and Staple's (2008) research at Railside School. The information relating to progress and attainment during the first year of research was therefore collected and analysed with the intention that this would then form a complete data set. This data therefore features in the Part A of the Findings chapter of this thesis and has been given in percentages to reduce the impact of any discrepancies in numbers. Nationally, pupils in Year 5 are expected to make one sub-level of progress. Expected attainment at the end of Year 5 is Level 3a. Pupils in Year 6 are expected to make three sub-levels of progress to reach Level 4b by the end of the year.

It is important to note that the three children who were admitted to Year 5 throughout the academic year have been omitted, as was one child who left West Side School at the beginning of the 2012 – 2013 academic year. These children were not present in West Side School throughout the research period in its entirety, and I therefore felt that their progress could not be solely attributed to the teaching methods described in this investigation. Similarly, it was necessary to exclude them from the analysis of attainment data because of the impossibility, in some cases, of comparing their attainment at the end of Year 4 with that at the end of Years 5 and 6. Equally, it was necessary to discount the data relating to some pupils who were in the two previous cohorts to the focus pupils. Here, data relating to progress and attainment was used as a means of comparison to help situate the results gained from the focus pupils, and thus to more accurately assess the impact of the Thinking Skills approach. These pupils left West Side School at various points between Years Two and Six, and have been discounted because of the impossibility of tracking their progress and attainment throughout the entirety of their primary education.

3.7.2 *The Self-Description Questionnaire*

The Self-Description questionnaire, or S.D.Q., was developed by Marsh, Smith and Barnes (1983) to analyse self-concept. It is based upon the assumption that self-concept is multi-faceted, ‘with perceptions moving from inferences about self in subareas (e.g. academic - reading and mathematics), to broader areas (e.g. academic and non-academic), and finally to general self-concept’ (Marsh *et al*, 1983: p. 334). The version used in this study, the S.D.Q.I. is specifically intended for use with pre-adolescents, and was developed in 1992 and consists of 76 questions, designed to measure self-concept for eight distinct dimensions[16]. These include five dimensions which are predominantly non-academic, such as ‘Physical Appearance’, ‘Physical Abilities’, ‘Peer Relations’, ‘Parent Relations’, and ‘General Self’. The remaining three dimensions relate more specifically to school and academic ability, aiming to ascertain pupils’ self-concept relating to ‘General School’, ‘Reading’ and ‘Mathematics’.

The inclusion of these multiple facets of self-concept relates to the work of Shavelson *et al* (1976) who emphasised the multidimensional nature of self-concept. Indeed, Marsh (2005) stresses that the incorporation of multiple dimensions of self-concept in the S.D.Q. reflects ‘a self-referent category system adopted by a particular individual and/or shared by a group’ (pp. 8 – 9), thus drawing on the tendency for people to identify themselves as either ‘a numbers person’ or ‘a words person’, regardless of their ability or achievement in these areas. It is also important to note Marsh’s assumption that ‘subject-specific components of

[16] A copy of the paper form of the S.D.Q. used can be found in Appendix F.

academic self-concept could be explained by a single, second-order factor of academic self-concept' (Marsh, 1992: p. 35). It is to this end that a more general question for both the non-academic and academic dimensions – relating to 'General School' and 'General Self' – was included in the version of the S.D.Q. used in this study.

Each of the dimensions listed above was the subject of nine or ten statements, interspersed throughout the questionnaire. These statements were rather repetitive, so children were asked for their opinion of each dimension of self-concept several times. Thus, for the statements relating to Maths, for example, children were asked to rate themselves in relation to their opinions of the subject by responding to six different statements: 'I hate MATHEMATICS', 'I look forward to MATHEMATICS', 'I am interested in MATHEMATICS', 'I like MATHEMATICS', 'I am good at MATHEMATICS', and 'I enjoy doing work in MATHEMATICS'. The remaining four statements required children to rate themselves in relation to their perceptions of their performance in Maths lessons: 'Work in MATHEMATICS is easy for me', 'I get good marks in MATHEMATICS', 'I learn things quickly in MATHEMATICS', 'I am dumb in MATHEMATICS'.

The repetitive nature of the different statements allowed comparison of each pupil's responses, not just between different stages in the research process, but also within each individual questionnaire, enhancing the reliability of the data collected, and permitting the generation of a mean score for each of the separate dimensions, thus reducing the potential impact of the 'low correlations found between responses of the same pupils on different occasions' (2006, p. 151) found by Black, Swann and William. Pupils gave responses using a five-point scale, selecting a number to demonstrate whether they found each statement false; mostly false; sometimes false, sometimes true; mostly true; or true. In order to ensure that children understood this scale, we read each question together as each class in the focus cohort completed the S.D.Q. This allowed us to spend a significant amount of time in discussing each question – particularly when initially completing the S.D.Q. – in order to allow pupils the opportunity to ask any questions they wished to ensure that they understood each statement. In addition, because each class completed the S.D.Q. simultaneously in a single space – in each individual classroom for the paper version of the questionnaire, or the I.C.T. suite for the online version – all children were able to hear the questions the pupils asked and benefit from the same explanations and clarifications.

Statements used on the S.D.Q. used both positive and negative wording, requiring pupils to respond to questions such as ‘I hate MATHEMATICS’ and ‘Work in MATHEMATICS is easy for me’ (Marsh, 1992). The inclusion of these negatively worded statements was particularly important to the validity of the tool as this enabled comparison with pupils’ responses to the positively worded statements, allowing me insight into the consistency of pupils’ responses for each dimension of self-concept and to determine the extent to which pupils’ responses to the negative statements correlated with their responses to the positive statements or was this indicative of children’s lack of understanding of statements of this type, the five-point rating scale, or even a lack of engagement with the self-rating process itself. To avoid confusion, when responding to negatively phrased statements, I offered additional explanation and clarification of what each response would indicate. For example, we discussed the fact that, to a question such as ‘I hate MATHEMATICS’, a response of false would actually indicate that pupils enjoyed Maths. The children appeared to grasp the meaning of questions of this type relatively quickly, however I also encouraged them to ask questions whilst completing the questionnaire. Furthermore, because each class in the focus cohort completed the S.D.Q. as a whole, with me, as teacher-researcher, reading each question aloud, all children had the opportunity to hear both questions and any clarification or explanation given.

I was particularly drawn to this data collection tool because of the potential insight it offered into self-concept. Self-concept is held by many, including Marsh *et al* (1995), and Wigfield & Karpathian (1991), to be one of the most potent factors for pupil achievement, with research suggesting that ‘as much as one-third of the variance in achievement can be accounted for by academic self-concept alone’ (McCoach & Siegle, 2003: p. 145). The tool was therefore used to explore the second of my research questions, relating to pupils’ opinions of Maths and their ability to succeed (self-concept). It was used on several separate occasions during the research process in order to chart any changes caused by the introduction of the Thinking Skills approach. It is important to note that this was not the first method that I considered in an attempt to measure pupils’ self-concept. Initially, I considered asking pupils to self-rate themselves as Maths learners using a simple 1 to 10 numerical scale. However, I believe that this method was inferior to the S.D.Q. for several reasons.

Firstly, I believe that this self-rating method would be likely to be less reliable than the S.D.Q. because it would rely upon a single rating, rather than multiple, repeated questions focusing upon the same dimension of self-concept. It would depend upon pupils reflecting carefully upon themselves as learners of Maths in general, and I feel that the pupils would possibly be more susceptible to influence from external or transitory factors which effected their mood on that particular day when rating themselves as learners of Maths, than when self-rating multiple different aspects of self-concept which I believe would encourage pupils to engage in more general reflections. Furthermore, self-rating using the numerical scale would also generate significantly more simplistic data, relating solely to the children in the focus cohort, without a means of comparing data with pupils of the same age in different contexts, or of comparing any shift relating to Maths with that relating to any other dimensions of self-concept. In contrast, a notable advantage of the S.D.Q. was the quantity of comparative data available from previous studies, providing a valuable means of comparing the data gained from the limited number of pupils in the focus cohort, with larger numbers of pupils in different schools in both domestic and international settings.

Further alternatives to the S.D.Q. could include self-concept judgements made by others who 'have sufficient knowledge of a person to be able to infer his or her self-concepts […] the systematic observations by trained observers, the frequency or intensity of specific behaviors, or the results of a skill inventory that is designed to parallel the dimensions of self-concept' (Marsh *et al*, 1983: pp. 336 – 337). I believe that these were not viable for this study because of my views regarding the necessity of actively involving pupils in research: like Lundy *et al* (2011), I believe that ensuring that pupils are given the opportunity to share their views is 'essential if children's rights and best interests are to be duly respected' (p. 716). For me, failure to allow the pupils themselves the opportunity to express their own views in their own words would amount to a disenfranchisement of my pupils, as well as an arrogant assumption that they are not capable of reflecting accurately upon their own beliefs about themselves, and that I – or any other external observer – could determine their thoughts and feelings more accurately than they could themselves. Instead, I agree with Marsh *et al* (1983) that self-concept is 'such a highly personal, complicated and private construct that there are no suitable criteria other than a person's own reports' (p. 336).

There are, however, several potential pitfalls in accepting even the S.D.Q. as a measure of self-concept. Perhaps the most potent of these again related to the question of the stability of children's self-concept. Whilst self-concept is commonly held to be 'relatively stable and "characteristic" of an individual' (Demo, 1992: p. 303), the decline in self-concept during childhood is well-documented, supported by the work of those such as Demo (1992) who suggests that 'children's thoughts and feelings about themselves are generally positive as they begin elementary school but are more negative, self-critical and self-doubting in later childhood' (p. 310). Black *et al* (2006) also reported 'low correlations found between responses of the same pupils on different occasions' (p. 151), challenging the reliability of pupils' responses relating to self-concept and therefore any attempt to attribute change to a particular educational approach.

Yet, this issue of the reliability of data produced by children is not limited to the S.D.Q. Dockett and Perry (2007) observe that there 'is often a sense that children will tell researchers what they want to hear, or that their responses change often' (p. 51). In the design of the S.D.Q. this has been taken into account, with questions varying between those with both positive and negative wording, and with several questions relating to each dimension of self-concept to allow the calculation of a mean score, rather than relying upon a single question alone. Like Dockett and Perry, I would also argue that this issue of trust and consistency is an issue for all research participants, rather than solely children. Certainly, when I reflect upon my own views, these often fluctuate slightly as a result of relatively short term factors: how I feel I am performing at a given time, recent feedback I have received, how tired I am, and so on. Perhaps, rather 'than seeking 'one truthful perspective' from children, we accept that children, as adults, may have many different perspectives on the same issue, and that these are reflective of their context/s' (Dockett & Perry, 2007: p. 49), and, therefore, that scrutiny of these fluctuations may allow further insight into pupils' perceptions and experiences.

The S.D.Q. data was collated using Excel spreadsheets before being analysed in several different ways. Firstly, the responses were listed by individual pupil. This enabled comparison of each child's response in order to establish the consistency of responses of individuals throughout the data collection period. Each time pupils completed the S.D.Q., a mean was calculated for each individual question. These means were then combined to give a mean response for each dimension as a whole. Means were used to limit the potential impact of any inconsistency in pupils' responses to the different questions relating to the same dimension of self-concept.

This approach echoes the analysis used by Marsh, Smith and Barnes (1983), for whose study the S.D.Q. was specifically designed. The multi-faceted nature of this analysis allowed the identification of patterns within an individual's responses at a single, or multiple points during the research period. Comparison of responses within a single questionnaire was important; because each of the eight dimensions measured was the subject of nine or ten questions on the S.D.Q., it was possible to determine whether responses for each dimension were consistent, thereby indicating reliability. This was particularly important in the case of the negatively worded questions, as I felt that these may have been most confusing when combined with the use of the five-point scale. I felt that employing the mean for each of the eight dimensions, whilst also clearly acknowledging any inconsistencies as they occurred, allowed clearest comparison of the responses gathered from each separate set of data.

Each of the above analyses was completed for the focus cohort as a whole, as well as for sub-groups relating to gender and levels of attainment. These were important in light of previous evidence to suggest that girls have 'significantly lower math self-concepts' (Marsh and Yeung, 1998: p. 723). I also felt that further investigation surrounding the impact of the Thinking Skills approach upon pupils working at different levels of attainment may help to clarify the rather confusing existing picture - evident in the differing views of Hu *et al* (2010), McGuinness (2006), Higgins *et al* (2004) and Cardelle-Elawar (1992) - regarding whether the impact of a Thinking Skills approach is more keenly felt amongst pupils of particular levels of attainment.

3.7.3 *Pupil views templates*

Pupil views templates (Wall & Higgins, 2006) were used to explore pupils' thinking about their Maths learning through uncovering evidence of metacognitive knowledge and skillfulness. The tool therefore aimed to investigate the third of my research questions by exploring pupils' understanding of the ways in which they learn Maths (the development of metacognition). The templates were based upon those described by Wall and Higgins (2006), which were specifically designed to 'gather information on pupils' attitudes and beliefs about teaching, curriculum content and school/classroom structures (the process of teaching), but also to go further into the realms of metacognition (thinking about the process of learning)' (Wall, 2008: p. 26). Thus, the pupil views templates were intended to provide an opportunity for children to express – as openly and honestly as possible – their experiences of Maths lessons in order to gain insight into interactions between pupils, and between pupils and the adults working within our classroom, as well as their thinking – about their mathematical learning, or even about matters unrelated to school in general – in order to explore whether or not this was affected by the introduction of the Thinking Skills approach.

Ordinarily, pupil views templates consist of a cartoon image of a specific learning situation, surrounded by thought and speech bubbles. An example of one such template, taken from Wall *et al* (2007: p. 23), can be seen in Plate 3.5.

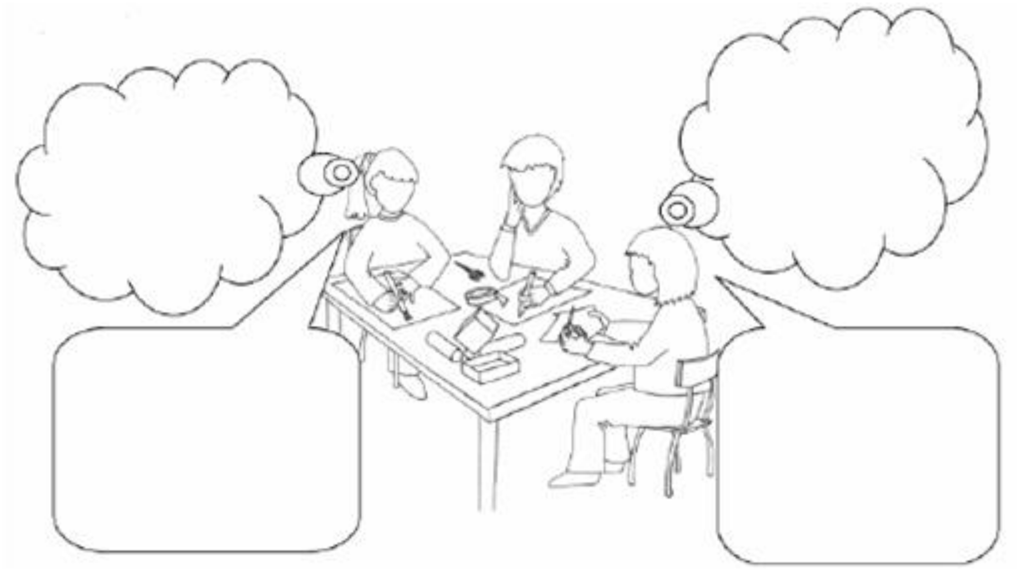


Plate 3.5 A pupil views template taken from Wall et al (2007: p. 23)

The speech bubble was used to investigate factors external to the pupils, such as the behaviour and interactions of those around them, as well as the realities of undertaking a particular task in a specific learning environment. When completing the pupil views templates, the children were therefore asked to record the things that they had said in the course of the lesson they had just experienced. Whilst I tried to emphasise that *anything* that had been said by any person in our classroom could feature in these speech bubbles, the pupils and I also made a shared list of the types of speech that could be included, such as questions asked by group members; shared answers and discussions about working; requests for classroom equipment such as pencils and rulers; and so on.

I was particularly careful to stress that I wanted these representations to be as accurate as possible: the children and I therefore discussed the inclusion of conversations which were not related to learning (for example, about out-of-school activities), again emphasising that the pupil views templates formed part of our research, rather than regular school-work, and that pupils would not be reprimanded in any way for recording conversations which did not focus upon learning but that, on the contrary, I was interested in gaining an honest picture about what children thought and spoke about during lessons. Whilst it is, of course, possible that some children felt obliged to censor the responses they included on this section of the pupil views templates, I believe that it is important to note that others seemed to welcome this opportunity to be honest about their experiences – and sometimes their frustrations – of working with others. This led to the inclusion of comments such as ‘I hope Noch will message me on minecraft all about the cheats and building ideas, Hmm? Arrrr Liam[17]!!!’

The thought bubble was used to encourage pupils to articulate internal processes, which could consist simply of their opinions regarding particular activities, but could also include more developed responses which demonstrate pupils’ thinking about the learning process itself. This thought bubble was particularly important in light of my aim of investigating the development of pupils’ metacognition as a result of the Thinking Skills approach and, again, I emphasised to pupils that any thoughts they had during lessons – whether related to learning or not – could be included in this section of the pupil views templates. However, it is important to recognise that this was not without potential challenges. For example, asking pupils to record their thinking in writing required pupils to draw upon appropriate language, which meant that only aspects of their thinking that they were able to recognise and describe could be captured. Nevertheless, whilst it would perhaps be possible to argue that this would render the insight gained into pupils’ thought processes incomplete, as it may not reflect pupils’ thinking in its full complexity, I believe that it is important to recognise that the pupil views templates are also a means of assessment, in addition to a research tool. Thus, the responses recorded give insight into the metacognitive language that the pupils had to work with at each point in the research process and, as a result, provide a means of charting any change or development.

The images included in the pupil views templates depicted familiar situations, supporting discussion. The argument in favour of the use of images to stimulate discussion is supported by the work of those such as Harper (2000), who argues that ‘the parts of the brain that process visual information are evolutionarily older than the parts that process verbal information’ (p. 13) and that, as a result, ‘images evoke different deeper elements of human consciousness [… evoking] a different kind of information’ (Harper, 2000: p 13). In addition, Wall *et al* observe the potential impact of personalizing the images the pupil views templates contain, finding that adding details of the classroom environment, as well as the faces of teachers and pupils can prompt additional reflection. Furthermore, Wall *et al*

[17] Names from the original data have been altered to preserve anonymity.

acknowledge that tailoring the templates to suit individual pupils or contexts is a ‘useful way to […] reduce any tension or implication that there is an expected or a correct way to complete the template and to ensure that the children are able to express their own thoughts and opinions’ (2007: p. 5).

In light of this potential, I produced a pupil views template which I hoped would enable pupils to describe not only their thoughts and speech, but also to create their own representation of lessons. Allowing pupils to express their views in this way lent a further layer of validity to this research, conforming to the principle of dialectics, giving ‘space to different voices and interpretations of the same events’ and reproducing ‘the voices of different people as authentically as possible - and to keep them so genuine and original that the informants can recognize their own thinking in them’ (Heikkinen *et al*, 2012: p. 9). The images generated thus provided a further level of insight into pupils’ experiences of Maths learning, and was inspired by Picker and Berry’s (2000) use of children’s drawings to investigate perceptions of mathematicians. The pupil views templates used in this research therefore consisted of an allocated space for pupils to draw themselves participating in a Maths lesson, together with both thought and speech bubbles to help them describe their thinking. These templates were given to pupils on A3 paper, and, as they completed the templates, pupils were encouraged to customise the blank format in order to make this their own. For example, children were encouraged to use the additional space on the paper to add as many of their own thought or speech bubbles as they wished in order to provide pupils with sufficient freedom to express their ideas in full and without the constrictions or limitations of adhering to a strictly pre-determined format. An example of one of the completed pupil views templates can be found in Plate 3.6.

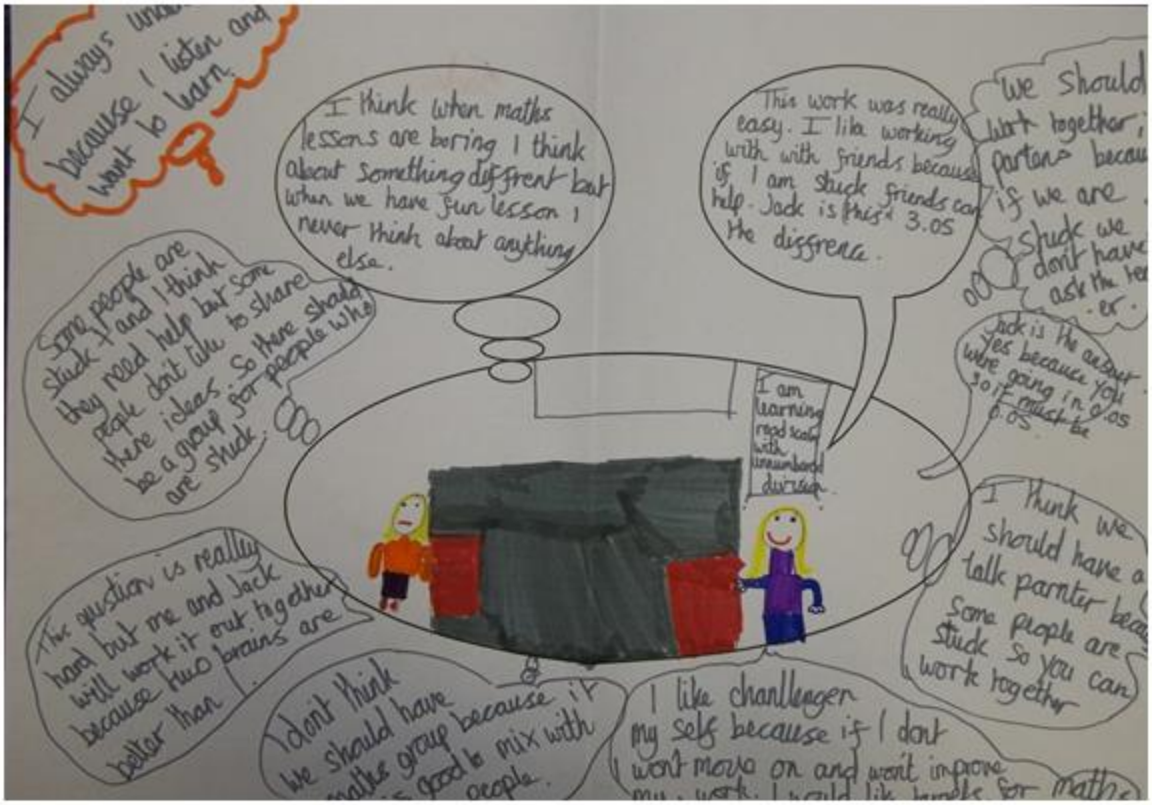


Plate 3.6 A completed pupil views template

Pupil views templates are intended to serve as a data collection tool that can be 'empirically influential and powerful, while also having an impact upon the pedagogical processes within classrooms' (Wall, 2008: p. 2). They were designed to be used by teachers in classrooms and are therefore particularly well suited to this research. Fundamentally, however, the pupil views templates provided a means for the pupils to articulate their own experiences of Maths learning. Involving pupils actively in the investigative process is one of the defining principles of this research, together with the use of more open problems, an increased emphasis upon collaboration and talk, and a focus upon reflections about learning. The involvement of pupils in research is not only ethically valid, but is also supported by the work of Kellet (2005), Pascal and Bertram (2009), and Lundy *et al* (2011). The use of this particular data collection tool ensured that, rather than relying upon inferences or assumptions regarding the pupils in my care, they were able to directly communicate their experiences of Maths lessons, granting me insight into their perceptions and, therefore, better understanding of how to further enhance teaching and learning to better suit the needs of my pupils.

It is important to acknowledge that there are those who argue that because pupil views templates encourage pupils to reflect upon their thinking, they cannot provide true evidence of metacognitive thought. To refute this, I draw upon Wall (2008) and her argument that

> 'evidence from a template where an individual has declared knowledge of metacognitive process, while also expressing that they are consciously using them in their learning would surpass any subjective evidence from observation completed by a third person. These pupils not only have the knowledge about metacognitive skills and process, but they also know *how* they are using them in different learning contexts' (p. 32).

As with self-concept, metacognition is an internal process which is not usually visible to external observers. I did consider several methods of attempting to capture pupils' metacognition, however, because of the very nature of metacognition, each of these came with their own flaws. Whitebread *et al* (2009), for example, decries the use of self-report methods such as rating scales or questionnaires because of their reliance upon pupils' verbal capability.

Perhaps the most obvious means of assessing metacognition – or, at least, the methods which I first attempted – was to observe the pupils at work in the hope of observing metacognitive behaviours and charting any development or change in these throughout the course of research. However, this method, too, was not without complications. Lai (2011), for example, considers that strategies which require pupils 'to "think aloud" while engaging in a task do not capture implicit cognitive processes' (p. 27) because 'subjects may not be aware of their cognitive knowledge and monitoring, which suggests that think-aloud methods may underestimate an individual's metacognitive capacity' (Lai, 2011: p. 27). Lai also suggests that these problems may be exacerbated in 'elementary-aged children, whose verbal ability and working memory capacities are incompletely developed' (2011: p. 27). The practical considerations of scrutinising video data also rendered this method of investigating metacognition problematic. Initially, I attempted to record a focus group of six volunteers from amongst the focus cohort as they worked, however, in addition to greatly reducing the number of pupils that it would be possible to observe in this manner, I quickly found the time required to transcribe and scrutinize the resulting interactions prohibitive in addition to the joint demands of my job as class teacher and teacher-researcher.

In contrast, the pupil views templates had the advantage of facilitating the collection of data from the focus cohort as a whole, rather than restricting the number of pupils able to share their views to a small proportion of volunteers. The data thus gathered was already in a written format, thus eliminating the need for transcription prior to analysis. I also felt that pupil views templates were superior to these methods which relied upon the interpretations of an external observer because of the opportunity they provided for pupils to articulate their own thinking and record this independently. Whilst these templates, by their very nature, require pupils to reflect upon their learning – thereby engaging in metacognition – I believe this particular method is nevertheless preferable to any attempt by a third party (myself, perhaps, as teacher-researcher) to interpret pupils' thoughts and reflections. Again, I believe that this would be a refusal to heed the 'voices' of my pupils, and would seriously compromise my aims of creating a more equitable learning community within the classroom that we share.

I would also argue that, far from being a disadvantage, the pedagogic nature of the pupil views templates was actually beneficial to this study, serving a dual purpose in prompting the pupils to reflect upon lessons, providing not only a form of data collection which allowed me insight into pupils' metacognition, but also – and perhaps more importantly - a teaching tool which prompted them to do so. Crucially, this act of asking my pupils to complete pupil views templates to search for evidence of metacognition may have been instrumental in encouraging pupils to engage in this type of thinking. Freire stresses that

> 'action upon an object must be critically analyzed in order to understand both the object itself and the understanding one has of it. The act of knowing involves a dialectical movement that goes from action to reflection and from reflection upon action to a new action. For the learner to know what he did not know before, he must engage in an authentic process of abstraction by means of which he can reflect on the action-object whole, or, more generally, on forms of orientation in the world. In this process of abstraction, situations representative of how the learner orients himself in the world are proposed to him as the objects of his critique' (1972: p. 7).

Thus, in this way, it may be that the use of pupil views templates has provided, not just a window for external observers to examine pupils' thinking, but rather a mirror to reflect pupils' thoughts and actions, enabling the children themselves to consider and develop their own 'thinking about thinking'. In short: the pupil views templates were used both as one of the strategies of the Thinking Skills approach, as well as a means of ascertaining the impact that the approach had upon pupils' experiences of Maths. The incorporation of this particular task into the routines of our Thinking Classroom gave pupils a forum for sharing their individual ideas and opinions. Furthermore, I believe, that the use of this paper-based format was beneficial because it gave pupils the opportunity to express views where they may not have felt sufficiently comfortable to share during discussion.

To avoid unduly influencing pupils and the comments they shared using the pupil views templates, although pupils were asked to record their thinking during a specific Maths lesson, they were not prompted with regard to the nature of this thinking. Consequently, responses ranged from the simple recall of processes such as "1.80 + 1.80" or "Let's use the inverse", to comments suggesting metacognitive skillfulness such as "I think when I work with other people I can let go of all my ideas and tell them out loud" or "I think I made progress because I would have just guessed if the answer was bigger or smaller but now that I get the idea I can get it right without guessing. I am actually working it out". A considerable advantage of the use of pupil views templates was that the data produced, often in the form of short, easily-categorised words and phrases, permitted both qualitative and quantitative analysis.

When attempting the analysis of the pupil views template data, I initially intended to employ a model for mapping frameworks for thinking devised by Wall (2008). This classified comments in one, or multiple, categories of cognitive skilfulness:

1. **Information gathering:** in which pupils recall ideas and processes, and demonstrate their understanding of information they have been told or have read.
2. **Building understanding:** in which pupils are required to organize their ideas and recollections, and to identify relationships, implications and patterns.
3. **Productive thinking:** in which pupils demonstrate skills of reasoning, problem solving, and the application of their concrete understanding to the abstract.

4. **Strategic and reflective thinking:** in which pupils demonstrate their awareness of, and ability to reflect upon, the learning process (taken from Wall, 2008: p. 28).

Again, drawing upon the work of Wall (2008), as well as Veenman *et al* (1997), I then attempted to reanalyze comments in the 'Strategic and reflective thinking' category to determine whether they best reflected evidence of 'Metacognitive knowledge' - in which pupils demonstrated their ability to think about their learning, demonstrating awareness of some of the ways in which they learn effectively - or 'Metacognitive skillfulness' - in which pupils demonstrated their ability to apply their understanding of the learning process to different contexts and to use this for different purposes. However, upon analyzing the data, it quickly became apparent that this form of coding often did not truly reflect the complexity apparent in the responses gained from pupils. For example, a comment such as 'I usually help Aidan but give him clues not the answer'[18] provided a fascinating insight into the changing way that pupils interacted during lessons. It also allowed me to glimpse the development of collaboration between pupils yet - because it detailed a pupil's straightforward recall of the lesson, rather than a more abstract exploration of the learning process itself - it did not expressly reveal metacognition.

This realization marked a major turning point in my developing understanding of the nature of evidence. As I have described here, I initially felt that it would be possible to scrutinise this data and to code it in a relatively clear cut and objective manner. In hindsight, I believe that this is a manifestation of my previous quantitative bias: my subconscious tendency to favour quantitative, objective data which I perceived to be safer, and less open to individual interpretation than that of a more qualitative, interpretivist approach. My realization and acceptance of the importance of my impressions and interpretations had a profound impact upon this research, ultimately leading this research to become increasingly cyclical and messy as it adapted according to findings as they emerged.

Upon further reflection, I decided to use a general inductive approach to more fully capture the richness of the pupils' responses, a strategy which Thomas (2003) believes 'is evident

[18] This is a child's comment from the pupil views templates completed by Class 2 during Term 1b.

in much qualitative data analysis […] often without an explicit label being given to the analysis strategy' (p. 2). The purpose of this form of coding is 'to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies' (Thomas, 2003: p. 2). Therefore, this form of analysis enabled me to consider the data set as a whole, identifying trends, patterns and areas of potential interest as they emerged, rather than being limited by a pre-determined analysis structure. This freedom was particularly appealing as it parallels neatly with my belief that education research is most valuable when it 'develops in response to specific problems of practice' (Hiebert *et al*., 2002: p. 6). Similarly, I believe that this data has been most informative precisely because the details contained within it have directly shaped its analysis.

I followed the procedures for inductive analysis of qualitative data outlined by Thomas (2003: p. 5). As a result, data was first prepared in a common format; in this case a series of Word documents. I then read the text closely to familiarise myself with the content, gaining an initial sense of themes and patterns emergent from the text. I subsequently read the pupils' responses several more times in order to further identify categories or themes. Similar responses were grouped to allow them to be read 'horizontally', in order to facilitate comparisons within categories, following the processes previously used by researchers such as Marshall, 1999 and Elliott & Gillie, 1998. This process continued until all themes and patterns had been identified, with no further examples presenting themselves. At this point in the data-analysis process, I had therefore identified three categories of interest:

1. the use of language (including the first and second person; use of causal connectives; and questions and speculation)

2. depictions of learning (including the classification of work as 'easy' or 'hard'; the shift towards the pupils' description of their 'progress'; and evidence of pupils' learning preferences)

3. the changing proportions of comments describing internal thoughts and feelings and external discussions

Comments were therefore coded using these criteria. An example of this can be found in Plate 3.7.

			Causal connectives	Use of questions	Speculation	Easy / hard	Progress	Preference for a learning style	Preference for a learning style with reason	Evidence of collaboration	Recalling steps in working out / learning
1.	1	It was really good of Erin to ask the teacher for help.						Y		Y	
	2	I loved this because I made progress and I found it really good	Y				y		y		
	3	Some people in our class were not concentrating, some people on my table were talking and weren't listening									
	4	This is fun because you are learning at the same time.	Y						Y		
	5	Eve should we go higher or lower		Y						Y	
	6	Erin was stuck because she didn't know how to do fractions. I tried to help her but it was too hard to explain	Y							Y	
	7	I am getting a new comic and I am bringing £2.50 to Fusion									
	8	How do you do this Ms Mulholland?		Y							
	9	Also you get to work with a partner to help you						Y		Y	

Plate 3.7 The coding used to analyse pupil views templates

Following the tenets of inductive analysis, some responses were coded in more than one category where I felt that this was applicable. Similarly, some responses were not included in any of the categories identified as I deemed that they were not relevant to the research objectives. This occurred in relatively few cases: just 18.59% of the total comments included on the pupil views templates remained un-coded. These largely included comments which were too short or too ambiguous to clearly ascertain the pupils' meaning, or comments which were not relevant to the lesson such as "I hope Noch will message me on minecraft all about the cheats and building ideas, Hmm? Arrrr Thomas!!!"[19]. The proportions of templates left un-coded can be seen in Table 3.3.

[19] This is a child's comment from the pupil views templates completed by Class 1 during Term 2a. Names have been altered to preserve anonymity.

Date	Number of text units for analysis	Number of un-coded units
December 2011	148	23 (**15.54%**)
February 2012	151	33 (**21.85%**)
March 2012	131	23 (**17.56%**)
May 2012	178	34 (**19.10%**)

Table 3.3 Proportions of un-coded text units

The trustworthiness of this coding was ensured primarily through consistency checks: a comparison of the coding used for different responses across the data collection process. For example, a response made on one particular template was compared with another made on a different template from a different point in the research process. These consistency checks were carried out in parallel to the analysis of the pupil views template data, to allow for constant cross-checking of similar or common responses such as “This is easy” or comments relating to progress such as “I think I’m making progress in this wonderful lesson”, together with the editing of coding in order to ensure uniformity where needed.

When considering the analysis of this data, it is important to note the role that those such as Lundy *et al* (2011) believe should be fulfilled by the pupils themselves, as ‘this crucial stage during which the findings are attributed meaning by the research team is a key matter affecting children and therefore one on which they are entitled to have their views given due weight under Article 12’ (p. 726). Furthermore, Lundy *et al* also suggest the potential advantages of involving pupils in the data analysis process, suggesting that, in their own research, the children ‘were able to provide expert perspectives that enabled us to gain insight and understanding into the reasons underlying the responses’ (2011: p. 726). Whilst I recognise the wisdom of this view, unfortunately it was not possible, on a large scale at least, to involve pupils in the data analysis process of the information collected by the pupil views templates.

Primarily, this was the result of time restrictions which came in various forms. One of these was that I did not feel, given the many demands on our time in terms of objectives and curriculum subjects to be taught, justified in asking pupils to participate in data analysis.

Although, as I have previously asserted, the permission letter sent to parents was deliberately rather vague, explaining only that we would use 'a range' of data collection methods in order to allow for a certain degree of flexibility within my research, it did not make mention of also asking pupils to conduct data analysis. Thus, I felt that engaging pupils in the analysis process would take time from their study of other curriculum areas and, whilst it may well have been beneficial both to their development as researchers and for their skills of metacognition, it would not be in accordance with the original parameters of the consent gained both from West Side School's leadership team and the parents of the pupils themselves, and could well, therefore, require me to seek further consent. Moreover, because of the dual demands of my role as both teacher and researcher, the vast majority of data analysis was completed during periods of school holidays, when I was unable to have contact with the pupils in order to ascertain their views on particular comments or feedback.

It would perhaps have been possible to rearrange data analysis to periods when it would have been more practical to share findings with pupils. I could, for example, have asked for a small number of volunteers to form focus groups who could then have scrutinised the lists of responses I created, such as that featured in Plate 3.7 in order to ask them for their opinion regarding the meaning or potential coding for particular comments. Unfortunately – and in all honesty - however, by the time I realised that the process of data analysis would not be quite as straight forward as I had expected, and I fully assimilated the implications of my shifting beliefs relating to evidence and the ways in which the pupil views templates data would ultimately be used, the focus cohort had left West Side School and it was no longer possible to involve them in this process. However, whilst this may seem to be a potentially damaging oversight on my part, this does not mean that the children were completely denied the opportunity to reflect upon some of the findings from the pupil views template data. Our feedback station, which was updated on a half-termly basis each time the pupil views templates were completed, contained information relating to responses from the templates and pupils were therefore given the opportunity to share their opinions on this, together with any further detail or ideas relating to these specific responses. Nevertheless, I do feel that this is, perhaps, one aspect of this research that, in retrospect, I would have altered in order to more fully involve pupils in this analytical process.

3.8 Ensuring reliability

When working with this range of data, it was important to consider how best to explore my position as teacher-researcher and the impact this may have upon interpretation of the evidence collected. Happily, I believe that my views about the ways in which research should be conducted and, ultimately, that any findings should be used, limit the potential impact of any bias. However, to further increase the reliability of this research, I gathered data from both classes within the focus year group during the first cycle of research. This was important because, although I was personally responsible for the planning of all Maths lessons, during the first year of research I taught and assessed Class 2 only. A colleague with 10 years of teaching experience taught Maths to Class 1, following the planning which I prepared as teacher-researcher. During the Spring Term (January to April 2012), one Maths lesson per week was taught by experienced P.P.A. staff [20] who also followed this same planning. Thus, although both classes were taught following a Thinking Skills based curriculum, during the first phase of research at least, only one of these classes was taught by myself as teacher-researcher. I hoped that, by including data gathered from Class 1, the impact of any discrepancies that arose between the classes would be considerably reduced.

During the second phase of research, I was responsible not just for the planning of Maths for both classes, but also for all of teaching and assessment. By continuing to gather attainment evidence during this time, I was able to further assess the extent to which my own influence impacted upon pupil progress and attainment. In addition to comparing information generated within the focus year group, I also resolved to gather comparative data from children in each of the year groups in Key Stage Two, including the focus year group. This aimed to more clearly establish whether the responses and reflections given by my own pupils was representative of pupils at West Side Primary in general: that is to say, whether these levels of thinking were naturally occurring, or the result of the Thinking Skills initiative.

[20] P.P.A. is the planning, preparation and assessment time given to all teachers on a weekly basis. During the Spring Term, Year Five teachers received this time on Wednesday mornings. This P.P.A. time was covered by the same experienced members of staff each week.

3.8.1 *Collection of attainment evidence*

To ensure the reliability of the attainment evidence compiled by myself, as Class 2 class teacher, and my colleague, as Class 1 teacher, during the first cycle of research (2011 – 2012), and then by myself alone during the second cycle (2012 – 2013), this data was moderated each half term by the school Senior Leadership Team. The measures used are outlined in Table 3.4.

Regularity	Member of Senior Leadership Team responsible	Method of scrutiny
Every term	Assessment Leader	Scrutiny of our use of the A.P.P. documents and supporting evidence
Every half term	Head Teacher	Pupil progress meetings to justify our teacher assessments through scrutiny of the evidence used to make level judgements
Every term	Mathematics Subject Leader	Scrutiny of planning and pupils' books to ensure appropriate challenge for pupils
Every term	Head Teacher	Moderation meetings for staff to assess pupils' work from across a range of abilities and year groups, and to promote discussion surrounding the issue of assessment

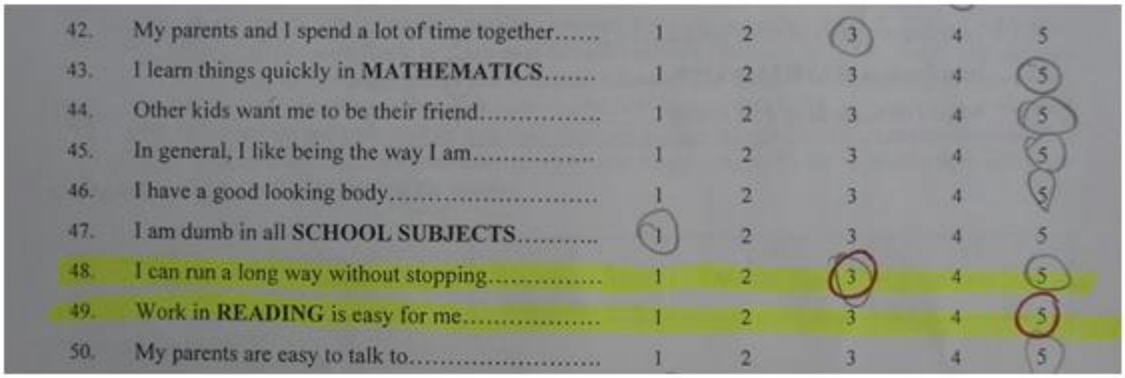
Table 3.4 Measures used to ensure reliability of assessment data

These measures formed part of West Side School's routine assessment practices, and were conducted regularly to ensure that all teacher assessments were accurate and consistent. During the second cycle of research, the pupils also completed past S.A.T.s papers each half term. This was part of West Side School's policy of preparing pupils for their Key Stage Two S.A.T.s, and it was expected that the levels that pupils achieved on these tests would broadly correspond to the levels submitted during teacher assessments, so these served as an additional measure to ensure the accuracy of my teacher assessments.

3.8.2 *S.D.Q.*

The S.D.Q. was used at the outset of research in October 2011 to provide baseline self-concept data. Subsequently, it was completed in both January and June 2012 to track any changes in responses. Following initial analysis of the data during Spring 2013, it was also decided that pupils should complete the questionnaire in July 2013 in order to further track emerging trends to see whether these remained consistent at the end of the second year of research. To more accurately situate this data within the context of West Side School, comparative data was also collected from pupils from across Key Stage Two. For this, I took care to select only volunteers and to stress that participation was not compulsory. Children were chosen to represent all ability groupings, so for each year group, the S.D.Q. was completed by two higher- children, two middle-, and two lower-attaining pupils from each year group.

Each time the questionnaire was administered, the questions were read aloud in an attempt to avoid any misinterpretation of questions. The pupils were given the opportunity to ask questions and to clarify meanings to ensure their full comprehension. The questionnaires were delivered to both classes in the focus year group and then, during the second cycle of research, to the 24 pupils in the comparative sample group, simultaneously. This ensured that all children had the benefit of any elaboration requested. Pupils were also given very frequent reminders of the meaning of the five-point scale to help them to select the correct option. Initially, a paper form of the S.D.Q. was used, and the children were required to circle the number on the five point scale which most accurately reflected their views. However, there were a number of transcription errors when pupils recorded their views in this way. It was easy, for example, to miss a line of numbers, recording no response to that particular question, instead circling two numbers on the line above or below. To address this, after the questionnaire was completed, an adult checked each form to ensure that all responses were indicated clearly and unambiguously. Where answers were unclear, the line in question was highlighted and the S.D.Q. was returned to the child to correct using a different coloured pen. An example of this can be found in Plate 3.8.



42.	My parents and I spend a lot of time together……	1	2	3	4	5
43.	I learn things quickly in **MATHEMATICS**…….	1	2	3	4	5
44.	Other kids want me to be their friend…………….	1	2	3	4	5
45.	In general, I like being the way I am…………….	1	2	3	4	5
46.	I have a good looking body……………………….	1	2	3	4	5
47.	I am dumb in all **SCHOOL SUBJECTS**……….	1	2	3	4	5
48.	I can run a long way without stopping……………	1	2	3	4	5
49.	Work in **READING** is easy for me………………	1	2	3	4	5
50.	My parents are easy to talk to…………………….	1	2	3	4	5

Plate 3.8 An S.D.Q. with unclear responses

To further simplify this process, the S.D.Q. was administered online in both January and June 2012. The online version of the questionnaire was a considerable improvement as the five-point scale was interpreted for the children, enabling to choose from terms such as 'false' or 'mostly true', rather than having to refer back to the top of the questionnaire form and select the corresponding number. Unfortunately, during the 2012 – 2013 academic year, this facility was no longer available, and thus I was obliged to once again employ the paper version of the S.D.Q. with children in the comparative sample from the across the school. At this time, I warned the children about the possibility of transcription errors and they themselves suggested using a blank piece of paper or a ruler to mark their place whilst completing the form. As a result, 100% of forms from the comparative group were completed without a single transcription error.

Regardless of whether the S.D.Q. was presented on a paper or computerised format, pupils appeared to enjoy sharing their views in this way; submission rates for the data collected were very high, with just one pupil opting out of submission during the data collection process.

3.8.3 *Pupil views templates*

Pupil views templates were completed for the first time in December 2011, and were then completed in the final week of each half term until May 2012. This process therefore yielded four completed templates per child, each detailing pupils' experiences of an individual Maths lesson. To help record experiences as accurately as possible, pupils were asked to complete each pupil views template immediately following the daily Maths lesson. This ensured that the experience was still relatively fresh in their memories, facilitating the production of a more accurate record of each individual's thoughts and feelings. All pupils completed the templates simultaneously. They were given the same instructions, encouraged to ask any necessary questions, and again reminded of the voluntary nature of contributing their views.

Children from both the focus and comparative groups were given around 30 minutes of class time to complete these templates, although this was very flexible to allow all pupils sufficient time to record their ideas. In light of the findings of Black *et al.* (2006: p. 167), children were informed at the outset of teaching that they would complete a pupil views templates based on that particular Maths lesson. This allowed pupils time for reflection prior to recording their views, and also perhaps encouraged them to think more about their learning throughout the course of the lesson than they may have done ordinarily. The decision to record their experiences of a specific lesson was heavily influenced by the work of Hoyles (1982), who found that an 'approach based on the description of real situations rather than the collection of generalities or opinions was thus felt to be more meaningful to the pupils concerned' (p. 350).

3.9 Mixed Methods Analysis

Whilst these methods have each been presented here in distinct sections, they are, as I have outlined above, intended to be combined in order to gain a richer, more detailed picture of pupils' experiences of the teaching and learning of Maths following the introduction of a Thinking Skills approach. The following chapter of this thesis - relating to the Findings of this study - will, in some respects, mirror this format by discussing the results of each method in turn in order to address each distinct facet of the research questions for this study, before synthesising these within the case-studies of Harry and Grace. In this way, this research is intended to be synergistic, combining these multiple forms of data 'so that their combined effect is greater than the sum of their individual effects' (Hall & Howard, 2008: pp. 250 – 251). Further consideration of the themes emergent from the data as a whole will be given within the Discussion, and it is hoped that, in this way, it may be possible to construct a more holistic picture of how pupils' experiences of the teaching and learning of Maths have been effected by the introduction of a Thinking Skills approach.

Chapter 4. Findings

As I have previously described in the 'Research Design and Methods' chapter of this thesis, I subscribe – along with those such as Stenhouse (1988) and Biesta (2007) – to the belief that the purpose of practitioner research is to provide an honest account of research in a specific context, so that fellow practitioners may decide whether or not it is relevant for their particular context, or to prompt their thinking with regard to whether a similar approach could be adapted to suit. Adherence to this belief renders the description of these findings fundamental, as any account of the evidence gained through the data collection tools employed throughout this research must be sufficiently objective to allow readers to draw their own conclusions. This also corresponds to the principle of reflexivity, suggested as one of the means of ensuring validation in action research, whereby researchers understand that

> 'the story has been created by him/her. He/she exposes his/her process of knowing to the readers by stratifying the text in a way that helps the readers to see the researcher's way of writing […] The principle of reflexivity also stresses that the research should be transparent; that is, the material and methods should be described in some way in the report' (Heikkinen et al, 2012: p. 9).

Thus, I have aimed to describe the findings included in this chapter as openly and as honestly as possible. I have included my thoughts as they have occurred to me as I have tried to make sense of the data, however, these are my conclusions only, and are, at times, coloured by my impressions of the realities of the impact of this research, not only as it is evident in the data, but also as I understood it in my day-to-day dealings with the pupils as teacher-researcher, and in our shared experiences of Maths lessons.

This has come to form a particularly important element of this chapter as my understanding of evidence has developed from an initial emphasis upon quantitative data, towards a growing appreciation for the greater subtleties I felt were encapsulated by the more qualitative, impressionistic evidence gathered from my own interpretations as teacher-researcher. Where these shifts in thinking have been particularly marked, I have again attempted to record this change in thinking by making use of the italicized font to *draw a distinction between my views and perceptions at different points in the research process.*

The research questions investigated during the course of this research were threefold, aiming to determine the impact of a Thinking Skills approach upon:

1. pupils' progress in Maths, in terms of National Curriculum levels.

2. pupils' opinions of the subject and their own ability to succeed and make progress (self-concept).

3. pupils' understanding of the ways in which they learn Maths.

This 'Findings' chapter offers analysis of the data relating to each of these three questions. For ease of interpretation, I have divided this section into three distinct parts and aim to address each of these research questions in turn, beginning with investigation of the impact of the Thinking Skills approach upon pupils' progress and attainment.

Part A. The Impact of a Thinking Skills Approach upon Progress and Attainment

The data contained in this chapter is divided into two distinct groups: data relating to progress and attainment. This is important because it allows me not just to monitor the final point reached by pupils in their learning, but also to take into account their different starting points, and thus to ascertain the extent to which the introduction of the Thinking Skills approach influenced particular pupil groups.

4A.1 Progress

4A.1.1 *Cycle 1*

The progress data was taken from the teacher assessment data submitted regularly throughout the academic year by all teachers at West Side School, and measured by comparing pupils' attainment at the end of Year 4 with that at the end of Year 5 in order to encompass a complete academic year. Figure 4A.1 shows the progress made by the focus cohort during 2011 – 2012. In order to provide a means of comparison, the progress made by pupils in the previous two cohorts[21] has also been included here.

[21] These previous cohorts are labeled throughout this chapter according to the year in which they were in Year 6 at West Side School. This makes the focus pupils the 2012 – 2013 cohort, with the previous two cohorts being the 2011 – 2012 cohort, and the 2010 – 2011 cohort.

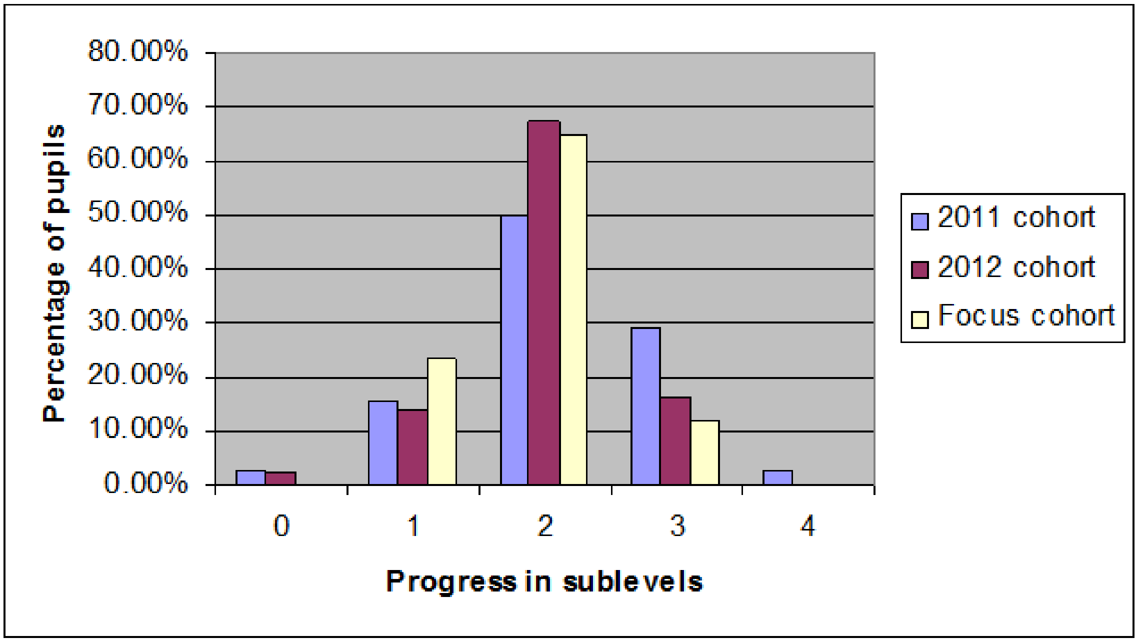


Figure 4A.1 Progress during Year 5

As this graph shows, at the end of Cycle 1, the progress made by pupils during Year 5 was rather less than that achieved by their counterparts in the two previous cohorts. This decrease is particularly evident in the proportions of pupils making accelerated progress, with just 11.78% of the 2011 – 2012 cohort making three or more sub-levels progress, compared with 22.22% of the children in Year 5 between 2009 and 2011. Nationally, Year 5 pupils are expected to make just one sub-level of progress during an academic year. Contrastingly, pupils in the focus cohort made a mean of 1.88 sub-levels progress, well above national expectations. However, whilst this initially seems positive, when contrasted with the mean from the previous two cohorts, the data suggests that, far from accelerating pupils' progress in Maths, the Thinking Skills approach has instead had a negative impact upon progress, with the mean number of sub-levels progress made decreasing slightly from 2.05 sub-levels, to 1.88!

There are several possible explanations for the apparent decrease in pupil progress data. Pupils in the previous two cohorts had been taught in sets for Maths, rather than in class groups, and it may be that this had impacted upon progress for some pupils. It may also have been influential that during the 2011 – 2012 academic year a new system for recording the progress of pupils was introduced, measuring progress not just in whole sub-levels, but also in half sub-levels or 'points', thus dividing each National Curriculum level into six, as opposed to three. Thus, when submitting Teacher Assessment data, it was possible to move pupils by a single point, rather than a full sub-level, enabling teachers to more accurately describe pupils who were on the cusp just before reaching a new level, or who were consolidating their current sub-level, so that this progress could be reflected in the data submitted to West Side School's S.L.T. without having to account for what had previously appeared to be stagnation, or lack of progress for prolonged periods of time.

It is my impression that the introduction of this slightly different format for Teacher Assessments encouraged teachers to be more cautious when assessing pupils: it became more common to move pupils by a single point, and indeed, questions were often asked by the S.L.T. during our regular Pupil Progress Meetings when pupils were moved by more than a half sub-level at a time. Table 4A.1 thus re-represents the data contained in the chart above, with the progress for the 2011 – 2012 cohort divided into these half sub-levels, as they were submitted to the S.L.T. of West Side School in July 2012.

Progress in sub-levels	Year 5 as a whole	2010 – 2011 cohort	2011 – 2012 cohort
0	0%	2.63%	2.33%
0.5	0%		
1	2.94%	15.78%	13.95%
1.5	20.59%		
2	32.35%	50%	67.44%
2.5	32.35%		
3	5.89%	28.95%	16.28%
3.5	5.89%		
4	0%	2.63%	0%
Mean	**2.18 sub-levels**	**2.13 sub-levels**	**1.98 sub-levels**

Table 4A.1 Progress during Year 5 in half sub-levels (points)

This table demonstrates that, when taking into account the new system of 'points', the mean progress made by the focus cohort increases to 2.18 sub-levels in comparison with the 2.13 sub-levels progress made by the 2010 - 2011 cohort, or 1.98 sub-levels made by the 2011 - 2012 cohort. Nevertheless, this difference is comparatively small and it is difficult to draw conclusions based upon this rather tentative data, particularly as there is no way to compare this points data with that from the previous two Year 5 cohorts. It was at this point in research that I recognized the potential implications of Boaler and Staple's (2008) research at Railside School which acknowledged that it was only after the second year of research that pupils were 'significantly outperforming students at the other schools.' (p. 610). Consequently, it was very possible that the full effects of the Thinking Skills approach may only become evident after a more prolonged period. As a result, I decided to add a second cycle to this research, and to continue to collect progress and attainment data relating to the focus cohort during the next academic year. The following section of this chapter therefore details the progress data relating to the second cycle of this research, once the focus pupils had moved into Year 6.

4A.1.2 *Cycle 2*

In this, the second cycle of research, I continued to collect and analyse data relating to progress and attainment in precisely the same manner as the previous year to continue to develop my understanding of how – or, indeed, if – the Thinking Skills approach was impacting upon the progress made by the pupils in my care. Nationally, Year 6 pupils are expected to make two sub-levels of progress. However, Table 4A.2, below, illustrates that mean progress for all three cohorts was considerably below this target. This is intriguing, particularly as the progress made by all three cohorts was substantially above the national expectation of one sub-level during Year 5. Nevertheless, this table clearly shows that there was little difference between the progress made by the pupils in either of the previous two cohorts, and that made by the focus cohort[22].

[22] This data is based upon teacher assessments submitted in July 2013, rather than S.A.T.s results. S.A.T.s results are not sub-levelled, with pupils instead receiving a single level (3, 4, or 5), and thus do not allow comparison to the same degree of detail as the data used routinely by West Side School. It is also important to note that the progress data for the 2010 – 2011 Year 6 cohort is given in full sub-levels only, rather than in the 'points' used for the other two cohorts as this data was submitted before the introduction of 'points' during the 2011-2012 academic year.

Sub-levels progress	Year 6 as a whole	2011 – 2012 cohort	2010 – 2011 cohort
0 or 0.5	0%	0%	6.98%
1 or 1.5	48.49%	46.52%	44.19%
2 or 2.5	45.46%	51.17%	41.86%
3 or 3.5	6.06%	2.33%	6.98%
Mean	**1.57 sub-levels**	**1.56 sub-levels**	**1.49 sub-levels**

Table 4A.2 Progress during Year 6

Again, it is only when considering the points data that this picture begins to change. The mean progress when calculated in points is notably different: 1.80 sub-levels for the focus cohort in comparison with 1.66 for the 2011 – 2012 cohort. This data is shown in Table 4A.3.

Sub-levels progress	Focus cohort	2011 – 2012 cohort
0	0%	0
0.5	0%	0
1	24.24%	27.91%
1.5	24.24%	18.61%
2	27.27%	48.84%
2.5	18.18%	2.33%
3	3.03%	2.33%
3.5	3.03%	0
Mean	**1.80 sub-levels**	**1.66 sub-levels**

Table 4A.3 Progress in half sub-levels (points)

Whilst, it has again been impossible to include data for the 2010 – 2011 cohort in this comparison as this was before the points (or half sub-levels) system was introduced at West Side School, this information nevertheless more clearly shows that a greater number of pupils in the focus cohort made progress within each sub-level, achieving for example 1.5 or 2.5 sub-levels of progress rather than just 1 or 2. This is represented in Figure 4A.2.

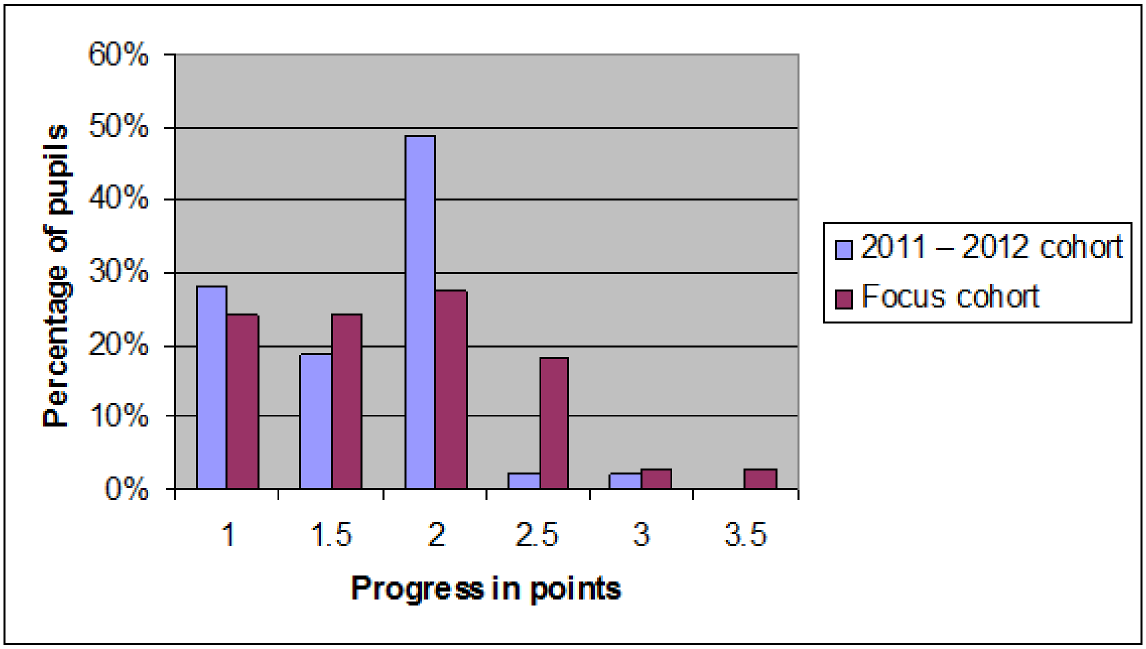


Figure 4A.2 Progress in half sub-levels (points)

As this graphs shows, this discrepancy is particularly evident in the proportions of pupils making the largest amounts of progress. To illustrate: whilst just 4.66% of pupils in the 2011 – 2012 cohort made 2.5 or more sub-levels of progress, almost a quarter of the focus cohort - 24.24% - were deemed to have made this same degree of progress. This is reminiscent of the accelerated progress made by those children attending Railside School, who, despite entering with lower mean test scores in algebra, were 'significantly outperforming' (Boaler & Staples, 2008: p. 620) students in comparable schools at the end of a two-year research period, perhaps suggesting that the Thinking Skills approach may have contributed towards this increase in accelerated progress.

4A.2 Attainment

4A.2.1 *Cycle 1*

To ascertain whether the impact of the Thinking Skills approach was consistent across the year group as a whole, or was more potent for particular groups of pupils, it was important to compare the information relating to progress with attainment data. Figure 4A.3 shows the attainment at the end of Cycle 1, when the focus cohort had just completed Year 5.

Again, the attainment of pupils in the previous two cohorts is included to provide a means of comparison.

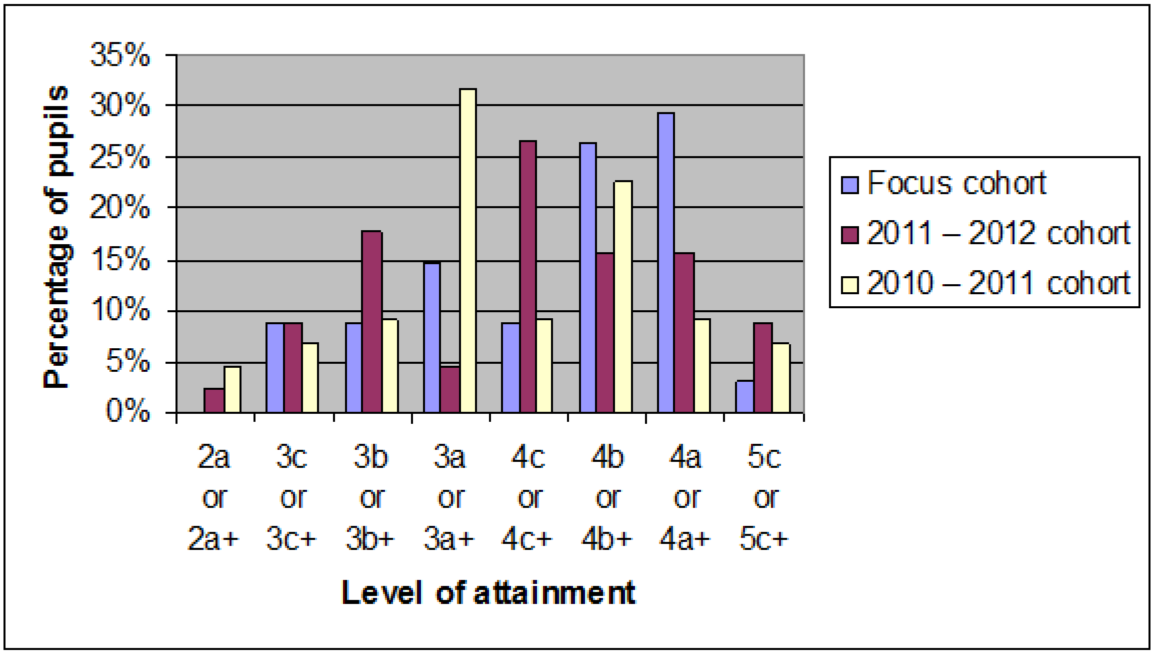


Figure 4A.3 Attainment at the end of Year 5

Pupils are expected to attain Level 3a by the end of Year 5. Pupils working at Level 3b or below are deemed to be working below age-expected levels, whilst those working at Level 4c or above are working above age-related expectations. Interestingly, this data clearly shows that the proportions of pupils in the focus year group working significantly[23] above age-expected levels are considerably higher than those for the two previous cohorts, representing 58.82% of the total number of pupils, compared with just 40.01% and 38.64% from the 2011 – 2012 and 2010 – 2011 cohorts respectively. Table 4A.4 provides further detail of the proportions of pupils working at these different levels.

[23] Pupils working two or more sub-levels above or below Level 3a are deemed to be working 'significantly' beyond age-expected levels. This terminology – referring to children as 'significantly above' or 'significantly below' age-expected levels - was used routinely at West Side School, and thus these terms have also been used throughout this thesis.

	Level of attainment	Focus cohort	2011 – 2012 cohort	2010 – 2011 cohort
Significantly below age-expected levels	**2a – 3c+**	8.82%	11.11%	11.36%
Below age-expected levels	**3b – 3b+**	8.82%	17.78%	9.09%
Age-expected level	**3a or 3a+**	14.71%	4.44%	31.82%
Above age-expected levels	**4c – 4c+**	8.82%	26.67%	9.09%
Significantly above age-expected levels	**4b – 5c+**	58.82%	40.01%	38.64%

Table 4A.4 Pupils working below, at, or above age-related expectations at the end of Year 5

Encouragingly, data submitted at the end of Year 4 reveals that the proportion of the focus cohort working significantly above age-related expectations increased during Cycle 1, further supporting the notion that this shift could be attributable to the Thinking Skills approach. Figure 4A.4 illustrates the proportions of pupils in the focus cohort working below, at and above age-related expectations at the end of Year 4 in comparison with the end of Year 5.

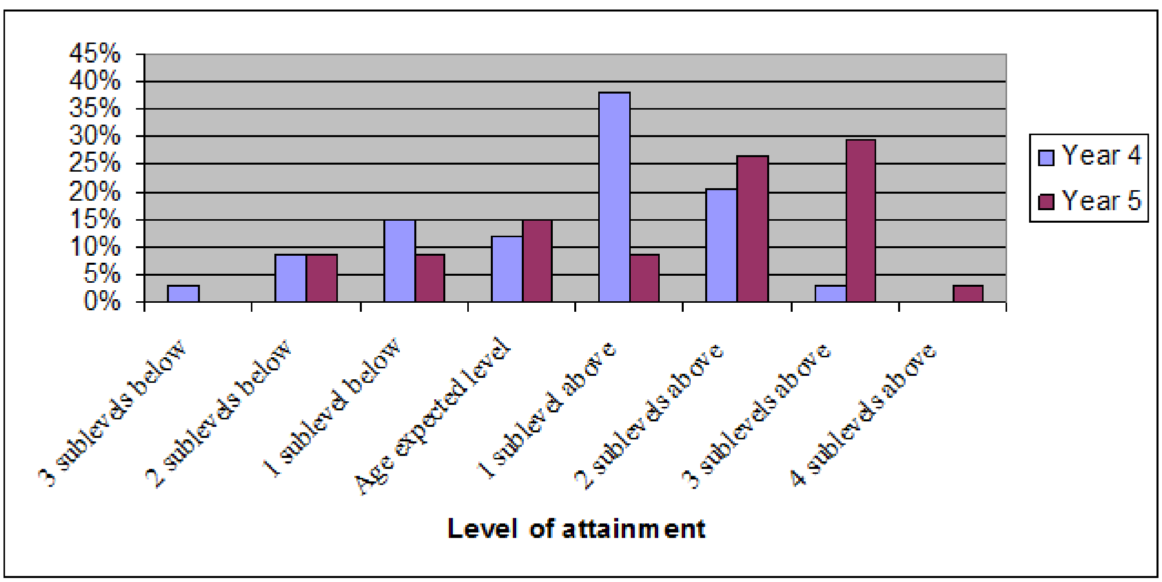


Figure 4A.4 Pupils working below, at and above age-related expectations at the end of Years 4 and 5

This suggests there has been a sizeable shift between the proportions of pupils working significantly above age-expected levels of attainment, suggesting that the Thinking Skills intervention may have impacted most powerfully upon higher-middle and higher-attaining pupils.

4A.2.2 *Cycle 2*

At the end of Year 6, pupils are expected to work at Level 4b, having made two sub-levels of progress from Level 3a at the end of Year 5. The following table, Table 4A.5, uses Teacher Assessments to again monitor the proportions of pupils working below, at and above age-related expectations.

	Level of attainment	Focus cohort	2011 – 2012 cohort	2010 – 2011 cohort
Significantly below age-expected levels	**3c – 3a+**	12.12%	17.78%	19.15%
Below age-expected levels	**4c or 4c+**	15.15%	13.33%	10.64%
Age-expected level	**4b or 4b+**	9.09%	15.56%	25.53%
Above age-expected levels	**4a or 4a+**	11.77%	17.78%	23.40%
Significantly above age-expected levels	**5c or 5a+**	66.31%	35.56%	21.27%

Table 4A.5 Pupils working below, at and above age-related expectations at the end of Cycle 2

Importantly, whereas, for the focus cohort, the proportion of pupils working significantly above age-related expectations increased by 7.49% from 58.82% at the end of Year 5, to 66.31% at the end of Year 6, for both the 2010 – 2011 and the 2011 – 2012 cohorts the numbers of pupils working at these higher levels decreased, by 17.37% and 4.45% respectively. This alteration in the proportions of pupils working at these different levels can be seen in Figure 4A.5.

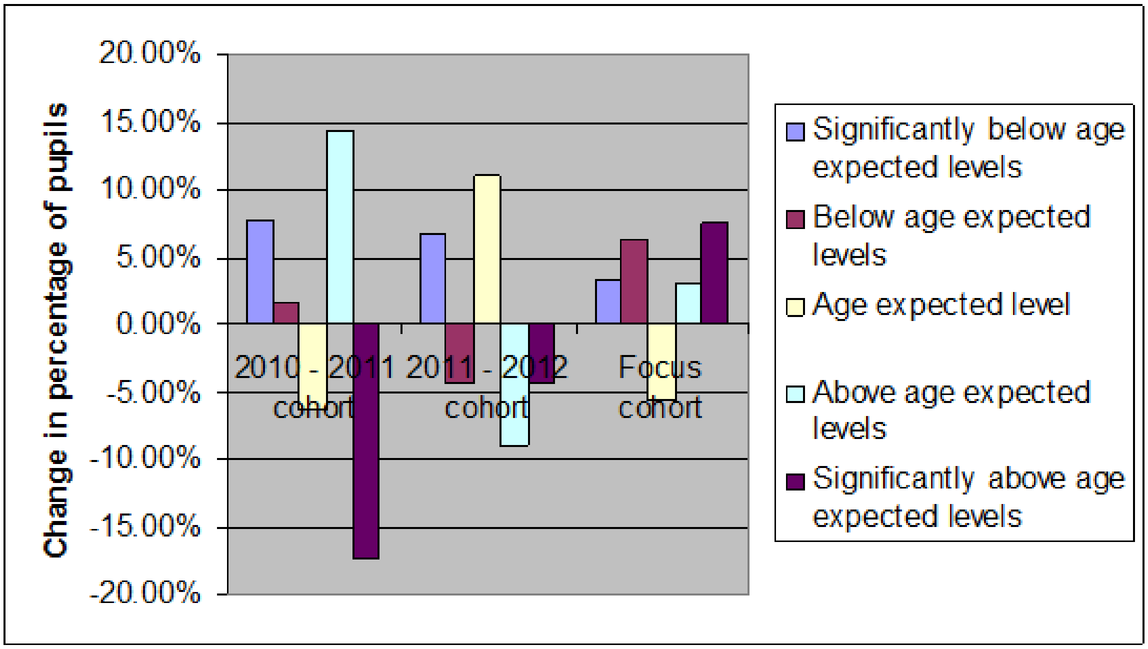


Figure 4A.5 Changes to pupils' level of attainment

4A.3 Key Stage Two S.A.T.s data

When considering the attainment of Upper Key Stage Two pupils, it is logical to take into account S.A.T.s results. As these assessments are statutory, and are externally marked, they constitute the most obvious means of comparing attainment. S.A.T.s results are reported in National Curriculum levels, without being further divided into sub-levels, thus providing a broader indication of attainment than the more specific levels provided by the sub-levels and points used for Teacher Assessments. They are also a judgement based purely upon pupils' performance at three separate tests: two written papers (including calculator and non-calculator), both of which must be completed within 45 minutes, and a mental test, with questions given via a C.D. It is also important to note that these tests are administered in May, and thus reflect pupils' attainment at that point in the academic year, in comparison with final Teacher Assessments, which are submitted at the end of the academic year in July. The expected level of attainment for Year 6 pupils is Level 4. Table 4A.6 shows the levels of attainment achieved by the focus cohort, as well as the previous two cohorts.

	2013 (Focus cohort)	2012	2011
Below	0%	0%	2.13%
Level 3	6.06%	15.91%	27.66%
Level 4	42.42%	44.44%	57.45%
Level 5	51.52%	37.78%	12.77%
Level 6	0%	2.22%	N/A

Table 4A.6 S.A.T.s levels

National results in 2011 showed that 80% of pupils achieved Level 4 or above, substantially higher than West Side School's figure of 70%. In 2012, the results from Year 6 pupils at West Side School were in line with national averages: both standing at 84%[24]. In contrast, the results for the focus cohort surpassed this, with 93.94% of pupils attaining Level 4 or above. Ofsted's School Data Dashboard, which compares S.A.T.s results with those of similar schools as well as schools nationally, judged these results to be in the highest 20% of similar schools, and the top 40% of schools overall. This is particularly interesting when compared with West Side School's results for Reading, Writing, and Spelling, Punctuation and Grammar (S.P.G.): for Writing and S.P.G. results were in the top 40% when compared with similar schools as well as schools nationally, whilst for Reading results were in the top 40% when compared with similar schools but the top 60% when compared with schools nationally. It is also interesting to note that the mean number of marks gained by the pupils increased from 55.78 in 2011, to 67.69 in 2012, to 75.33 in 2013. This shows that, not only did pupils in the focus cohort gain higher levels of attainment, they also answered considerably more questions correctly, demonstrating their superior understanding of Maths.

4A.4 Attainment relative to age-related expectations

Although these results appear encouraging, to better understand whether these higher levels of attainment are truly resultant from the Thinking Skills intervention it is important to compare this information with the pupils' previous levels of attainment to determine whether this has truly been subject to a substantial shift. Figure 4A.6 tracks the attainment

[24] Statistics gained from http://dashboard.ofsted.gov.uk/dash.php?urn=108457, accessed on 4.1.2015.

data for the focus pupils beginning at the end of Year 2, and then at the end of each year group throughout their time in Key Stage Two, detailing the proportions of pupils in the focus cohort working below, at, and above age-related expectations.

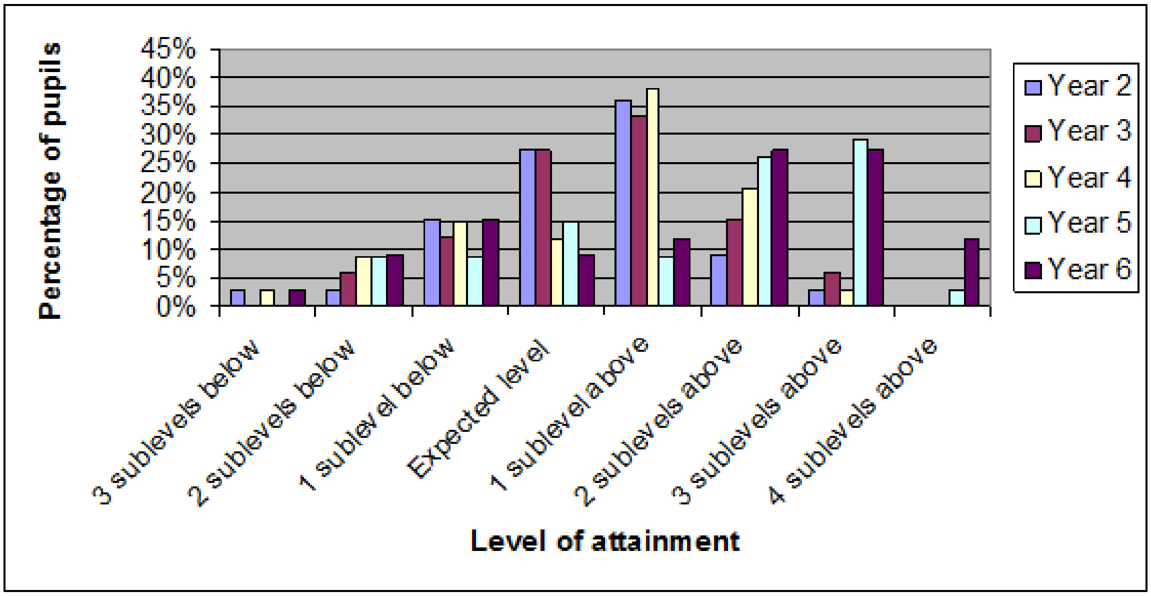


Figure 4A.6 Pupils working below, at, or above age-related expectations between Years 2 and 6

I believe this graph demonstrates that, after Cycle 2 - once pupils had engaged in the Thinking Skills approach for two complete academic years - the shift in pupils working significantly above age-expected levels became even more marked. Whilst there is some consistency in the proportions of pupils working below age-expected levels, showing that, by and large, lower-attaining pupils continue to work below age-expected levels throughout Key Stage Two, there is a change in the proportions of pupils working at, and above, age-expected levels, particularly from Year 5 onwards. Furthermore, whilst the increase in the numbers of pupils working two or more sub-levels above age-related expectations can be seen as a gradual progression, the shift – coinciding with the introduction of the Thinking Skills approach from Year 5 onwards - in the proportion of pupils working three and four sub-levels above the expected level can be seen more clearly as a marked jump, further strengthening the impression that the Thinking Skills approach may have impacted most profoundly upon middle-, higher-middle- and higher-attaining pupils.

Unfortunately, it is not possible to compare data from across Key Stage Two with that of the previous two cohorts as I was unable to access progress and attainment data from prior to 2008. Instead, the following three graphs – Figures 4A.7, 4A.8, and 4A.9 – each track the proportions of pupils working below, at, and above age-related expectations between Years 4 and 6 for the focus cohort, as well as the two previous cohorts.

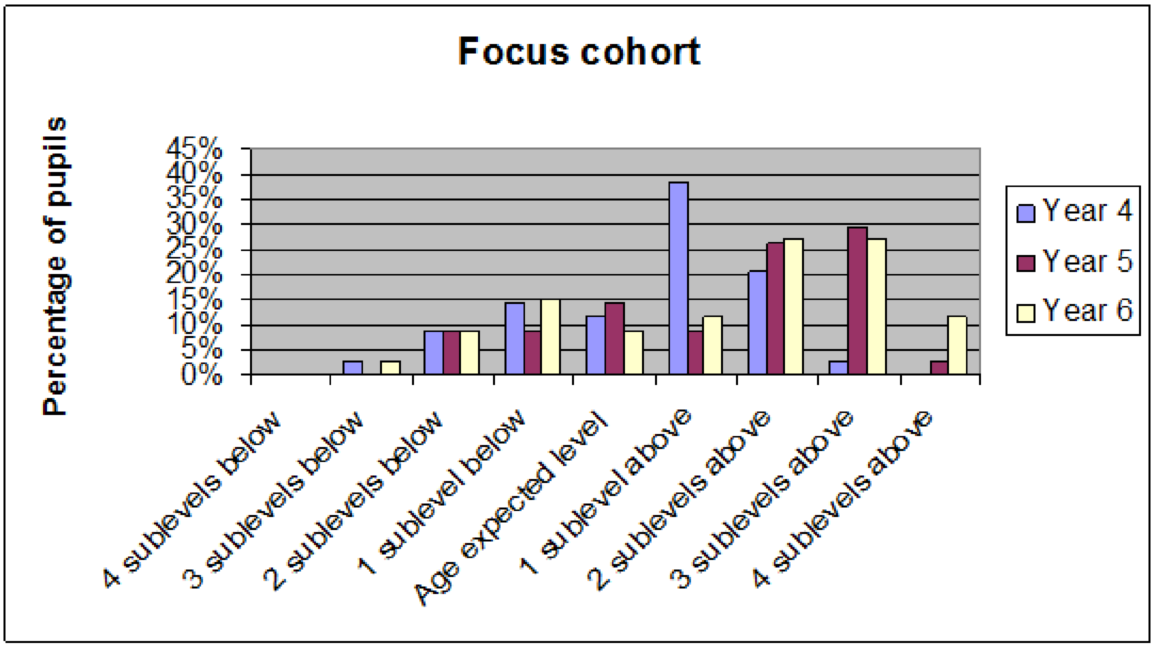


Figure 4A.7 Pupils in the focus cohort working below, at, or above age-related expectations at the end of Years 4, 5 and 6

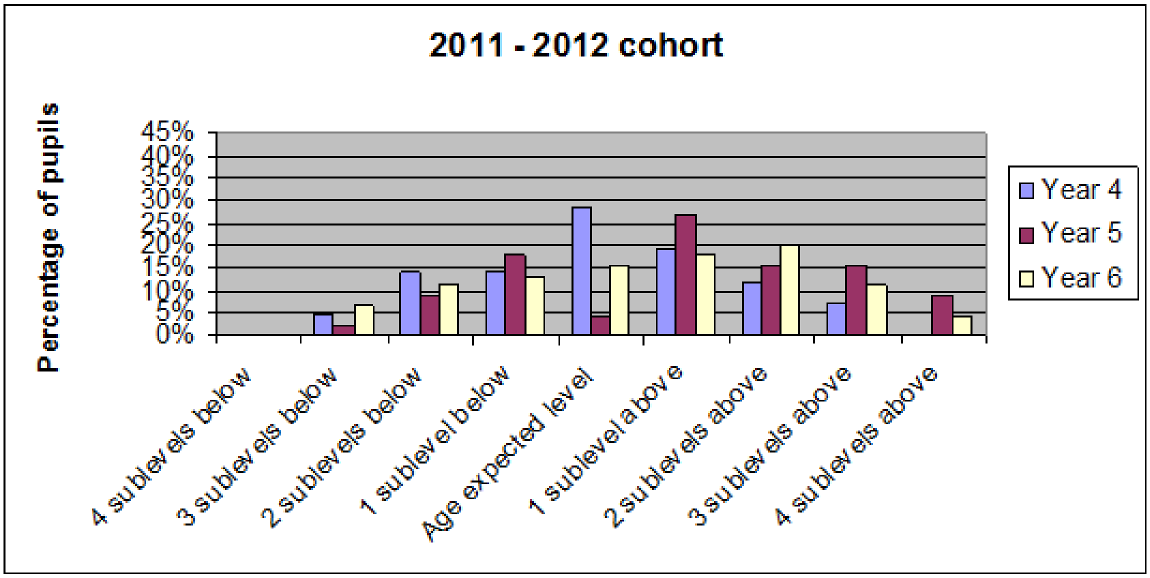


Figure 4A.8 Pupils in the 2011 – 2012 cohort working below, at, or above age-related expectations at the end of Years 4, 5 and 6

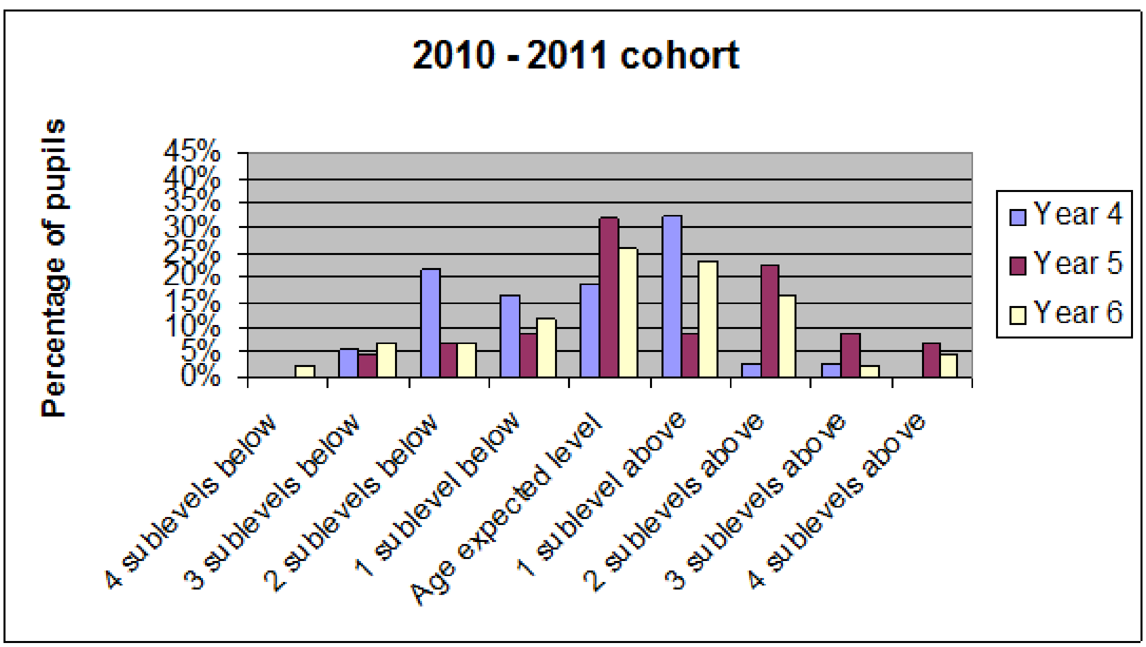


Figure 4A.9 Pupils in the 2010 - 2011 cohort working below, at, or above age-related expectations at the end of Years 4, 5 and 6

These graphs demonstrate that, although there is an increase in the numbers of children working above and significantly above age-related expectations for each of the cohorts detailed above, the increase in these numbers is considerably larger for the focus pupils than for either of the two previous cohorts. This discrepancy can be more clearly seen in Figure 4A.10, which shows the difference between the proportions of pupils working at these different levels at the end of Year 4 and Year 6.

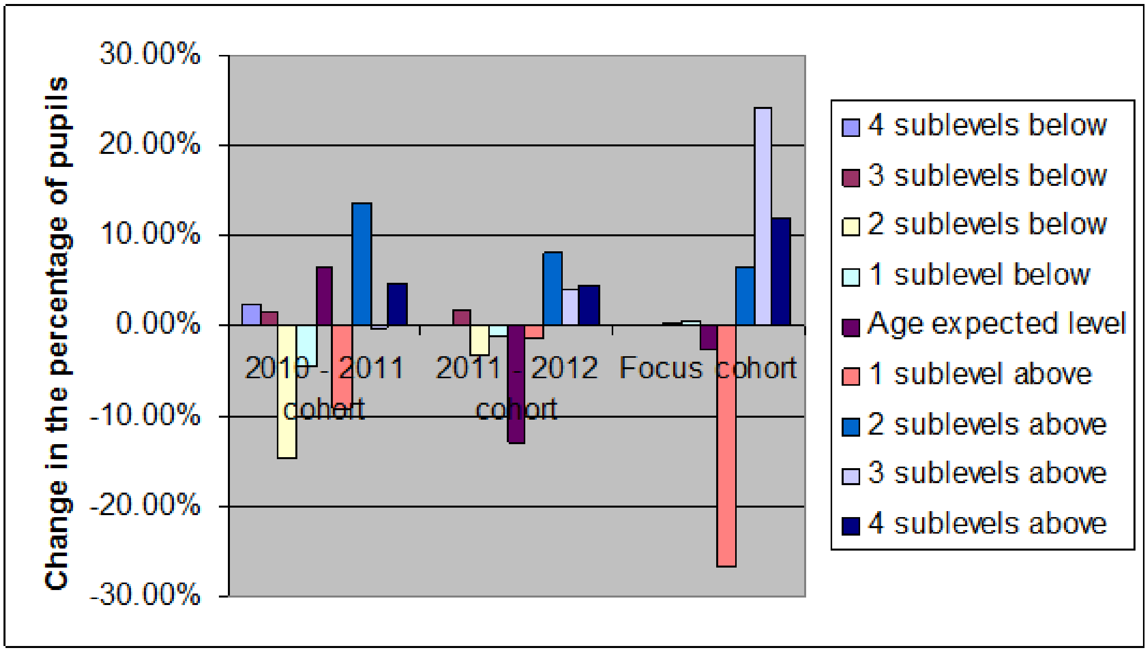


Figure 4A.10 Changes in proportions of pupils working below, at, and above age-related expectations at the end of Year 4 and Year 6

This graph demonstrates that the shift in the proportions of pupils working above - particularly those working three or more sub-levels above - age-expected levels is considerably more pronounced for the focus cohort than for either of the previous two, again suggesting that this shift was caused by the change in teaching methods.

4A.5 Thoughts

When considering the data collected here, I believe there is evidence to suggest that the use of a Thinking Skills approach has – in the context of West Side School and with these particular pupils – resulted in:

1. an increase in the number of pupils making 2.5 or more sub-levels progress after the second year of research, leading to an increase in the number of pupils working significantly (two or more sub-levels) above age-expected levels

2. an increase in the mean number of marks obtained in the Maths S.A.T, as well as an increase in the proportions of pupils both attaining the expected level (Level 4) and above (Level 5).

Taken together, I believe this evidence indicates that the Thinking Skills approach had the greatest impact upon middle- and higher-attaining pupils. This is concurrent with the findings of similar research, such as those of Hu *et al* (2010), who found that the effects of their 'Learning To Think' initiative 'were concentrated in students in the middle band of initial ability' (p. 1), or McGuinness (2006) who found that 'Children with moderate to high developed abilities benefited most' (p. 3), whilst 'no positive outcomes were identified for children with poorer developed ability' (2006, p. 3).

4A.5.1 *Reflections upon professional learning*

When first planning this research, I believe that I envisaged that the data contained in this chapter would form the most objective - and therefore, in my initial opinion, the most 'trustworthy' – evidence in favour of the use of a Thinking Skills approach. I hypothesized that, like Robson (2006), Hu et al (2010), and Higgins et al (2005), my data would demonstrate that 'when thinking skills programmes and approaches are used in schools, they are effective in improving pupils' performance on a range of tested outcomes' (p. 3). This feeling intensified as I became immersed in the Thinking Classroom that the focus cohort and I succeeded in creating together. I felt that I could see the effect of the Thinking Skills approach upon pupils' understanding of Maths: I could see pupils experiencing those 'light-bulb moments' in which something clicks into place and a child makes a connection or a leap in conceptual understanding that had previously eluded them.

The initial data, with its slight decrease in the mean number of sub-levels of progress made by the children during the first cycle of research, therefore contrasted with my perceptions of the impacts of the Thinking Skills approach upon pupils' progress in Maths. Indeed, even when considering the data more closely and considering the more detailed picture provided by the points data, the impact upon progress and attainment still was not as profound as I had expected or, indeed, had experienced through observing the pupils, and working with *them closely to discuss their developing understanding. This discrepancy prompted a process of reflection upon my use of this data to attempt to capture the impact upon the development of pupils' mathematical understanding. For example, it was important to consider whether the criteria necessary for pupils to move from one sub-level to another corresponded to the skills that the Thinking Skills approach was designed to foster. To wit: was it reasonable to judge the success of an intervention designed to improve pupils' thinking by pupils' application of skills of calculation, shape and space, or data handling?*

Despite the drawbacks to using the system of National Curriculum levels to assess progress and attainment, I continue to believe that – because of my obligation to compile this data as part of my routine role as teacher, thus leading to the ready availability of this data and the ease of comparison with the progress and attainment of children nationwide – this was the most logical choice. Yet, the surprising nature of this data, and its contrast to my understanding of the realities of the classroom and my pupils' response to the Thinking Skills approach encouraged me to consider this data more critically in order to reconcile my perceptions with the representation contained in this data. This data also taught me about the importance of flexibility and reflexivity in research – of the need to adapt to suit the realities of research – as well as to trust my instincts as a teacher-researcher: to dig deeper when the 'objective' data which I had previously prized so highly did not match up with my bone-deep understandings of the realities of my classroom. Thus, in addition to any insight into pupils' experiences of Maths, it must also be considered an important turning point in my understanding of the nature of 'good' evidence and my role, rights and responsibilities as a teacher-researcher.

Part B. The impact of a Thinking Skills approach upon pupils' opinions and academic self-concept relating to Maths

The impact of the Thinking Skills approach upon pupils' opinions and self-concept was measured through use of the S.D.Q. (Marsh *et al*, 1983). The pupils' response to this data collection tool was encouraging: they were enthusiastic about completing the questionnaire, particularly the online version. I also felt that the process of completing the S.D.Q. prompted pupils' personal reflections of their likes and dislikes; certainly, the occasions when the pupils were asked to complete the questionnaire were often followed by impromptu discussions of their perceptions of lessons and more general aspects of school and wider life, as well as the types of questions used in the questionnaire itself and what they might mean or be useful for. This positive response is reflected in the submission rates for the S.D.Q. data, which were very high, with just one pupil opting out of submission during the data collection process. The number of questionnaires completed at each point in the data collection process is shown in Table 4B.1.

Date	Number of S.D.Q. completed	Number submitted
October 2011	34	34 (**100%**)
January 2012	34	33 (**97.06%**)
May 2012	37	37 (**100%**)
July 2013	36	36 (**100%**)

Table 4B.1 Completed Self-Description Questionnaires

Nevertheless, whilst these questionnaires were submitted for use in this study, I was unable to use each and every one of them to answer each and every question. The form of analysis used here compares data at various points throughout research. For some of these, I have compared the data collected from the focus cohort as a whole. As a result, I was able to compare means from however many templates were submitted at that particular point in the data collection progress with however many templates were submitted at the subsequent points in this same process. At times, the numbers of templates compared were not always identical but, because I was comparing mean results, this was unproblematic. Yet, contrastingly, for some subsequent analyses – namely when comparing groups of pupils working at different levels of attainment – I tracked individual pupils over the course of research. Where one S.D.Q. was missing[25], this meant discounting that child from analysis. I thought this particularly important due to the small numbers - some as low as just three or four pupils – involved.

4B.1 S.D.Q. data

At first glance, the initial results obtained from the S.D.Q. data appear positive, seeming to contradict the widely accepted idea that self-concept declines during childhood and adolescence, before increasing again during early adulthood. For example, Marsh (1989), in a study of more than 12,000 responses to the S.D.Q., found that ‘Except for Parent Relations, all the SDQI scales were significantly related to age. For most of the SDQI scales and for the total score, there was a moderate decline in self-concept’ (p. 418) in pupils between Grades 2 and 5[26]. Contrastingly, responses from the focus cohort indicated that self-concept increased for each of the eight dimensions, with mean responses to just three (or 3.95%) of the 76 questions (two relating to Reading, and one to Maths) decreasing between October 2011 and June 2012. This upward trend is represented in Figure 4B.1.

[25] Because of the high submission rates, this was predominantly due to pupil absence.
[26] Pupils in Grade 2 will turn 7 years of age during the course of the school year. Pupils in Grade 5 will turn 10 years of age during the school year.

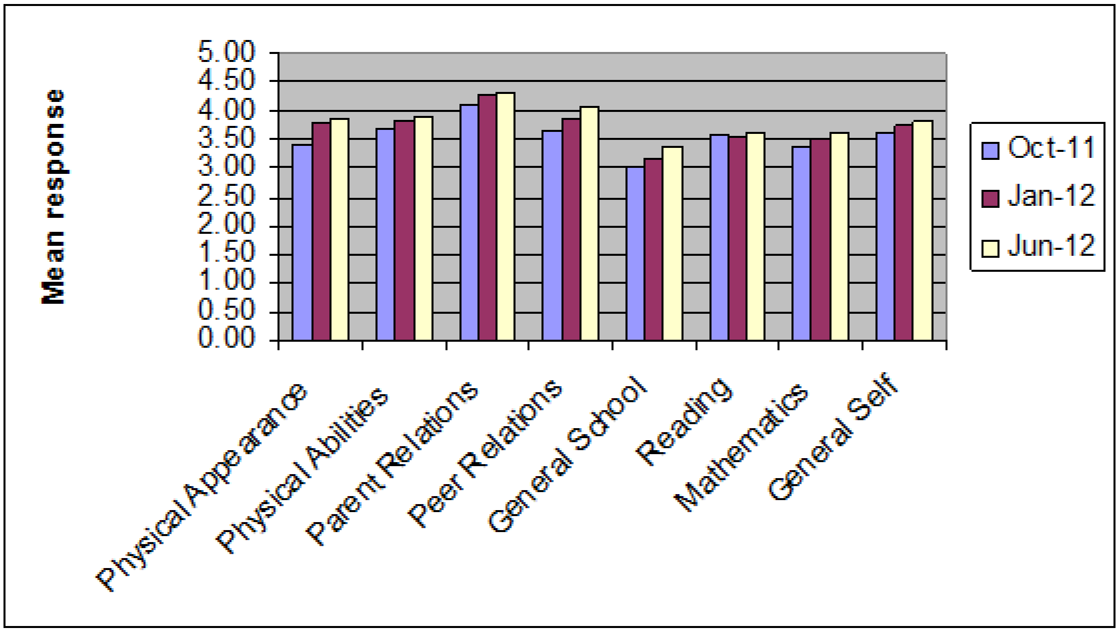


Figure 4B.1 Changes to the mean responses for the eight dimensions of self-concept

4B.1.1 *Variation between dimensions*

Whilst self-concept increased in each of the eight dimensions measured by the S.D.Q., this increase was by no means uniform. The increase in the mean responses given by pupils is illustrated in Figure 4B.2. As this graph demonstrates, there is a noteworthy difference in the increase of the distinct dimensions, ranging from an increase of just 0.03 for Reading, to an increase of 0.47 for Physical Appearance.

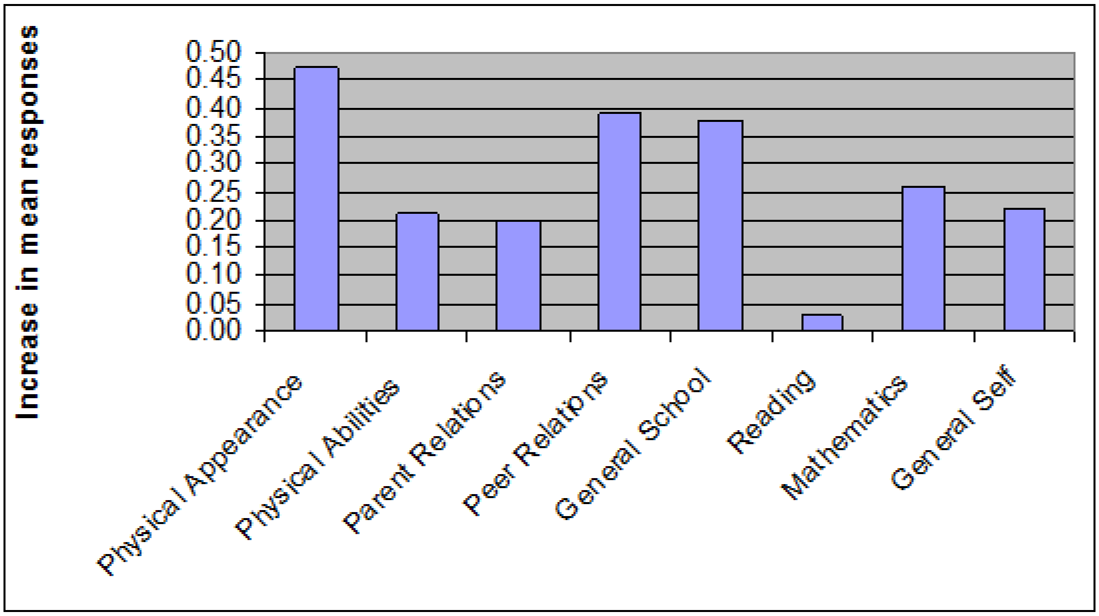


Figure 4B.2 Increase in mean responses for the eight dimensions of self-concept

Encouragingly, whilst mean responses relating to Reading remained fairly constant between October 2011 and June 2012, increasing by just 0.03, from 3.59 to 3.62, responses relating to Maths increased by 0.26, from 3.36 to 3.62. Whilst this increase is relatively small, its contrast to Reading could indicate the positive influence that the Thinking Skills approach may have had upon pupils' confidence and perceptions of the subject. Pupils' responses relating to General School also increased by 0.38, from 3.01 to 3.39. This is particularly interesting in light of the constancy in the responses for Reading, suggesting that it is pupils' changing perceptions of other areas of school life that have caused them to return more positive responses to the questions about General School. Interestingly, the responses for Peer Relations were also subject to a considerable shift during the first cycle of research, increasing by 0.39, from a mean of 3.67 to a mean of 4.06. This suggests that encouraging pupils to work collaboratively may have impacted positively upon relationships within the focus cohort.

This mean of 4.06 is particularly interesting as it suggests the overwhelmingly positive response of the focus cohort to collaborative working, despite the oft-encountered complaints from some children during group-work tasks that they are ignored or left to complete an unfair share of the work-load. I believe that the preparation for group work –

as well as the many discussions and 'debriefs' - that the pupils and I had about how to work together effectively may have influenced this positive outcome. Moreover, as can be seen in the pupil views template data later in this Findings chapter, the children embraced opportunities for collaboration, and repeatedly expressed their opinion that working with others was instrumental in helping them to develop understanding. It is my belief that this also further motivated pupils to engage pro-actively with their groups, creating a positive cycle in which pupils first believed that group work was beneficial, therefore engaged more enthusiastically, consequently ensuring that group work was indeed successful in developing their understanding. This cycle is illustrated in Figure 4B.3.

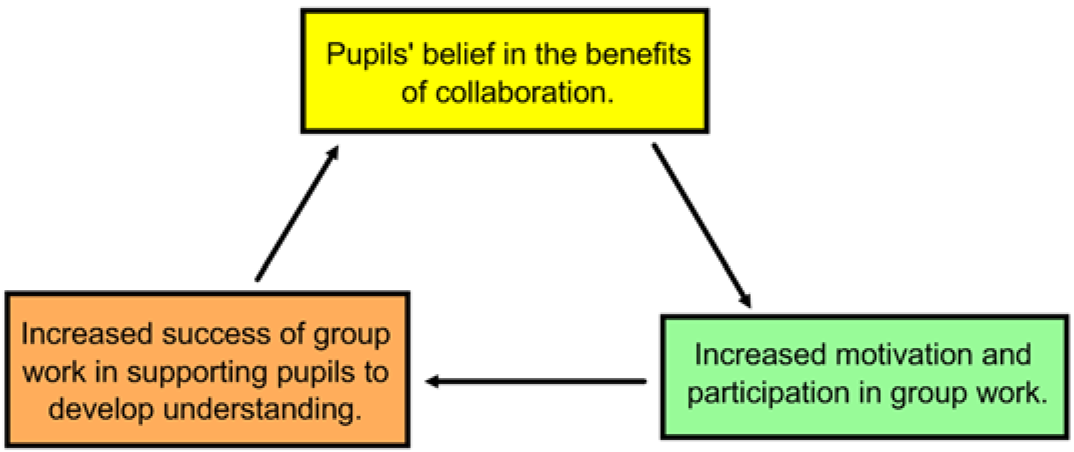


Figure 4B.3 Positive cycle created by pupils' belief in the advantages of collaboration

Whilst it may, of course, be possible to attribute this positive trend to external factors, when considering the reasons behind the deterioration in self-concept between childhood and adolescence, it is easy to understand why a Thinking Skills approach could help reverse this pattern. Demo (1992), for example, believes that

> 'There are several processes that may explain decreasing self-acceptance during later childhood. First, self-concept is characterized by a social exterior at this stage, meaning that children attach importance to, and judge themselves on, abilities and achievements (Damon & Hart 1982, Rosenberg 1986). Academic performances are of particular concern at this age, and Entwisle *et al* (1987) argue that negative feedback is prevalent, if not normative, among elementary school teachers. Children's reference groups also change during this period as identification with peers increases and parental influence wanes.

> Greater reliance on perceived, often negative, evaluations of peers challenges self-concept and stirs self-doubts' (p. 310).

Thus, according to Demo, the principal causes of a decline in self-concept are three-fold, the result of: (1) academic performance, (2) feedback from teachers, and (3) interactions with peers. Yet evidence containing in the literature and, indeed, in this study, demonstrates how a Thinking Skills approach could have counteracted these causes, thereby impacting positively upon self-concept. For example, the attainment and progress information relating to the focus cohort already suggests that the Thinking Skills approach may have increased attainment, particularly for middle- and higher-attaining pupils. Furthermore, as previously noted, Boaler (2006) maintains that multidimensionality may also have played an extremely important role in the increased success of students: 'Put simply, when there are many ways to be successful, many more students are successful. Students are aware of the different practices that are valued and they feel successful because they are able to excel at some of them' (p. 42). Moreover, under a Thinking Skills approach, feedback from teachers takes a different focus with comments aiming to extend thinking, or to question. Comments on success are given to the group as a whole, and thus pupils share praise or constructive criticism equally. Thus pupils do not feel as though they compete for individual praise, but rather work together in order to earn it, learning to support and question each other and, as a result, work together more productively as a team.

Nevertheless, the data collected with the S.D.Q. also raises some doubts. The dimension of self-concept which was subject to the greatest increase during the data collection period related to Physical Appearance. Responses for this dimension increased by 0.47, from a mean response of 3.41 to 3.88. This is particularly important because Physical Appearance is wholly unrelated to school, and therefore cannot have been influenced by the Thinking Skills approach. The logical conclusion is, of course, that the apparent improvement in S.D.Q. responses is attributable to some external factor. For example, O'Dea and Abraham found that self-concept was 'significantly related to students' standard body weight' (1999: p. 69), and that self-concept relating to physical appearance is also influenced strongly by the physical maturity that accompanies the onset of puberty, with 'early-developing females having a less positive body image than their on-time or late-developing peers', whilst, for boys, the opposite is true, 'with early maturation being linked to a positive body image and late maturation being associated with dissatisfaction with the physical self' (both O'Dea & Abraham, 1999: p. 70).

It is also possible that this could have been influenced by pupils' emerging appreciation of multiplicity of perceptions, perhaps suggesting that the cognitive flexibility we have worked to develop in Maths may be transferrable. Having explored multiple ways of 'seeing' in relation to Maths, it is possible that may also have begun to accept that there may be more than one way of being beautiful. Whilst this would be an incredibly positive outcome, this is merely one possible interpretation. I believe that this merely serves to highlight the complex, many-faceted, nature of any influences upon the focus cohort – or indeed, any other children – and the necessity of accepting that human responses to particular conditions vary widely and are difficult to predict. This links once again to the notion of praxis, and of practical philosophy, which is 'an 'inexact' science which yields a form of knowledge that cannot be applied universally and unconditionally' (Carr, 2006: p. 427).

4B.2 Comparative data

The issue of whether the use of a Thinking Skills approach has impacted positively on self-concept or whether there is some unknown, external factor at work is further brought into question when considering the comparative data gathered from across Key Stage Two. This data was collected from 24 volunteers from across Key Stage Two – comprising six (two higher-, two middle-, and two lower-attaining) children from each year group. The mean responses of this comparative sample can be seen in Figure 4B.4.

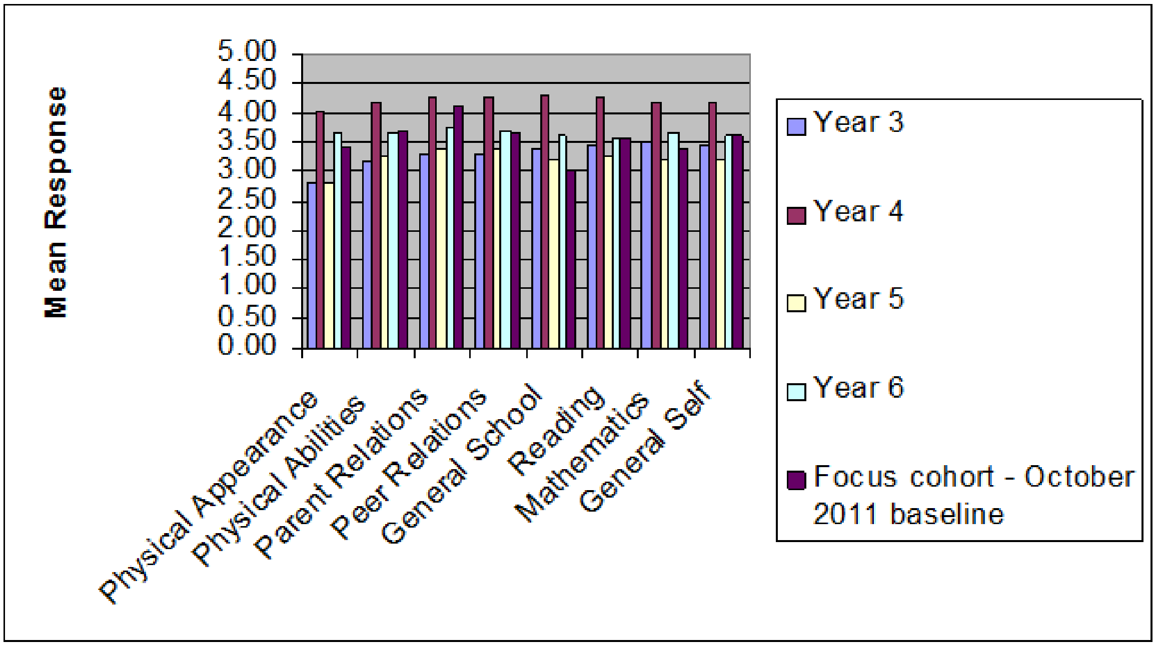


Figure 4B.4 S.D.Q. comparative data

This graph is rather interesting because, again, it contradicts the trend prevalent in data relating to self-concept. Like the data obtained from the focus cohort (who were in Year 6 when this comparative data was gathered), this does not conform to the expected gradual decrease in self-concept throughout pre-adolescence identified by Marsh (1989) but instead demonstrates that, for pupils in Years 3 and 5, mean responses relating to pupils' self-concept for Physical Appearance, Physical Abilities, Parent Relations and Peer Relations are fairly stable – although, still, it must be noted, with a very slight positive trend – increasing by 0.00, 0.09 and 0.08 respectively. The exception to this was in pupils' responses to the questions relating to General Self which decreased by 0.25, conforming more openly to the expected decline. Furthermore, mean responses relating to more specifically school-related aspects of self-concept such as General School, Reading and Maths were also subject to a marked decrease of 0.12, 0.18, and 0.28 respectively. Mean responses from the focus cohort (shown on the graph above as Year 6) are, contrastingly, much more positive than those of the pupils from Years 3 and 5. A comparison of the mean responses given by these three year groups can be found in Table 4B.2.

	Year 3	Year 5	Focus cohort	Difference between Years 3 and 6	Difference between Years 5 and 6
Physical Appearance	2.81	2.81	**3.65**	+ 0.84	+ 0.84
Physical Abilities	3.17	3.24	**3.66**	+ 0.49	+ 0.42
Parent Relations	3.29	3.38	**3.74**	+ 0.45	+ 0.36
Peer Relations	3.28	3.36	**3.70**	+ 0.42	+ 0.34
General School	3.35	3.23	**3.60**	+ 0.25	+ 0.37
Reading	3.45	3.27	**3.57**	+ 0.12	+ 0.30
Mathematics	3.49	3.21	**3.65**	+ 0.16	+ 0.44
General Self	3.47	3.22	**3.62**	+ 0.15	+ 0.40

Table 4B.2 S.D.Q. data for the comparative sample from Years 3 and 5, as well as the focus cohort

This table clearly demonstrates that Year 6 pupils, all of whom have been taught using a Thinking Skills approach during the previous two academic years, had more positive self-concept in general. This is also true of the pupils' self-concept in Maths: the focus cohorts' mean responses for Maths were 0.16 higher than the Year 3 pupils, and 0.44 higher than the Year 5 pupils. However, it is inescapable that the largest discrepancy once more relates to Physical Appearance, again implying that there may well be another explanation - or, indeed, a range of factors - responsible for the positive trend in the self-concept.

This likelihood is even more marked when considering the responses of the Year 4 pupils. These were considerably higher than any of the other three year groups, ranging from a mean response of 4.02 for Physical Appearance to a mean of 4.33 for General School. The mean response for Maths was also considerably higher than the other three year groups, with a mean response of 4.19, in comparison with 3.49 for Year 3, 3.21 for Year 5, and 3.65 for Year 6. These children were taught by one teacher of five, and another teacher of 13 years of experience, using a conventional format for Maths teaching, with a modelled introduction, followed by independent work in which they applied this new learning. They had also worked together with this same teacher both during Years Three and Four, and had developed extremely positive working relationships. However, regardless of what may or may not underpin the positive results of this particular group of children, the fact remains that it cannot be attributed to the Thinking Skills approach investigated here. This does not, however, negate the positive impact, evident in the S.D.Q. data, that the Thinking Skills approach appears to have had upon the pupils in the focus cohort, but does suggest the likelihood that there are many different routes to positive self-concept, of which the Thinking Skills approach may be just one.

4B.3 Cycle 2

Following analysis of the comparative data, in Spring 2013 – and the question this raised about the impact of the Thinking Skills approach upon self-concept – I decided to collect a further sample of S.D.Q. responses in July 2013, at the end of the second cycle of research in the hope that this may help to further elucidate the initial findings. Table 4B.3 compares the mean responses for each dimension of the S.D.Q. between June 2012 and July 2013: the end of Cycles 1 and 2, respectively.

Dimension	June 2012	July 2013	Difference
Physical Appearance	3.88	3.77	-0.11
Physical Abilities	3.89	3.80	-0.09
Parent Relations	4.32	4.37	+0.05
Peer Relations	4.06	3.97	-0.09
General School	3.39	3.38	-0.01
Reading	3.62	3.67	+0.05
Mathematics	3.62	3.62	+0.00
General Self	3.84	3.76	-0.08

Table 4B.3 Changes to mean responses between June 2012 and July 2013

Initially, I found this data disappointing, interpreting it as evidence that the Thinking Skills approach did not substantially influence pupils' self-concept – at least as it was measured by the S.D.Q. – during the second year of research, with mean responses to just two of the eight dimensions measured increasing during this period and the mean responses to five dimensions decreasing slightly. Furthermore, mean responses for Maths remained constant, with identical mean responses at the end of both Cycles 1 and 2. I believe that it is essential to recognise that this data continues to contrast with the decline in self-concept evident in the work of Demo (1992) as well as Marsh (1989), who, in a study of more than 12,000 responses to the S.D.Q., found that 'For most of the SDQI scales and for the total score, there was a moderate decline in self-concept' (p. 418) in pre-adolescent pupils. In this way, I believe that it is possible to argue that, even in remaining relatively constant – and thus counteracting a negative shift – the self-concept of the focus cohort has been positively affected throughout the research period. It is also important, and perhaps even more encouraging, to note that all of the mean responses given in July 2013 were higher than those given in October 2011 at the outset of research. Figure 4B.5 represents these findings.

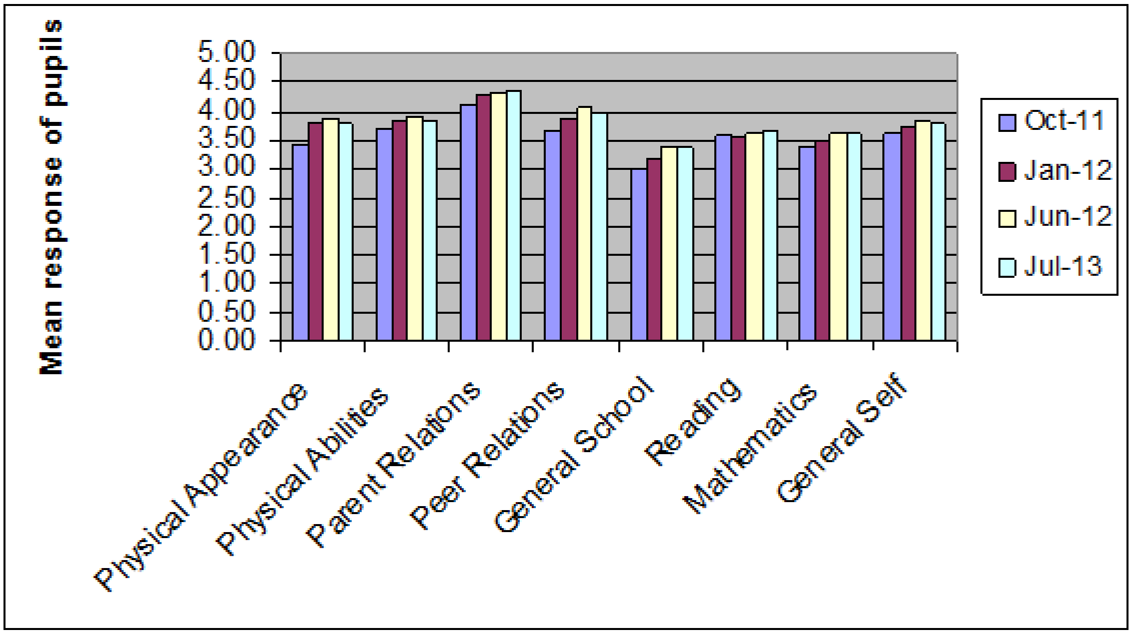


Figure 4B.5 S.D.Q. responses throughout the research period

Because the data for all eight dimensions of self-concept measured by the S.D.Q. defies the negative trend identified by Demo (1992) and Marsh (1989), it perhaps remains difficult to attribute this positive impact to the Thinking Skills approach alone. However, I believe it is nevertheless heartening that this data suggests that pupils within the focus cohort are perhaps more confident and resilient than their peers, particularly as this final set of S.D.Q. data was taken just weeks after pupils undertook their end of Key Stage Two S.A.T.s., which Boaler (2009), for example, blames for pupils becoming ‘extremely de-motivated in the tested subjects – especially maths’ (p. 80).

4B.4 Subsets within the data

4B.4.1 *Gender differences*

In addition to the above analysis regarding the focus cohort as a whole, it is also important to consider whether there are discrepancies within subsets of the data. For example, previous research has found that girls have 'significantly lower math self-concepts' (Marsh and Yeung, 1998: p. 723), than boys. In light of this assertion, it was useful to consider the responses of girls and boys separately to ascertain firstly, whether this is true of the children in the focus cohort and, secondly, whether this altered during the course of research. The following figures - Figures 4B.6, 4B.7 and 4B.8 - show the mean responses to the S.D.Q. at the outset of research in October 2011, the end of Cycle 1 in June 2012 and the end of Cycle 2 in July 2013.

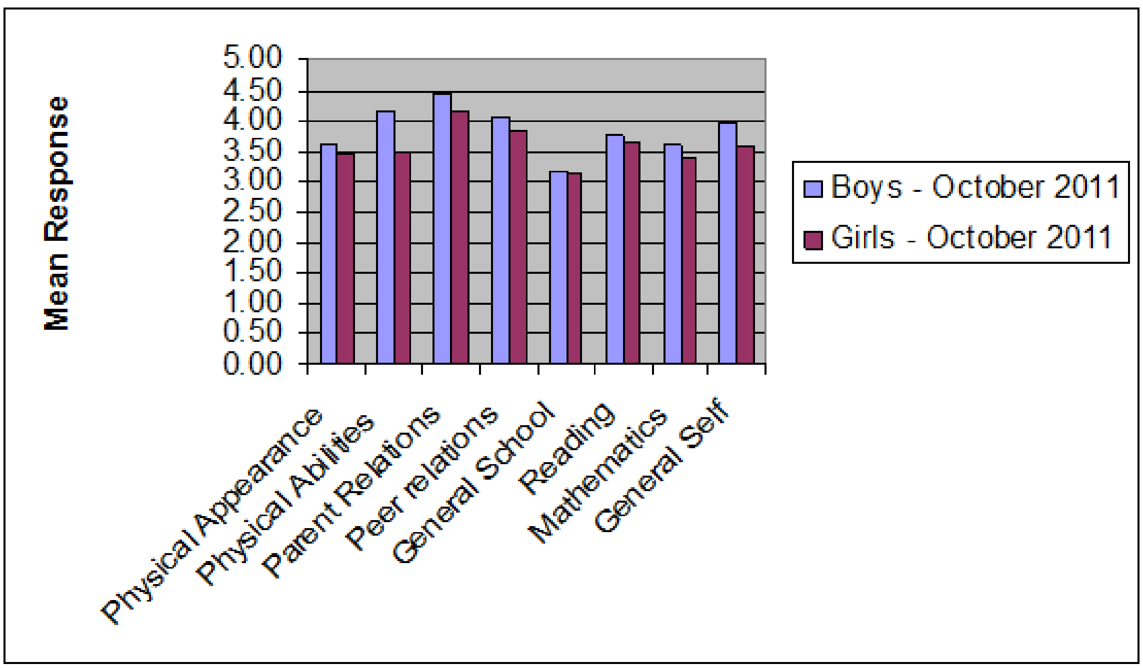


Figure 4B.6 Comparison of boys and girls (October 2011)

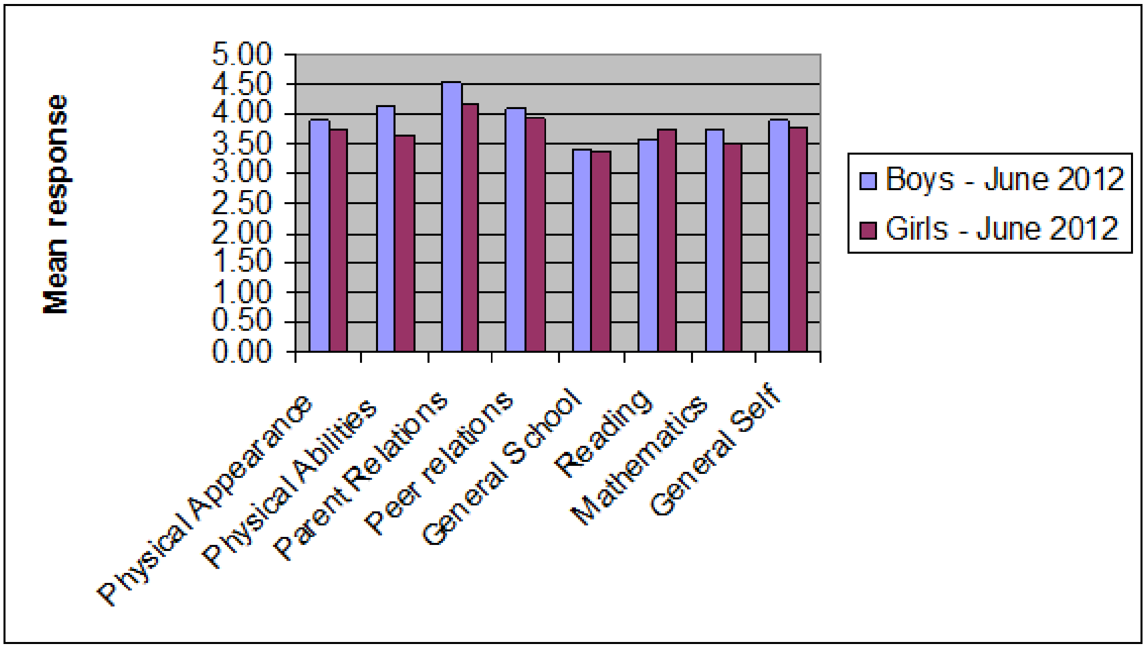


Figure 4B.7 Comparison of boys and girls (end of Cycle 1)

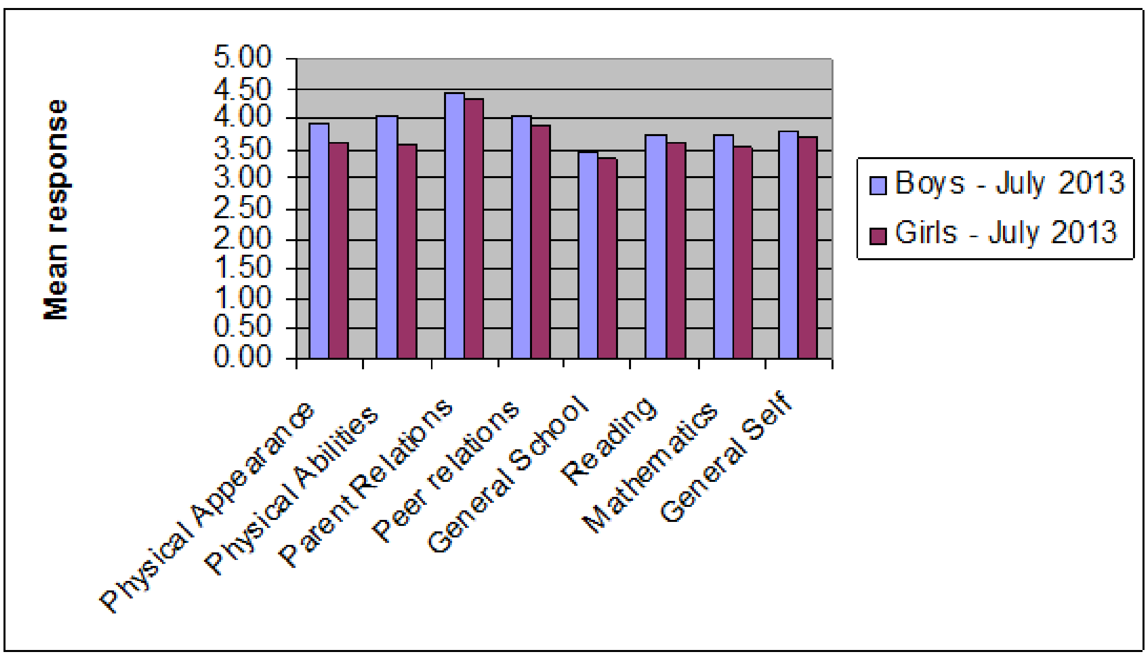


Figure 4B.8 Comparison of boys and girls (end of Cycle 2)

As these graphs show, the data collected during this research concurs with the findings of Marsh and Yeung (1998) that self-concept of boys in the focus cohort is indeed more positive than that of girls, not just for Maths, but also for each of the dimensions measured by the S.D.Q., with the sole exception of Reading during the June 2012 S.D.Q. data, when boys returned a mean response of 3.58 in comparison with 3.72 from girls. Despite this, it is interesting to note that there has been some, relatively small, improvement in the mean responses given by the girls in the focus cohort between October 2011 and July 2013. This change in mean responses to each of the eight distinct dimensions can be seen in Figure 4B.9.

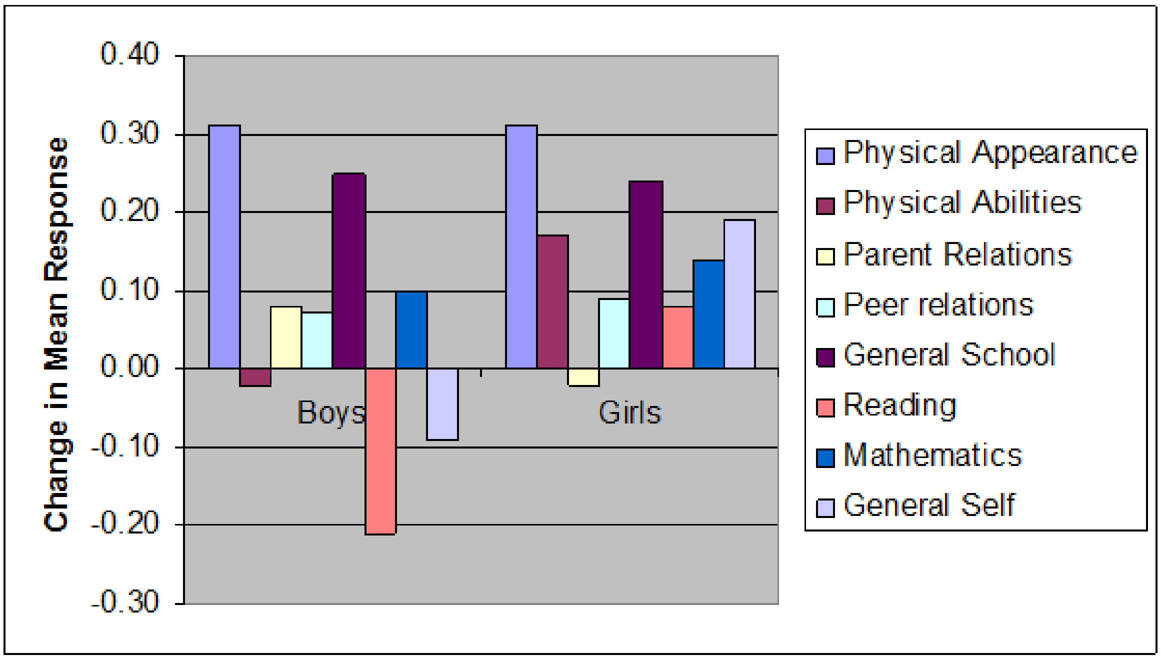


Figure 4B.9 Changes to responses for boys and girls

This graph shows that, whilst the change in responses for Maths given by girls in the focus cohort was indeed more positive than that of boys, the discrepancy between these changes was rather small: just 0.14 in comparison with 0.10 from boys. Furthermore, this change was dwarfed by the changes in girls' responses to other dimensions measured by the S.D.Q. such as Physical Appearance, General Self or Physical Abilities, thus suggesting that the Thinking Skills intervention did not substantially impact upon gender differences in self-concept amongst the focus cohort.

4B.4.2 *The impact on pupils of different levels of attainment*

It is also important to consider the impact of the Thinking Skills approach upon pupils of different levels of attainment. In the literature, there is some confusion regarding the pupils for whom the approach is most successful. Hu *et al* (2010), for example, found that the effects of the 'Learning To Think' initiative 'were concentrated in students in the middle band of initial ability' (p. 1). Similarly, McGuinness (2006) found that 'Children with moderate to high developed abilities benefited most' (p. 3), whilst 'no positive outcomes were identified for children with poorer developed ability' (2006, p. 3). Yet, contrastingly, Higgins *et al* (2004) indicated that 'there may be greater impact on low attaining pupils' (p. 5) and Cardelle-Elawar (1992), found that the teaching of Thinking Skills enabled low-ability pupils to develop 'as problem solvers in (a) understanding how to approach a problem, (b) identifying the appropriate schema for organizing the information, (c) recognizing there may be more than one right way to solve the problem, and (d) verifying their solutions' (p. 119). This last assertion is particularly interesting as it highlights the potential that a Thinking Skills approach may hold in increasing the self-concept of lower-attaining pupils. In light of this, it would be extremely interesting to further analyse the results by level of attainment, in an attempt to discern whether changes in the data are more pronounced for different groups of pupils.

To investigate this possibility, I classified the 29 pupils who submitted data both in October 2011 and July 2013 as either working significantly below, below, at, above or significantly above age-related expectations. This judgment was based on attainment at the outset of research - at the beginning of Year 5 in September 2011 - and the proportions of pupils working at these different levels was by no means equal. This is evident in Table 4B.4.

Level of attainment	Number of pupils
Significantly below (Level 2a or below)	3 (**10.34%**)
Below (Level 3c)	4 (**13.79%**)
Working at age-expected levels (Level 3b)	3 (**10.34%**)
Above (Level 3a)	12 (**41.38%**)
Significantly above (Level 4c or above)	7 (**24.14%**)

Table 4B.4 Pupils working below, at, or above age-related expectations at the beginning of Year 5

Table 4B.5 shows the change in mean response to the eight dimensions measured by the S.D.Q. during the research period.

	Significantly Below	Below	At Age Expected Level	Above	Significantly Above
Physical Appearance	+0.00	+0.56	+0.37	+0.40	+0.22
Physical Abilities	-0.18	+0.83	-0.18	+0.17	+0.27
Parent Relations	+0.00	+0.31	+0.15	+0.29	+0.00
Peer Relations	+0.04	+0.72	+0.11	+0.02	+0.40
General School	+0.13	-0.53	+0.37	+0.22	-0.06
Reading	-0.47	-0.38	+0.20	+0.16	+0.04
Mathematics	-0.13	+0.08	+0.43	+0.20	-0.24
General Self	-0.30	-0.08	+0.03	+0.23	+0.01

Table 4B.5 Change in responses for pupils working below, at, or above age-related expectations

This data gives some impression of the varied impact which the Thinking Skills approach may have had upon different groups of pupils within the focus cohort. With regard to self-concept relating to Maths, mean responses for three of the five groups improved. These positive effects are most evident upon pupils working loosely at age-expected levels of attainment: at age-expected levels, as well as one sub-level either side of this. This is again consistent with Hu *et al* (2010)'s finding that effects of the 'Learning To Think' initiative 'were concentrated in students in the middle band of initial ability' (p. 1). Furthermore, it is heartening to recognize that this shift was larger than that recorded for pupils' self-concept relating to Reading. This discrepancy was most marked for pupils working below age-expected levels, for whom there was a mean decrease of 0.38 for Reading, in comparison with a mean increase of 0.08 for Maths. For these pupils, as well as those working at age-expected levels, this increase was also greater than the increase in self-concept relating to General School.

Contrastingly, responses from pupils working both significantly above and significantly below age-expected levels suggested that self-concept in Maths decreased by a mean of 0.24 and 0.13 respectively. It is tempting to speculate on the causes for this, yet it is possible that the reactions of these different pupils could be the result of disparate aspects of the approach. For example, could it be that the highest-attaining pupils were used to being 'right' and that their confidence in their own mathematical ability was shaken by the change in working? Certainly, this negative change contrasts with the increase in mean responses given to the majority of the other dimensions of self-concept measured by the S.D.Q. Furthermore, and interestingly, the views of these pupils relating to Reading increased very slightly – by a mean of 0.04 – during the same period, further suggesting that this negative shift in attitude did not apply to all school subjects and may, therefore, be attributed to the Thinking Skills approach.

Although the self-concept of pupils' working significantly below age-expected levels decreased throughout the research period, this decrease formed part of a wider trend, encompassing four of the eight dimensions measured by the S.D.Q. All of these decreases were larger than the negative shift of 0.13 evident in responses for Maths, including a mean decrease of 0.30 for General Self and, perhaps most interestingly, a decrease of 0.47 for Reading. Thus, it could be argued that this decline has been smaller than may perhaps have been expected. Consequently, I believe that it may be rather premature to conclude - in agreement with those such as McGuinness (2006) - that 'no positive outcomes were identified for children with poorer developed ability' (p. 3). Certainly, my own impressions of these pupils - gained during my observations throughout our day-to-day interactions -

were that, by working with others and establishing a community of enquiry in which all answers and ideas were valued, these pupils became more confident. They ventured ideas more readily during lessons and, as the research period progressed, they engaged more actively both within their groups and with their own learning.

4B.5 Thoughts

The S.D.Q. data was intended to measure the impact of the Thinking Skills approach upon pupils' opinions of Maths and their own ability to make progress. When considering the results relating to Maths alone, the picture appears positive, suggesting:

1. a steady increase in pupils' concept of themselves as learners of Maths during Cycle 1. Self-concept remained constant between the end of Cycles 1 and 2, contrasting with the decline evident in the work of Marsh (1989) and Demo (1992).

2. comparative data from Year 3 and 5 pupils demonstrated that the increase in self-concept for the focus cohort is not necessarily typical of a trend in which self-concept towards Maths increases with age in West Side School as a whole.

This sense of enthusiasm and confidence surrounding Maths learning is also in keeping with my casual observations of pupils in the focus cohort. Certainly, the pupils themselves appear to believe that collaborative group work, with the opportunities it provides for them to discuss their learning, is extremely useful. For example, many pupils recorded comments on their learning such as 'Working in a group helped me today' both in their books and on pupil views templates. Furthermore, in an informal survey 100% of pupils said that they thought they made more progress working as part of a group rather than alone.

The fact remains that, for the focus cohort as a whole, although the pupils' self-concept in Maths improved during the course of research, so too, did self-concept relating to the other dimensions measured by the S.D.Q., many by a greater margin than the increase recorded in Maths. In addition, the use of a Thinking Skills approach did not substantially impact upon gender biases evident in pupils' self-concept: girls consistently gave less positive responses for each of the eight distinct dimensions measured by the S.D.Q. and this was not greatly affected by this research. Similarly, evidence in the data relating to pupils working at different levels of attainment was rather inconclusive, with both positive and negative shifts recorded for different pupil groups. Like the findings of Hu *et al* (2010), positive impact was strongest for pupils working in the central band of attainment, whilst pupils working both significantly above, as well as significantly below, age-expected levels experienced a decline in responses relating to Maths, thus contrasting with the work of those such as Cardelle-Elawar (1992), who found evidence that a Thinking Skills could be linked to improvements in self-concept in Maths for lower-attaining pupils.

4B.5.1 *Reflections upon professional learning*

Having considered the findings gathered from the S.D.Q. data, I must own, once again, to a certain nagging feeling that the quantitative data featured here does not truly correspond to my own interpretations of the realities of the Thinking Classroom. As I have admitted above, I found it slightly disappointing that the self-concept data did not reflect the positive change I could feel taking place within our classroom, particularly for a number of middle-attaining girls, and for children currently working significantly below age-expected levels. Whilst I continue to remind myself that the consistent self-concept recorded by the pupils of the focus cohort should, in itself, be viewed in a positive light because of the well-documented decline, I nevertheless feel that the S.D.Q. data did not, perhaps, succeed in capturing the shift in the pupils' confidence which took place during the two-year research process.

I believe that this may be the result of a certain separation in the pupils' minds of the confidence they felt on a day-to-day basis, and their more general perceptions which, I suppose it is logical to accept, may require a greater period of reflection to undergo a more substantial and long-term change. While contemplating this, I believe that it is interesting to reconsider my selection of the S.D.Q. in light of my developing understanding of evidence. Upon reflection, I feel that one of the reasons why I may have felt so comfortable with the S.D.Q. was because of my previous subconscious bias towards quantitative methods and data. The means of comparing the results from my research with that of *researchers from an enormous of studies across the world was not only an excellent means of ensuring the reliability of this study, but was also, to some extent, a comfort blanket which enabled me to increase my own sense of safety and security that I was conducting this research in the 'right' kind of ways.*

Now, with the benefit of hindsight, I may have been tempted, not to omit the S.D.Q. data, but to supplement this with further information about the children's feelings in relation to their self-concept in Maths. For example, I believe that, when it first became apparent that the children's declarations regarding their increased confidence were not necessarily reflected in their responses to the S.D.Q., it would perhaps have been interesting toinvolve the children more actively in discussion in order to ascertain the underlying causes for this. Why – and in what ways - did their confidence increase? Was there a difference between doing well in a Maths lesson, and their feelings about Maths in general? What were they thinking when completing the S.D.Q.? Would they have been able to suggest an alternative strategy for documenting any shift in their self-concept relating to Maths? I cannot help but feel that my failure to do this constitutes a missed opportunity, not only to gain further insight into this data, but also to further engage the pupils themselves in consideration of the nature, and potential importance, of self-concept, as well as in the development of research, further expanding the children's role as co-researchers. Yet, although this realisation has, unfortunately, come too late to influence this research, I believe that it nevertheless constitutes an important development in my professional learning as a teacher-researcher; one that I hope I will be able to act upon in the future.

Part C. The impact of a Thinking Skills approach upon pupils' understanding of the learning process

The impact of the Thinking Skills approach upon pupils' understanding of the learning process and the development of metacognition was principally measured through use of pupil views templates. The data collected was both qualitative – in terms of the comments recorded by pupils – and quantitative – in that it was possible to classify and then count particular types of comments. As such, it provides the most open form of data collected in this study, and the one which best allowed pupils in the focus cohort to share their own views, in their own words. It is also important to note that the pupil views templates can be seen both as a data collection tool, in terms of recording pupils' reflections upon their learning at several, distinct points throughout the research process, and also an integral part of the Thinking Skills approach, as a means of prompting pupils to reflect upon their learning during individual lessons. The pupil views templates thus served a purpose similar to that of 'the river' by providing a starting point for discussion and a means of rendering pupils' thinking visible.

4C.1 The pupils' response

A considerable advantage of the pupil views templates was the response of the pupils themselves to this particular method. In February 2012, the 32 pupils of the focus cohort who were present that day were asked to describe their experiences of completing the templates. The responses given were extremely encouraging: 25 (75.76%) of these responses were positive and eleven (33.33%) also demonstrated awareness of the opportunity that the templates provided to share feelings and ideas. A further three children (9.09%) also recognised that Maths lessons changed as a direct result of the views shared using the pupil views templates, even at this early stage in the research process.

Seven (21.21%) responses were apathetic, stating that they "did not mind" or were "not bothered" about completing the templates. It is interesting to note that a further three (9.09%) of these children gave positive reasons in support of their answer. Just one (3.03%) response was negative, and it is interesting to note that the very purpose of the templates –

asking for pupils' own views and opinions – was the reason given for the pupil's dislike. It is also perhaps important to note that this response was given by a child who joined Year 5 midway through January from another school in the local area and so had not participated in earlier stages of research. These responses are represented in Figure 4C.1.

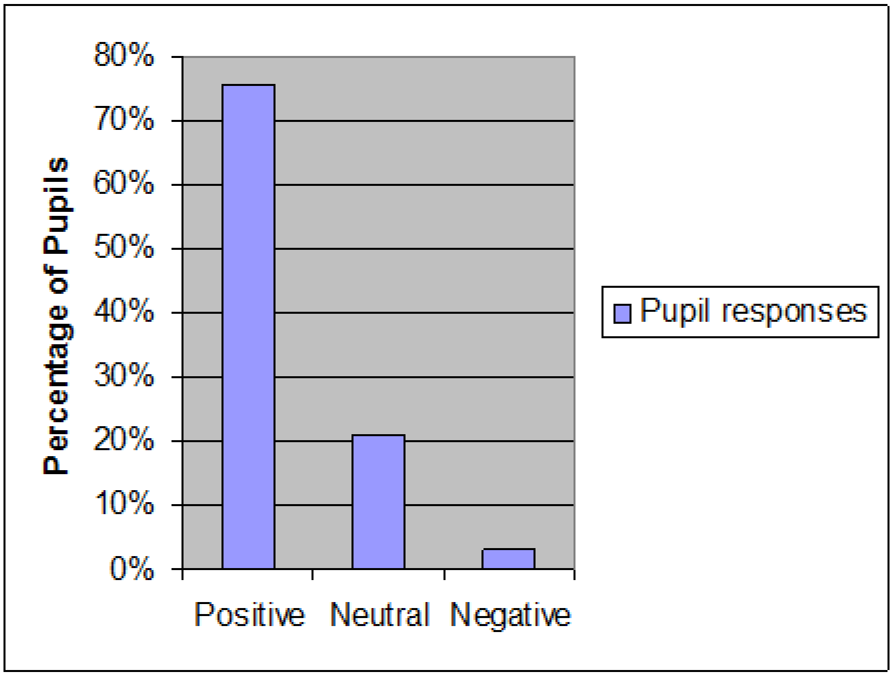


Figure 4C.1 Pupils' opinions about sharing their views

4C.1.1 *Non-submission*

Pupils' positive response is further emphasized by the submission rates: these were very high and, indeed, increased throughout the course of research so that, by the end of Cycle 1 in May 2012, 100% of completed pupil views templates were submitted for analysis. Further information regarding the number of templates completed, those submitted for analysis by the children, and the number of text units they contained can be found in Table 4C.1.

Date	Number of templates completed	Number of templates submitted
December 2011	30	28 (**93.33%**)
February 2012	34	31 (**91.18%**)
March 2012	34	33 (**97.06%**)
May 2012	36	36 (**100%**)

Table 4C.1 Pupil views templates submitted

The reasons given for non-submission were varied, and were often indicative of an ongoing desire to please or of inferiority. One girl from Class 1, for example, chose not to submit her template because she was 'embarrassed' about the drawing she had produced. Interestingly, there was a discrepancy between the Year 5 classes, with just one pupil from Class 2 choosing not to submit a completed template during the data collection period as a whole, in comparison with five children from Class 1. The most likely explanation for this inconsistency is the impact of my own role of teacher-researcher. During the first cycle of research, whilst I planned Maths for the year group as a whole, and worked daily with the children in Class 1 as part of the Year 5 team, I was not their class teacher: I spent the majority of my time with Class 2.

This possibility is strengthened by the 100% submission rate from the templates submitted in May 2012, at a time when I was responsible for the teaching and learning of both classes due to a colleague's departure for maternity leave. However, although my own influence is the probable cause of this difference, it is less obvious whether this influence is positive or negative; the result of a more trusting relationship between myself and my pupils, or simply an indication of my pupils' desire to please. Because of the positive response of the pupils to this particular data collection tool, I hope that the latter is more probable, a belief supported by the steady increase in the submission rates throughout the academic year.

It is important to note that this is an issue peculiar to this particular set of data. I continued to collect S.D.Q. and attainment data during both the first and second years of research. Furthermore, during Cycle 2, when the focus cohort had moved into Year 6, I taught all of the pupils Maths, thus eliminating any anomalies in the data that may have been caused by a different teacher. Nevertheless, in an attempt to further reduce any discrepancies that may have been caused by my different position and resultant relationship with the pupils, I held an additional feedback session for the focus year group as a whole to ensure that all pupils were fully informed about the purposes of this research, and the potential that their responses held for the transformation of the teaching and learning of Maths in West Side Primary.

I hoped that feedback of this nature would increase engagement with the pupil views templates, as well as the other data collection tools employed in this research, in line with the findings of Hattie and Timperley who found that some forms of feedback could lead to increased motivation in pupils (2007: p. 86). The feedback session held was informal, in which we discussed the purpose of the information we gathered and the changes that we made to teaching and learning as a result. Pupils were encouraged to ask questions and express their views freely. The information shared was then displayed on the 'feedback station' in each classroom, and pupils were expected to interact with this information, adding their own thoughts and comments.

4C.1.2 *An intervention half-life?*

It is interesting to note that the level of detail in which pupils completed templates remained largely stable throughout research, varying between a mean of 3.97 at the lowest point to a high of 5.29. This means that pupils consistently included between 4 and 5 text units per template. This data is shown in Table 4C.2 below.

Date	Number of templates submitted	Number of text units for analysis	Mean number of text units per template
December 2011	28	148	5.29
February 2012	31	151	4.87
March 2012	33	131	3.97
May 2012	36	178	4.94

Table 4C.2 Mean numbers of text units

It is important to acknowledge that the views of the focus cohort as a whole are included here. With some of the data detailed in the previous sections of this 'Findings' chapter it has been necessary to omit data collected from some pupils because they were present in West Side School for just part of Years 5 and 6, and thus I was unable to track their attainment, progress or self-concept throughout the two-year research period as a whole. However, the pupil views template data is slightly different. Part of the reason for this is that this data collection tool was used only during the Cycle 1, during the 2011 – 2012 academic year, when the focus cohort were in Year 5. Consequently, although two pupils left West Side School at the end of Year 5, I nevertheless have a full set of completed templates and felt it unnecessary – and even a dismissal of their opinions – to discount them from research. Therefore, this chapter describes the findings obtained from the 36 children in the focus cohort during the first cycle of research.

4C.2 Pupil views templates data

The following section details the analysis of each of the seven categories identified through the inductive coding process. At this point, it is important to note that the data contained in the pupil views templates should not necessarily be expected to form part of any kind of progression. The templates were each completed after a randomly selected lesson. Consequently, these lessons were very different, consisting of a game-based, practical lesson on probability which the pupils completed working in mixed-attaining pairs in October 2011; a lesson on mixed word problems, including those involving measures, which the pupils completed working in mixed-attaining groups of three or four in December 2011; a problem-solving lesson based on one of the 'Challenges for More Able Pupils' (D.f.E.E., 2000) which pupils again completed in mixed-attaining groups of three or four in March 2012; and a practical measures investigation which pupils designed and carried out themselves, working in mixed-attaining groups of three or four in May 2012. As a result of these differences in focus and format, it is perhaps more helpful to view the templates as insights into pupils' thinking at each individual point in the research progress.

This view of the pupil views templates as an insight into pupils' thinking at each individual point in the data collection process is again indicative of the shift in my thinking as a teacher-researcher. Initially, I must admit that I did expect that I would be able to quantify the data collected using the templates and that this would reveal an increase in *metacognition as research progressed. I suppose, therefore, that, subconsciously at least, I was looking for this data to provide 'proof' of my hypothesis: that the introduction of a Thinking Skills approach would result in increased metacognition for pupils. Learning to embrace the responses included by the pupils for the representations of their experiences of the Thinking Classroom that they provided therefore constitutes an important step in my learning journey about myself as a teacher-researcher and my understanding of just what constitutes 'good' evidence, as well as regarding how this should be used to inform research, as well as teaching and learning. Similarly, my decision to abandon my intended form of data analysis – using the categories for thinking drawn from Wall (2008), as well as Veenman et al (1997) – in favour of a form of inductive coding, which Thomas (2003) believes is often present in qualitative data analysis, and which allowed 'research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies' (Thomas, 2003: p. 2), demonstrates my increasing confidence in my own interpretations of the realities of our Thinking Classroom, rather than an over-reliance upon more traditional – and predominantly quantitative - methods.*

4C.3 The use of language

4C.3.1 *Causal connectives (so / because)*

I consider causal connectives to be significant because of their linguistic function in introducing explanation. I therefore believe that these responses provide some of the best examples of pupils explaining their reasoning both in their reflections upon the learning process, as well as in their descriptions of their thinking about the mathematical activities they engaged in during the focus lessons. All comments including the causal connectives 'because' or 'so', as well as comments featuring an explanation, were included in this category. Typical comments classified in this category include 'I was confused but now I get it *because* I worked with somebody' or 'I think we should gamble *because* it is an even chance and if we go for it to being higher and it might be lower and you won't win you will lose'[27]. The proportions of responses of this type are given in Table 4C.3.

[27] Both comments are from pupil views templates completed during Term 2a.

	Percentage of text units containing causal connectives
December 2011	18.92%
February 2012	21.19%
March 2012	5.34%
May 2012	10.67%

Table 4C.3 Text units containing causal connectives

This data clearly reveals a rather disappointing decrease in the number of responses containing causal connectives. I had hoped that the use of causal connectives would increase throughout research, suggesting that pupils were becoming more accustomed to explaining their reasoning both orally and in writing, but unfortunately this does not appear to have been the case! However, it is interesting to note that, although a relatively small proportion of responses contained causal connectives, there was evidence of responses of this type on a relatively wide range of templates, as Table 4C.4 illustrates.

	Percentage of templates containing causal connectives
December 2011	39.29%
February 2012	51.61%
March 2012	21.21%
May 2012	33.33%

Table 4C.4 Templates containing causal connectives

I believe that this suggests that, although the proportion of text units containing causal connectives peaked at 21.19%, the number of pupils who used these connectives was considerably higher, peaking at 51.61%. Upon reflection, it is perhaps logical to expect the proportion of text units featuring causal connectives – and therefore explanations – to be lower than the proportion of pupil views templates in which these featured. I believe that it makes sense that we would include a variety of responses to more accurately represent our experiences of the lesson as a whole and that, consequently, it would be unrealistic to expect all, or even almost all, responses to include an explanation. It is also interesting to note that this peak – in the proportions of text units containing causal connectives, and the proportion of pupil views templates in which these featured – came at the same point in research: in February 2012. This lesson took the form of a game, in which pupils worked in mixed-attaining pairs to calculate the probability that the next card would be higher or lower, inspired by ITV's 1980s game-show 'Play Your Cards Right'. I believe that this suggests that this particular lesson may have been more conducive to explanations, emphasizing the importance of task in fostering reflection upon learning.

4C.3.2 *Questions and speculation*

This category relates to the sixth level of Bloom's Revised Taxonomy (Krathwohl, 2002), 'Creating', in which pupils are involved in 'Putting elements together to form a novel, coherent whole or make an original product' (Krathwohl, 2002: p. 215). This category includes questions asked by the pupils themselves such as 'How many left til it breaks do you think?' and 'What can we do to improve?'[28] as well as speculative responses such as 'I wonder how he does it. Does he look at the cards?'[29] and 'I wonder what bag is going to be the stronger and when it could break'[30]. Language of this type is particularly important in light of the emphasis McGregor and Gunter (2006) place upon this language as a means of 'engaging students in analysing what they already know and then synthesizing (or extrapolating) forward' (pp. 43 – 44).

	Percentage of text units containing questions
December 2011	16.89%
February 2012	13.91%
March 2012	25.19%
May 2012	29.78%

Table 4C.5 Text units including questions

Again, when considering the number of templates on which these questions appear, this accounts for a considerably greater proportion of all completed templates, suggesting that

[28] Both comments from pupil views templates in Term 3a.
[29] Comment from a pupil views template in Term 2a.
[30] Comment from a pupil views template in Term 3a.

the majority of pupils used language of this type in the course of the research period. The proportion of templates featuring questions can be found in Table 4C.6.

	Percentage of templates containing questions
December 2011	50%
February 2012	45.16%
March 2012	63.64%
May 2012	58.33%

Table 4C.6 Templates including questions

This data demonstrates that the number of questions recorded by pupils increased substantially during Cycle 1, perhaps suggesting that pupils were beginning to show more curiosity about their work, asking their own questions and speculating about possible outcomes. These results are particularly interesting when taken together with the results describing the different proportions of speculative comments used. These are shown in Table 4C.7.

	Percentage of text units containing speculative comments
December 2011	0
February 2012	4.64%
March 2012	3.05%
May 2012	6.74%

Table 4C.7 Text units including speculative comments

Although comments of this type represent a small proportion of the total number of text units recorded, I believe it is interesting to note their inclusion, particularly in light of the absence of responses of this type in the templates completed in December 2011. Furthermore, when considering the proportion of the templates upon which speculative comments featured, the shift throughout the course of research becomes more marked, as the data in Table 4C.8 demonstrates.

	Percentage of templates containing speculation
December 2011	0
February 2012	19.35%
March 2012	12.12%
May 2012	33.33%

Table 4C.8 Templates featuring speculative comments

As this table suggests, pupils' comments containing evidence of speculation also increased throughout the data collection period, but, yet again, this was not consistent, with a dip in Term 2b. Evidence of speculation was found only in a relatively small proportion of pupil views templates: language of this type was evident in just 12 out of the 36 templates (33.33%) completed in May 2012. Nevertheless, given that this type of language was not evident in pupils' responses at the outset of research, it is possible that this increase could be attributed to the Thinking Skills approach. It is also interesting to observe that the pupil views templates themselves may have been instrumental in prompting speculation. Were the pupils more conscious of their thoughts because, by this point in the data collection process, they were familiar with having to record these views on a template? Thus, did the act of completing the pupil views template cause pupils to reflect more deeply upon the learning in which they were engaged?

The pupil views templates were specifically designed as a stimulus for discussion about learning. However, I believe that it is most important to note that by far the greatest proportion of both speculative comments and questions were recorded for the final lesson, in May 2012, suggesting that something specific to this particular lesson was responsible for the larger numbers of these comments at this point in research. This lesson was very practical, and required pupils to work collaboratively in mixed-attaining groups to investigate which was the strongest carrier bag. It was also extremely open, with pupils selecting their own strategies, equipment and form of recording. Moreover, it required pupils to constantly compare and contrast strategies and results, and so it is logical that pupils extended this by engaging in hypothesizing and speculating, further underscoring the importance of task selection in engaging pupils to engage in particular types of thinking.

4C.4 Depictions of learning

In addition to these shifts in the language used on pupil views templates, there was also some change in the depictions of learning used by pupils in their descriptions of lessons. This was particularly noteworthy because these reflections upon learning suggested pupils' understanding of, and engagement with, metacognition.

4C.4.1 *This is easy / hard*

At the outset of research, I noticed that, when giving an opinion about their learning during a given lesson, pupils most regularly classified work as either 'easy' or 'hard'. Interestingly, it was very common for pupils to describe work as 'too hard' and then, having received support or practiced a particular concept, this work would then become 'easy'. I found this intriguing because it appeared to me that pupils did not associate this change with the development of their own understanding, but rather as something separate and externally imposed – as if the work they had previously found too difficult had suddenly undergone some mysterious change and had transformed into something that they could confidently accomplish.

As a result, a common feature of our conversations about learning was discussion surrounding work which was 'easy' and 'hard', as I attempted to encourage pupils to recognise that they found tasks easier to complete because of the progress they were making. Similarly, an integral element of the Thinking Skills approach – and of encouraging the mastery-orientated mind-set defined by Dweck (1986) – involved educating pupils about the importance of appropriately challenging tasks, and fostering pupils' determination to challenge themselves with respect to their learning, developing resilience and perseverance. The proportions of comments describing work as 'easy' or as 'hard' are given in the following tables.

	Percentage of comments describing work as ‘easy’ or ‘hard’
December 2011	18.24%
February 2012	5.30%
March 2012	3.05%
May 2012	1.12%

Table 4C.9 Text units describing work as ‘easy’ or ‘difficult’

	Percentage of templates featuring descriptions of work as ‘easy’ or ‘hard’
December 2011	67.86%
February 2012	19.35%
March 2012	12.12%
May 2012	2.78%

Table 4C.10 Templates describing work as ‘easy’ or ‘difficult’

This data clearly demonstrates that there was a steady decline in the numbers of pupils referring to their work in simplistic terms such as ‘easy’ and ‘hard’. I believe that this reflects a shift in pupils’ thinking about their learning, away from thinking that work is easy or difficult towards more complex reflections upon lessons and their learning and progress. It is possible that this decrease was, in turn, an indication that pupils have shifted away from performance-related goals towards a learning-focused mastery-orientated mind-set. However, it is important to note that comments describing work as ‘easy’ or ‘hard’ are not directly replaced by comments referring to progress, as the following table shows.

	Percentage of text units referring to progress
December 2011	4.05%
February 2012	8.61%
March 2012	1.53%
May 2012	6.74%

Table 4C.11 Text units referring to pupils’ progress

	Percentage of templates referring to progress
December 2011	17.86%
February 2012	38.71%
March 2012	3.03%
May 2012	19.44%

Table 4C.12 Templates referring to progress

As this data demonstrates, although the proportions of comments referring to progress fluctuated throughout the data collection period, there was no clear shift in responses of this type between the initial and final pupil views templates. However, I believe that this is not necessarily an indication that pupils did not value progress in understanding, but could perhaps suggest that pupils moved away from simplistic valuations of specific lessons and became increasingly focused on engaging with – and in - learning.

4C.4.3 *Evidence of learning preferences*

Comments in which pupils' expressed a preference for a specific mode of learning were particularly fascinating because of the insight they provided into the development of metacognitive knowledge - specifically pupils' ability to reflect upon their learning and develop awareness of some of the ways in which they learn effectively – and thus their potential to answer the third of my research questions: what is the impact of a Thinking Skills approach upon pupils' understanding of the ways in which they learn Maths. These responses included a wide range of comments, encompassing both those with supporting detail and those without, such as 'I enjoy working in a team', 'I feel confident by the teacher explaining on the carpet', and 'This is so more easy because when I'm stuck my team can explain and help me work the problem out'. Table 4C.13 shows the number of comments of this type at each point in the data collection process.

	Percentage of text units indicating a preference for a particular learning style	Percentage of text units indicating a preference for a learning style and giving a supporting reason	Total
December 2011	17.57%	18.92%	36.49%
February 2012	27.82%	11.26%	39.08%
March 2012	19.08%	2.29%	21.37%
May 2012	8.99%	5.06%	14.05%

Table 4C.13 Text units indicating preference for a particular learning style

Contrary to what may perhaps have been expected, there was a decline in the number of comments of this type during the research process. Comments indicating a preference for a particular learning style without a supporting reason peaked in Term 2a, when 27.82% of all responses contained in the pupil views templates contained an expression of pupils' preference for a particular method or type of activity, reaching their lowest point in Term 3a, when just 8.99% of all comments showed reflections of this type. Similarly, and rather surprisingly, comments where pupils stated their learning preferences and gave a reason in support of this were actually most prevalent at the outset of research, in Term 1b, when 19.60% of all comments were of this nature, reaching their lowest ebb in Term 2b, when they represented just 2.29% of all comments.

There are many possible explanations for this decline. One of these is, of course, that the Thinking Skills approach did not substantially affect pupils' metacognitive knowledge or skillfulness, or - at the very least - that the templates did not succeed in capturing any change. However, this is contradictory to my own sense of the pupils' developing interest in learning, together with their determination to identify the source of errors and to improve, which was evident in the increasingly frequent comments which children included in their work to explain the reasons for their mistakes, or to show 'how do I know'. I wonder whether, instead, this gradual decline could suggest saturation – for example, is it possible that the children felt that they had now told me about their learning preferences, and so had nothing further to add on this subject? It could even, perhaps, indicate satisfaction with the current methods of teaching and learning, reflecting the pupils' preference for the Thinking Skills approach. Certainly, an informal survey – a show of hands – showed me that 100% of the focus cohort believed that working collaboratively helped them develop their understanding in Maths.

Whilst I appreciate that this is not the only learning style about which pupils could comment, could the decline indicate that pupils feel confident that I understand their preferred learning styles, that I am planning lessons which enable them to work in these ways – or even, perhaps, that we have succeeded in opening up discussions about learning so that the templates are no longer the sole means of sharing opinions about learning – and that expressing their views in this way is therefore redundant? Of course, now, after the point when these views have been analysed, it is impossible to do more than speculate upon pupils' possible reasons for including (or omitting) comments of this type, however it is important to recognize that this dearth of comments relating to learning preferences does not necessarily indicate that the Thinking Skills approach was unsuccessful in encouraging pupils to reflect upon their learning, merely that this metacognitive thought – as an internal and invisible process - has unfortunately not been captured in all of its richness and complexity during this particular study.

4C.5 Representations of internal and external processes

One further possible explanation for the decline in comments indicative of metacognition is the changing way in which pupils used the pupil views templates throughout the course of research. Upon reading the pupils' comments, I quickly gained the impression that many of the pupils' responses shifted away from expressions of internal thoughts and feelings towards representations of the discussions they had in their collaborative groups. This shift can be seen in Table 4C.10.

	Internal thoughts and feelings	Representations of discussions
December 2011	81.08%	18.92%
February 2012	78.15%	21.85%
March 2012	59.54%	40.46%
May 2012	62.92%	37.08%

Table 4C.14 Internal thoughts versus representations of discussions

This data shows a decrease of 18.16% in the representation of thoughts and feelings, together with a corresponding increase of 18.16% in the representation of discussions. I believe this suggests that the ways in which pupils were working had indeed changed substantially, reflecting the changing nature of Maths lessons, away from more traditional, individualistic methods, and towards a collaborative approach. Importantly, it was not just the proportion of representations of discussions which was subject to change, but the very nature of these interactions. For example, in Term 1b, interactions focused heavily upon comments which showed the pupils checking answers with each other. Typical comments at this point in the data collection process include: ‘Jack is 3.05 the difference?’ or ‘What’s your answer? I got 301.9. Did you?’ However, this changed dramatically by Term 2b when more than a third of responses indicated that pupils were discussing their *learning* rather than just simple answers, revealed in comments such as: ‘Olivia and Brooke when you do this problems like this do you have to + or x or ÷?’ or even questions to others such as ‘Do you think we should start off like this?’ This shift in responses can be seen in Figure 4C.2.

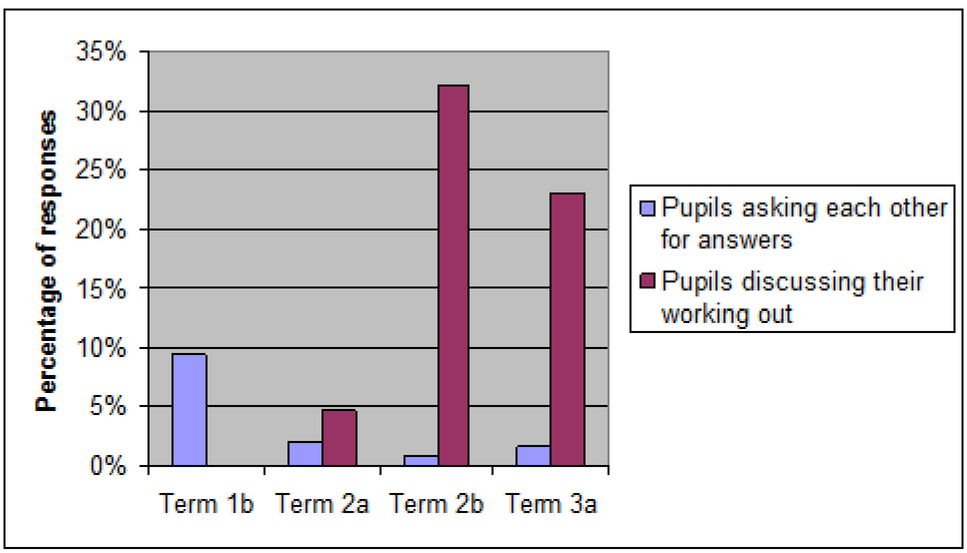


Figure 4C.2 Comments asking for answers versus collaborative discussions

Thus, I believe that this demonstrates that the Thinking Skills approach accomplished what it was intended to do: to encourage pupils to discuss their learning more explicitly. Whilst it is unclear whether the resultant discussions induced pupils’ to simultaneously consider the learning process itself and their roles as learners, it is important to acknowledge the work of those such as McGregor and Gunter (2006), and Wright and Taverner (2008), amongst so many others, who emphasise the role of talk in developing understanding, suggesting that, through listening to others' explanations of their thinking, and in the process of attempting to articulate their reasoning themselves, pupils firstly, 'become aware of alternative ways of doing things and ways of learning', and secondly, 'stimulate the realization that there may be gaps in understanding or that the successful articulation has reinforced and clarified learning' (both Wright and Taverner, 2008: p. 112). Thus, I believe that, by encouraging pupils to discuss their learning, they have taken – at the very least - their first few steps along in their journey towards understanding.

4C.6 Thoughts

The data collected using the pupil views templates aimed to investigate the development of metacognition throughout the research period. It demonstrates that:

- Pupils' use of language to describe their learning experiences altered during the course of research. There was a decrease in the use of causal connectives, suggesting a decline in the proportion of written explanations included. There was an increase in questions and speculation, suggesting that pupils engaged more regularly in hypothesising. There was also a decrease in simplistic descriptions of work as 'easy' or 'hard'.

- Templates did not include greater proportions of metacognitive comments as the research progressed. Instead, there was a decrease in comments indicating a learning preference during the data collection period.

- There was a decrease in the numbers of representations of internal processes and an increase in representations of discussions, suggesting a shift in working away from individualistic methods and towards a more collaborative, discussion-based form of learning.

Initially this data appears discouraging because of the lack of clarity surrounding the development of metacognition and my resultant inability to answer one of the research questions for this study. However, for me, this data was fascinating, providing precious insight into pupils' perceptions of Maths lessons and how these may have been influenced by the Thinking Skills approach. I valued the wealth of detail that these templates gave me about what actually went on: the conversations my pupils had, who was participating and who was not doing their fair share, and the feedback about the tasks themselves and whether the pupils found these sufficiently challenging. These insights formed part of a feedback loop which enabled me to hone teaching and learning to better suit the needs of my pupils. I also believe that through communicating via the pupil views templates, the focus cohort and I were able to open up discussions about learning. I believe that, ultimately, this was so successful that these became commonplace, rendering discussion of learning on the templates more inefficient, thus accounting for the decline in pupils' comments about learning preferences.

Thus, although the information contained in the pupil views templates – and even the outcomes resultant from use of the templates themselves - was not what I perhaps expected, it was nonetheless valuable. This is in keeping with the notion of reflexivity, one of the principles for validation in action research described by Heikkinen *et al* (2007), and also resonates with Fielzer's (2010) assertion that 'The acknowledgement of the unpredictable human element forces pragmatic researchers to be flexible and open to the emergence of unexpected data. This means that […] pragmatism reminds researchers of their ''duty'' to be curious and adaptable' (Fielzer, 2010: p. 14). I also believe that this acceptance that my interpretations of my classroom reality and those captured by the data collection tools employed throughout this study do not always correlate as closely as I would like is in keeping with the hidden, or unexpected, research question which emerged throughout the course of this research: how has the process of engaging in this research affected me both as a practitioner and as a teacher-researcher? Looking back, I feel that, at the outset of research, my beliefs regarding the nature of evidence were rather more simplistic or monochromatic. I believe that I expected findings to be rather more clear cut, or self-evident. The information contained in the pupil views templates has therefore emphasised the importance of the original aims of this research: to discover as much as possible about the realities of my classroom context, rather than trying to shoehorn findings into preconceived notions.

4C.6.1 *Reflections upon professional learning*

My attempts to explore the development of metacognition – and consequent use and analysis of the pupil views templates – constituted, without doubt, the greatest challenge in this research. Metacognition is - as I have repeatedly acknowledged – an internal process and thus any attempt to render this visible is necessarily subject to potential difficulties in terms of the accuracy of representation, not just on the part of anyone seeking to interpret the information gathered, but also on the part of the children themselves in their attempts to accurately record their thinking. Yet, as flawed as the pupil views templates may have been, other methods too were not without potential obstacles. For example, although I initially attempted to capture the discussions of the children as they worked in their collaborative Maths teams, I quickly found that recording, transcribing and analysing verbal utterances was not practicable for this study: quite simply, the time required for transcription and analysis was just not feasible in addition to the demands of a full-time teaching role and part-time doctoral research.

Instead, I continue to believe that the pupil views templates were the most appropriate means of investigating pupils' thinking about thinking. The real problem, I have come to acknowledge, came not in my selection of this data collection tool, but rather in the ways in which I sort to use the data gathered. This relates, once again to my shifting thinking which arose in response to the analysis of the data contained in this chapter, and my initial attempts to quantify the data gathered in a vain search for 'proof'. Despite the use of inductive coding, the ways in which the pupil views templates data had been utilised did not accurately reflect the fascinating insight that the pupils' responses provided into the reality of our Thinking Classroom. I therefore decided to explore these further. My close consideration of the pupil views templates data led me to acknowledge the importance of considering these templates as a form of narrative, describing individual pupils' experiences of the teaching and learning of Maths.

By placing a substantially greater emphasis upon the representation of the views of the pupils in their own words, through the incorporation of the embedded case studies of Harry and Grace into this thesis, I believe I have moved closer to using the pupil views templates *as they were originally intended: as a means of gaining insight – albeit a limited and imperfect one - into pupils' thought processes and simply studying them for whatever may emerge that could be of interest, rather than trying to impose a rigid set of expectations or limiting potential learning simply because it does not fit with what the researcher may have already decided may be of interest. These case studies include each of the four pupil views templates completed by these pupils in their entirety, allowing them to describe their own experiences in their own words, providing a coherent description of their experiences at these different points in the research process. I felt this decision to be extremely important: not only did it allow me to privilege the pupils' perspectives, acknowledging the fundamental nature of their contribution as co-researchers, but it also allowed me to transparently present the findings of this particular aspect of research in an informative manner, so that readers may judge for themselves the significance of the data.*

Chapter 5. Case-Studies

Thus far, the findings of this research have been multiple. These are summarized in Table 5.1.

Focus	Findings
Progress	**End of Cycle 1: Increase in mean progress** Focus cohort: 2.18 sub-levels 2011 – 2012 cohort: 1.98 sub-levels
	End of Cycle 2: Further increase in mean progress Focus cohort: 1.80 sub-levels 2011 – 2012 cohort: 1.66 sub-levels
	End of Cycle 2: Substantial increase in rates of accelerated progress Focus cohort: 24.24% pupils 2011 – 2012 cohort: 4.66% pupils
Attainment	**End of Cycle 1: Increased proportions of pupils working significantly above age-expected levels** Focus cohort: 58.82% (compared with 27.27% at the end of Year 4) 2011 – 2012 cohort: 40.01% (compared with 18.60% at the end of Year 4) 2010 – 2011 cohort: 38.64% (compared with 5.41% at the end of Year 4) This suggests the Thinking Skills intervention may have had the most significant impact upon higher-middle and higher-attaining pupils.
	End of Cycle 2: Further increase in rates of pupils working significantly above age-expected levels Focus cohort: 66.31% 2011 – 2012 cohort: 35.56% 2010 – 2011 cohort: 21.27%
	End of Cycle 2: Increased proportions of pupils achieving Level 5 in S.A.T.s Focus cohort: 51.52% 2011 – 2012 cohort: 37.78% 2010 – 2011 cohort: 12.77%
Self- concept	**End of Cycle 1: Increased responses for all eight dimensions of self-concept** Reading: +0.03, from 3.59 to 3.62 Maths: +0.26, from 3.36 to 3.62 General School: +0.38, from 3.01 to 3.39 Peer Relations: +0.39, from 3.67 to 4.06 Physical Appearance: +0.47, from 3.41 to 3.88 This suggests that improvement in self-concept may well be attributable to some external factor rather than the introduction of the Thinking Skills approach.
	End of Cycle 2: Mean self-concept relating to Maths remains constant Mean responses for all eight dimensions of self-concept were higher than those given in October 2011. Responses for Reading and Parent Relations increased by +0.05 each (to 3.67 and 4.37 respectively). Responses for the remaining five dimensions decreased by between -0.01 and -0.11.

	End of Cycle 2: Increase in self-concept relating to Maths concentrated upon the central ability band Significantly below: -0.13 Below: +0.08 At age-expected levels: +0.43 Above: +0.20 Significantly above: -0.24
Development of metacognition	**End of Cycle 1: Decrease in causal connectives** December 2011: 18.92% of all text units, featuring on 39.29% of templates May 2012: 10.67% of all text units, featuring on 33.33% of templates
	End of Cycle 1: Increase in questions and speculation Questions: • December 2011: 16.89% of all text units, featuring on 50% of templates • May 2012: 29.78% of all text units, featuring on 58.33% of templates Speculation: • December 2011: 0% of all text units • May 2012: 6.74% of all text units, featuring on 33.33% of templates
	End of Cycle 1: Decrease in descriptions of work as ‘easy’ or ‘hard’ December 2011: 18.24% of all text units on 67.86% of templates May 2012: 1.12% of all text units on 2.78% of templates
	End of Cycle 1: Decrease in comments indicating a learning preferences December 2011: 36.49% of all text units May 2012: 14.05% of all text units This could reflect saturation, or could suggest that pupils no longer needed to use pupil views templates to share opinions of this type because of the greater prevalence of discussions about learning.
	End of Cycle 1: Decrease in representations of internal processes and an increase in representations of discussions Internal processes (thoughts and feelings): • December 2011: 81.05 of all text units • May 2012: 62.92% of all text units Representations of discussions: • December 2011: 18.92% of all text units • May 2012: 37.08% of all text units This may suggest that the Thinking Skills approach encouraged a shift in working away from individualistic methods and towards a more collaborative approach.

Table 5.1 Summary of findings

As teacher-researcher, I was an active participant in the collaborative, Thinking Classroom that the focus year group and I created together. Whilst carrying out this research, I felt certain that the introduction of the Thinking Skills approach had impacted positively upon my pupils’ thinking about learning. I witnessed it in their conversations during lessons; I saw it in their increased determination and perseverance; and I heard it remarked upon by my colleagues who observed my teaching or who taught my pupils for different curriculum subjects. My role as teacher-researcher allowed me an immersive experience of this research. This is fundamental as I believe that it is teachers' understanding of our individual learning environments, and particularly our knowledge of what Lytle and Cochran-Smith term 'a historical framework' (1992: p. 465), which enables us to successfully develop teaching and learning, irrespective of the findings of more objective, and perhaps transferable, 'evidence'.

5.1 Why use case-studies?

Nevertheless, upon analysing the responses contained on the pupil views templates, I quickly realised that the forms of analysis I was initially using did not allow me sufficient insight into the effect that the use of a Thinking Skills approach had upon the development of pupils' metacognition. As a result, I resolved to look more closely at individual pupils in order to see whether, by looking at the children on a case-by-case basis as the unique individuals they are, I would be able to more easily determine the impact that the approach had upon the development of pupils' thinking about learning. Unfortunately, despite my attempts to use multiple data collection tools in an attempt to capture 'the richness' (Pring, 2000: p. 248) of Class 2, I believe that the evidence collected does not reflect the complexity of the reality. This reflects the limitations of formal research methods in capturing the sense of experience in its entirety.

In light of my developing understanding of the richness of potential insight that the pupil views templates offered into my pupils' experiences of Maths, after completing analysis of the templates data, I decided to incorporate two narrative-based case-studies into this research to tell the stories of a boy and girl in the focus cohort: Harry and Grace. The stories of Harry and Grace form 'embedded case studies' (Yin, 2009: p. 50) as they consist of multiple units of analysis, again encompassing both qualitative and quantitative data. They are intended to enrich the evidence collected throughout this research, offering further insight into the experiences of the children in the focus cohort. I felt that these case-studies would further increase the validity of this research by adhering to the principles of dialectics described by Heikkinen *et al* by aiming to 'reproduce the voices of different people as authentically as possible - and to keep them so genuine and original that the informants can recognize their own thinking in them' (2012: p. 9). As a result, the structure of these case-studies is distinct to that used elsewhere in this thesis. They are presented in two separate columns: one of which contains a narrative of each case, whilst the other contains analysis. This structure was adopted in an attempt to more clearly distinguish between the different voices represented. I wanted Harry and Grace to express themselves and their experiences from their own perspective, in their own words, and I felt that the column format provided a physical space in order to separate their voices from my own interpretation of them.

Enabling Harry and Grace to describe their experiences of Maths in their own words fulfils one of their fundamental rights, not only according to my beliefs as a teacher-researcher, but also according to the U.N. Convention on the Rights of the Child which states that any child 'who is capable of forming his or her own views should have the right to express those views freely in all matters affecting that child' (U.N.C.R.C., 1991: Article 12). Furthermore, I felt that, given the wealth of valuable yet unforeseen information that emerged from the pupil views templates, it was logical to simply explore the information provided – without agenda or preconceived notions – and simply discover whatever I could regarding our classroom reality. It was with this aim that the following case-studies were created.

5.2 The representative nature of the case-studies

In selecting Harry and Grace as the subjects of these case-studies, I followed the advice of Pettigrew (1988), who suggests that, considering the limited number of cases which can usually be studied, it is logical to select extreme situations in which the process of interest is 'transparently observable' (p. 275). Flyvbjerg also supports this view, emphasising that, when attempting to maximise insight into a given phenomenon, the selection of random or representative cases may not be the most 'may not be the most appropriate strategy. This is because the typical or average case is often not the richest in information' (2006: p.13). This is true of Harry and Grace: they intrigued me precisely because they stood out from their peers, rather than being representative of them. They were distinct in terms of the comments they recorded in their books, their contributions to discussions, and, for Grace, in the change in her attitudes towards Maths.

I believe that, as a result, the case-studies of Harry and Grace not only provide an opportunity for two of the participants in our Thinking Classroom to express their own experiences in their own words, but may also serve to provide further insight into the possible impact of the Thinking Skills approach upon pupils in the focus cohort. Whilst they may not be typical of pupils in the focus cohort as a whole, they provide what Flyvbjerg defines as 'most likely' cases - 'cases which are likely to either clearly confirm or irrefutably falsify propositions and hypotheses' (2006: p. 14) – precisely because, ostensibly, they *appear* to have been positively influenced by the Thinking Slills approach. Indeed, Flyvbjerg believes that cases of the 'most likely' type are particularly suited to the falsification of propositions – here the question of whether or not the Thinking Skills approach impacted positively upon pupils' thinking and metacognition in Maths.

I have proposed – and strongly believe – that it is important to recognise that, if research is to provide a 'basis for judgement about the action that individual teachers might take in their own settings' (Rudduck, 1985: p. 123), the task of generalization is shifted from the researcher to the reader. In other words, knowledge is largely dependent upon its context and I believe that it must be the responsibility of the reader to determine whether or not the research is relevant to their own situation. However, I believe that, in using the case-studies of Harry and Grace as 'most likely' cases, it may be possible to provide further insight into the impacts of this research. Consequently, in exploring whether or not these pupils - in whom the impacts of the Thinking Skills approach appear to be most evident - recorded evidence of a shift in pupils' thinking and metacognition about Maths learning throughout the course of research, I hoped it would be possible to form a generalisation of the sort proposed by Flyvbjerg: in which 'If it is not valid for this case, then it is not valid for any (or only few) cases' (2006: p. 14).

Part A. The Case-study of Harry:

‘I feel I understand more because my friends and teacher help me’

Analysis

When considering my pupils and the habits of reflection they developed as a result of the Thinking Skills approach, one name immediately sprung to mind: Harry. Harry was a boy in my own class, Class 2, and was singularly thoughtful about his learning. As research progressed, Harry not only reflected when prompted during discussions, but also spontaneously began writing comments in his Maths books which showed the incredible extent to which he was reflecting upon his learning. An example of one of these comments can be found in Plate 5A.1.

Harry thus provides an exemplar, representing the focus cohort as a whole. This form of ‘personal narrative’ offers an alternative, contextually grounded account ‘whose function is to provide a sense of coherence and continuity’ (Mishler, 1990: p. 428) which could otherwise be lost in the quantitative analysis of snippets of text drawn from the pupil views templates as a whole.

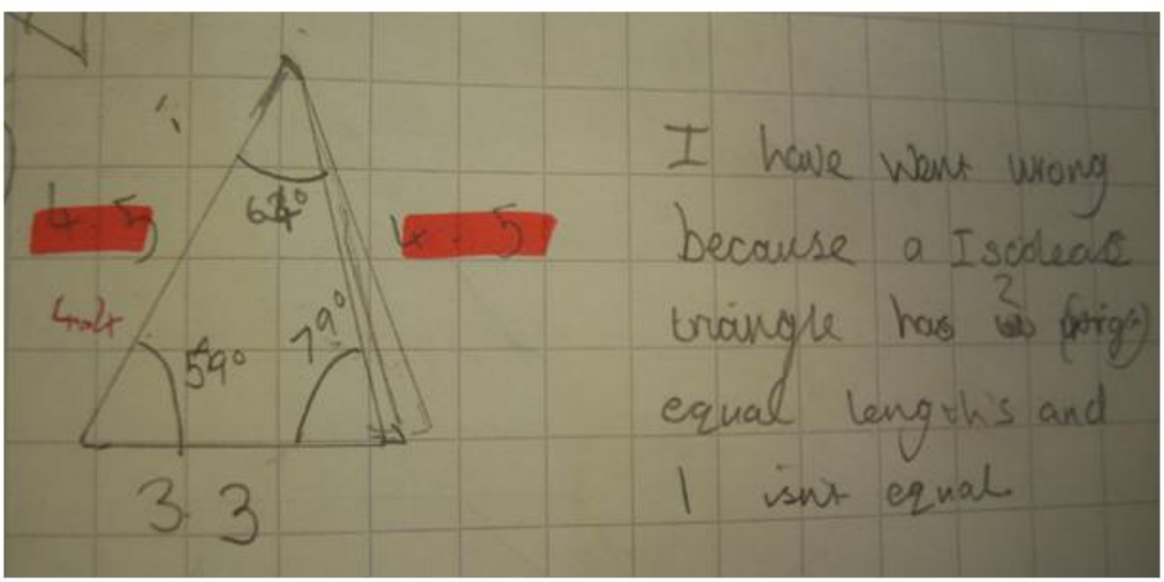


Plate 5A.1 Example of a comment explaining a misconception

Harry made outstanding progress in Maths during his time in Key Stage Two. At the end of Key Stage One, Harry was

This further supported my choice of exemplar, as it suggested that the Thinking Skills approach had teacher assessed at the age-expected level of 2b. However, during Years 3 and 4, Harry made accelerated progress so that, by the end of Year 4, he was working at Level 4c, two sub-levels above the expected level, and indeed, even above the level pupils are expected to be working at by the end of Year 5. Throughout Years 5 and 6, Harry continued to make better than expected progress. In his Key Stage Two S.A.T.s in May 2012, Harry was assessed as Level 5, receiving a combined mark of 82% for both written tests and the Mental Maths paper, and was teacher assessed at Level 5b at the end of the academic year.

been highly successful for Harry and that, through closer scrutiny of his experiences, it might be possible to gain better understanding of the impact on the focus cohort as a whole. This follows Pettigrew's (1988) reasoning that it is logical to choose extreme cases in which the process of interest is 'transparently observable' (p. 275).

At first glance, this appears encouraging, however, whilst Harry made five sub-levels of progress during Lower Key Stage Two, he made just four in Upper Key Stage Two. Whilst both of these figures surpass the national expectation of three sub-levels of progress per phase, it is nevertheless evident that Harry made more progress before being introduced to the Thinking Skills approach than he did afterwards, suggesting that this did not materially affect his progress in Maths. Furthermore, despite the high level at which Harry was working, his self-concept decreased during the research period, from a mean of 3.3 to 2.8, contrasting strongly to the improvement in his self-concept in Reading, which increased from a mean of 3.6 to 4.2, indicating that Harry was considerably more confident in Reading than Maths throughout the entire research process.

This is symptomatic of the recurrent problem of what counts as progress. Under the current assessment system, academic progress is measured in National Curriculum levels and sub-levels, however this does not take into account progress made within these levels or developments in less visible traits such as confidence and fluency.

The decline in Harry's self-concept in Maths is disappointing, but is in keeping with the general decline identified by Marsh (1989: p. 418). This makes the increase in his self-concept in Reading all the more impressive, underscoring the inability of the Thinking Skills approach to materially affect Harry's perceptions of his own competency in Maths.

I find these results particularly intriguing because, impressionistically, I considered Harry to be one of the pupils who most embraced the Thinking Skills approach. Certainly he included greater detail in his pupil views templates than many of his peers, using substantially more text units in each of his templates than the mean number given by his peers at all points in the data collection process with the exception of February 2012, where the number of text units he included was nevertheless slightly above average. A comparison of Harry's responses with those of the focus year group as a whole can be found in Table 5A.1.

It is also interesting to note that the number of text units Harry included in his pupil views templates decreased after the first template was completed, before slightly increasing for each subsequent template. I believe this may reflect the novelty of being actively encouraged to express an opinion about lessons and learning. This could be supported by the mean number of text units contained on the templates of the cohort as a whole, which was also highest the first time this data collection tool was employed.

Date	Mean number of text units per template	Text units included on Harry's templates
December 2011	5.29	12
February 2012	4.87	5
March 2012	3.97	6
May 2012	4.94	8

Table 5A.1. Text units used in Harry's templates

Clearly the level of reflection this implies does not appear to have impacted positively on Harry's progress or self-concept. It is perhaps this apparent discrepancy that makes Harry's case so intriguing, suggesting that it is possible for the Thinking Skills approach to influence a pupil without registering upon any of the measures I employed in an attempt to capture this.

The question raised is that, if my impression as teacher-researcher is correct in suggesting that Harry engaged whole-heartedly in the Thinking Skills lessons, has this impacted on an aspect of his learning not measured in terms of attainment or self-concept? Could it be that Harry's metacognition has instead been affected by the Thinking Skills approach and, if so, is this reflected in his pupil views templates?

The remainder of this section shows Harry's completed pupil views templates at each point in the data collection process. It features a description of each focus lesson, as well as analysis of the responses. Again, it is important to note that the data contained in the pupil views templates should not necessarily be expected to form part of any kind of progression. They are based upon disparate lessons, each requiring pupils to use a wide range of different mathematical knowledge and skills. These differences in focus and format rendered any attempt to chart a development in the pupils' thinking problematic and, as a result of, it is perhaps more helpful to view the templates as insights into Harry's thinking at each individual point in the research progress.

Inclusion of the templates in their entirety conforms to Mishler's interpretation of the role of the exemplar, in which the text is presented in full so that it is possible for others to 'inspect it and assess the adequacy with which the methods and interpretations represent the data. Further, availability of the primary data allows for a reasonable judgment […] of whether and how representative it might be of the other texts. That is […] of the possible generalizability of findings and interpretations' (1990: p. 437).

5A.1 December 2011

This template was completed about a word-problem lesson in which pupils worked in mixed-attaining teams of three or four to solve a range of challenging multi-step word problems for all operations in a range of contexts including time, money and measures.

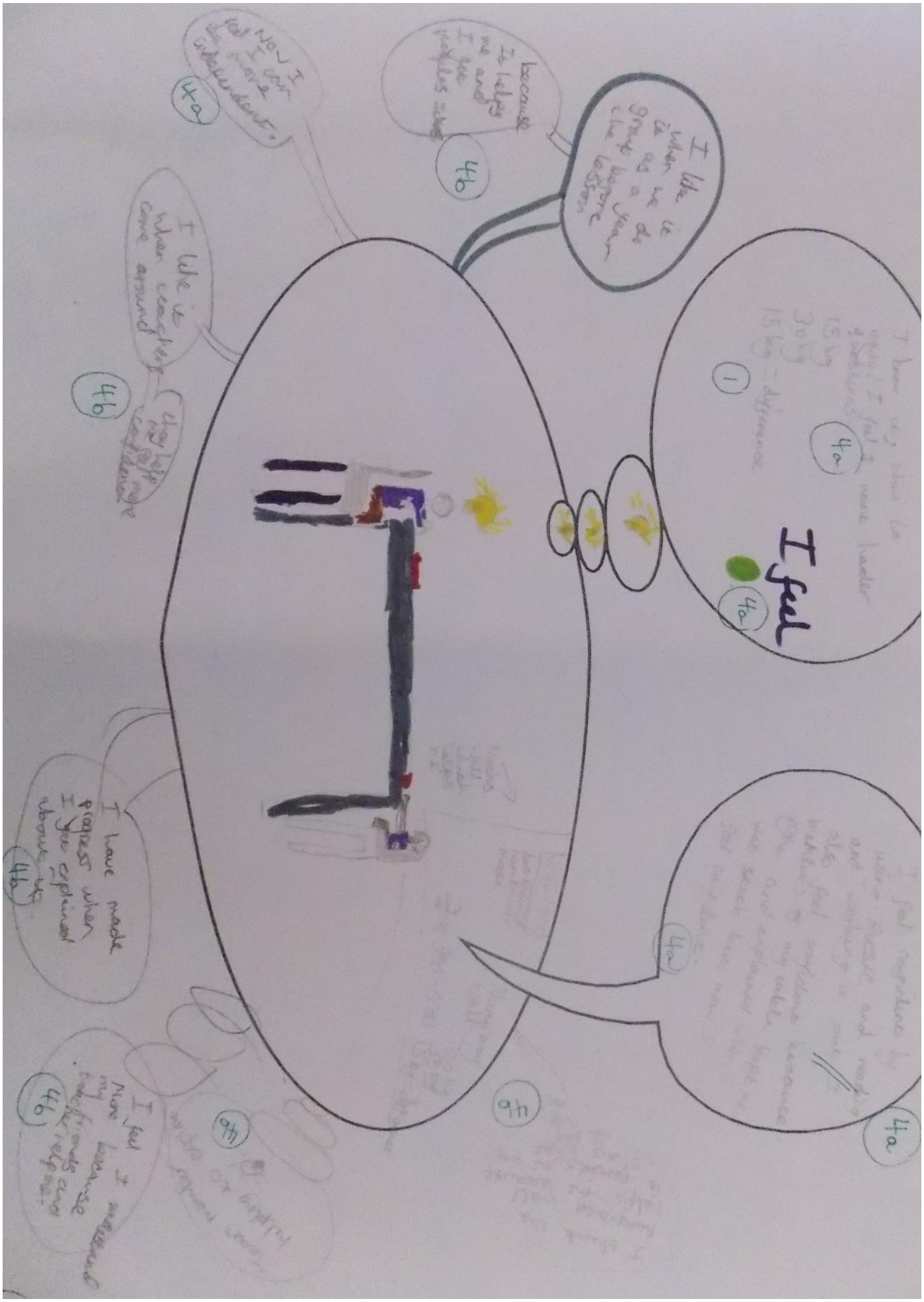


Plate 5A.2 Harry's pupil views template, December 2011

This template contains very clear evidence that, even at the outset of research, Harry reflected upon his learning and was able to identify some of the ways in which he learned most effectively. Indeed, eight of the twelve comments contained on the template are indicative of metacognitive knowledge or skillfulness. For example, Harry commented that:

1. ‘I like it when we do it as a year group before the lesson because it helps me and I get people’s ideas’.
2. ‘I like it when the teacher comes around this help me feel more confident’.
3. ‘I have made progress when I get explained about it’.
4. ‘I feel I understand more because my friends and teacher help me’.
5. ‘I think the Numeracy wall helps me because it reminds me and shows what I need help on’.
6. ‘I feel confident by using RUCSAC and reading and working it out’.
7. ‘I also feel confident because members of my table kept me right and explained when I was stuck but now I am confident’.
8. Harry even further emphasised his own belief that working collaboratively with his peers helped him to develop his understanding in Maths by writing: ‘Team member helping to explain [drawing of a light-bulb]’.

These comments unquestionably demonstrate that Harry was able to identify some of the ways in which he worked most effectively very early in the research process, however, I believe this raises some questions. Was Harry already metacognitively skillful, and did completing the pupil views template therefore simply provide a vehicle for expressing his

This is one of the principal criticisms of this particular data collection tool: that because the pupil views templates encourage pupils to reflect upon their thinking, they cannot provide true evidence of metacognitive thought.

learning preferences? This is certainly possible: these templates were specifically designed to provide a stimulus for discussion about learning. Furthermore, the Thinking Skills approach itself is intended to provide opportunities for pupils to discuss their learning, so regardless of whether Harry was metacognitively aware prior to the introduction of the Thinking Skills approach, the fact that he was clearly reflecting upon his learning at this point in the data collection process can be seen as evidence that, in providing these opportunities both during lessons and in the process of completing the pupil views templates, it has been successful.

Wall (2008) argues that, because metacognition is an internal process, evidence from pupil views templates 'would surpass any subjective evidence from observation completed by a third person' (p. 32). Furthermore, although pupils were asked to record their thinking, they were not prompted with regard to the nature of this, thus any metacognitive skillfulness in particular – in which Harry moved beyond this specific lesson in order to generalise about the ways in which he learns most effectively - is entirely spontaneous.

It is also encouraging to note that, at this point in research, Harry was clearly appreciative of the opportunity to collaborate with his peers, and to discuss ideas and learning. Indeed, in six of the eight comments cited above, Harry specifically referenced the sharing of ideas, or an explanation from a team member or teacher as crucial in developing confidence, making progress or helping him when 'stuck'. Again, this demonstrates the success of the Thinking Skills approach from an early point in the research process, confirming that, for Harry at least, opportunities for talk and collaboration were instrumental in helping him to feel more confident in his Maths learning.

This is unsurprising. There is a wealth of literature extoling the advantages of creating opportunities for talk and collaborative working, and Jansen (2008), Boaler (2006) and Westwood (2011) also emphasise the importance of this for Maths in particular.

I find the fact that Harry readily describes three distinct scenarios – help from a teacher, methods such as RUCSAC, and support from group members – which help him feel more confident rather incongruous with the decline in self-concept evident in his S.D.Q. data. It remains to be seen whether Harry continues to make reference *to improvements to his confidence, or whether these disappear from subsequent templates.*

5A.2 February 2012

This template was completed about a very different lesson, featuring a game-based lesson on probability during which pupils worked in mixed-attaining pairs to calculate the probability that the next card would be higher or lower, inspired by I.T.V.'s 1980s game-show 'Play Your Cards Right'.

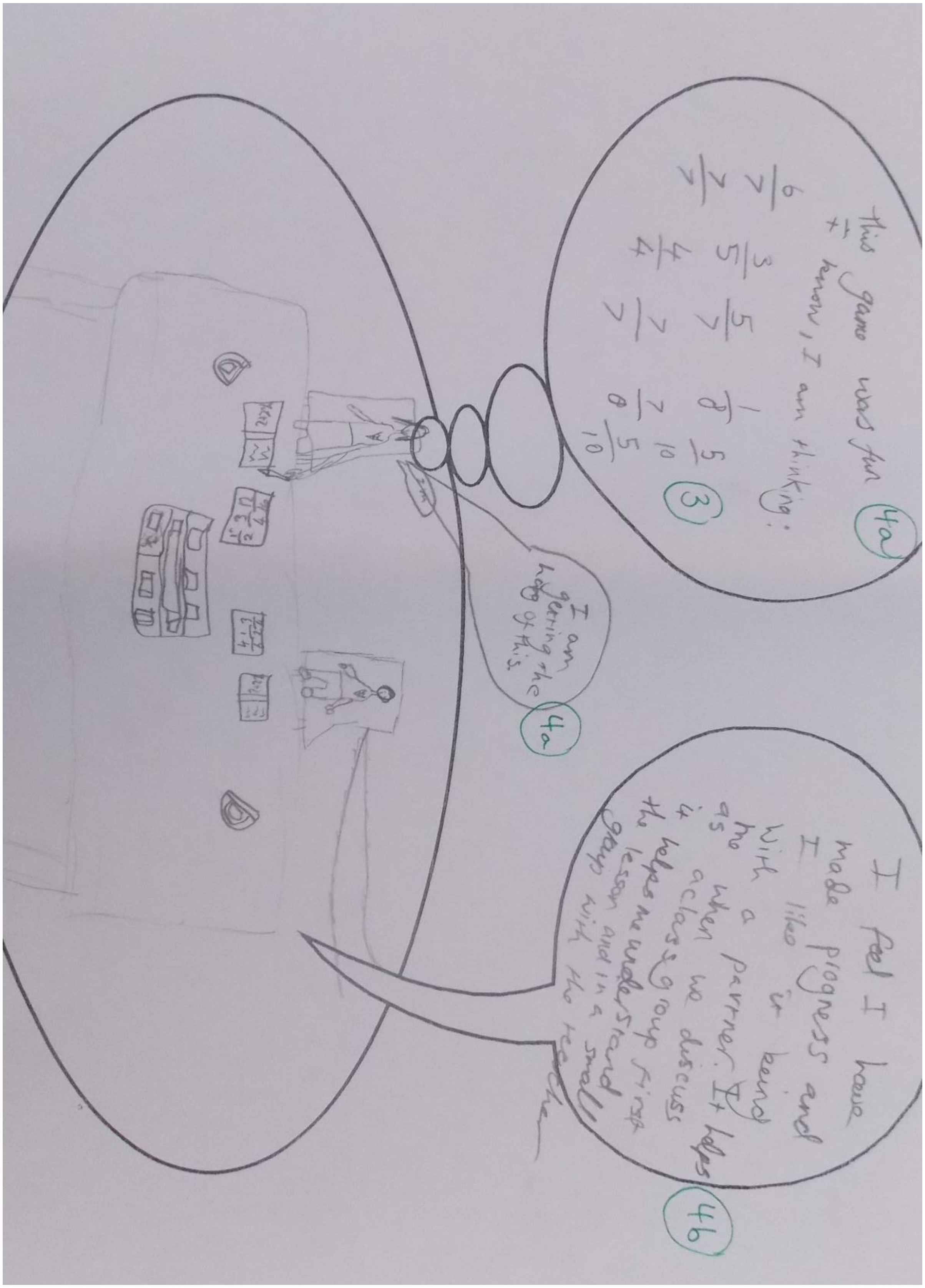


Plate 5A.3 Harry's pupil views template, February 2012

Harry included just five units of text on this template:

1. 'This game was fun'.
2. 'I know, I am thinking 6/7, 3/5, 5/7, 1/8, 5/10, 7/7, 4/4, 7/7, 7/8, 5/10'.
3. 'I am getting the hang of this'.
4. 'I feel I have made progress and I like it being with a partner'.
5. 'It helps me when we discuss as a class group first it helps me understand the lesson and in a small group with the teacher'.

I believe the comparative scarcity of detail included on this template emphasises that some lessons are better than others in encouraging reflections of this type, and that this kind of simple and repetitive task perhaps did not require the same complex thinking or collaborative teamwork as the previous lesson. In addition, although I had originally intended pairs to work together to produce the probabilities, the pupils interpreted the activity as a contest in which they competed against one another to win the 'game' by working out the most probabilities correctly. I believe that this competitive spirit curtailed collaboration, as pupils sought not to support one another to develop understanding for the shared benefit of the team, as in the previous collaborative problem-solving lesson, but rather to beat the other in order to emerge victorious.

Upon reflection, it is important to admit that the central activity of this lesson was not one which was based upon Thinking Skills principles. This lesson provided rather mechanical practice of representing probabilities as fractions. The pupils enjoyed it, but it was not backed with the level of discussion which more customarily characterised our lessons. However, this lesson was – like each of the lessons about which the pupil views templates were completed – selected at random.

Of the five comments listed above, only the final two contain reflections surrounding ways in which Harry felt that he learned most successfully. It is heartening, however, to note that these comments echo Harry's belief that working

Following my analysis of the previous template it is interesting to note that whilst Harry acknowledges that he enjoys working with a partner and feels collaboratively aided the development of his understanding. However, in light of the competitive manner in which pupils interpreted this task, it is unclear whether Harry was one of those who did work collaboratively, or whether he had simply learned that I, as teacher-researcher, believe that working with others helps children to learn more effectively, and whether he therefore gave the answer he believed I wanted to hear.

that this helps him make progress, he does not again refer to an improvement in his confidence. This could suggest that Harry did not find this lesson sufficiently challenging. However, it could also correspond with the decline in his self-concept in Maths.

I believe that both of these scenarios are likely to be true: my reading of Harry's character, having been his class teacher for two years, is that he was not a competitive child, but, rather, that he was likely to carry out instructions carefully. He was instructed to work with his partner to produce the probabilities; therefore he will have done this to the best of his ability. Whilst I also believe that Harry was perceptive enough to deduce that I wanted him to find that working collaboratively helped him to learn, he was honest and remarkably self-possessed for a child of his age. He knew his mind and felt comfortable expressing this. Therefore, I believe that the fact that he has reiterated his belief that talking about his learning and working with others helped him emphasises that he perceived that the Thinking Skills approach was instrumental to helping him make progress in Maths.

Whilst my knowledge of Harry has led to this inability to determine the 'truth' of his responses, I feel I must argue that these would have been just as elusive to an outside researcher, if not more so. Indeed, the 'historical framework' (Lytle and Cochran-Smith, 1992: p. 465) provided by my understanding of Harry's character, allows me an insight into his motives which would not have been accessible to anyone else, and without which other observers may have been tempted to ascribe his actions more definitively one way or another.

5A.3 March 2012

This template was completed following a lesson in which pupils worked collaboratively in a mixed-attaining team of three or four pupils to solve one of the 'Mathematical Challenges for Able Pupils' produced by the D.f.E.E. (2000). This challenge required pupils to use their understanding of inverse operations to work out how many of each different type of fish a customer bought with £20.

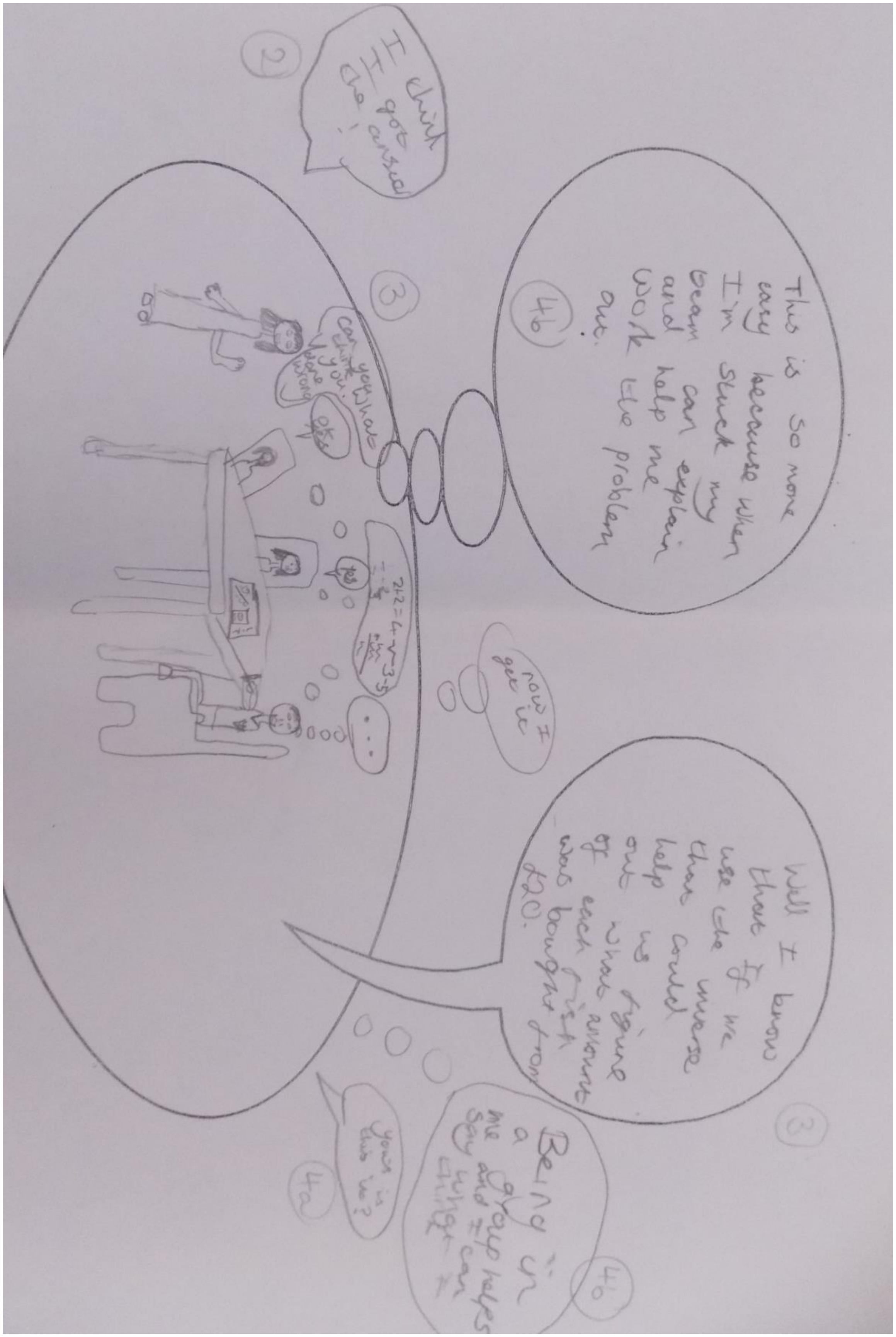


Plate 5A.4 Harry's pupil views template, March 2012

Harry included six units of text on this template. Four of these are of particular interest:

1. ‘This is so more easy because when I’m stuck my team can explain and help me work the problem out’.
2. ‘Well I know that if we use the inverse that could help us figure out what amount of each fish was bought from £20’.
3. ‘Being in a group helps me and I can say what I think’.
4. ‘Yous is this it?’[31]

Two of these text units, responses 1 and 3, again refer to Harry’s continued belief that collaboration supports his learning in Maths. I also find the second response interesting as it demonstrates the extent to which Harry could explain why a particular strategy was needed, suggesting his deeper understanding of the Maths involved. This is encouraging as it is precisely this deeper understanding of why specific methods were needed for particular situations that originally drove my desire to adopt a Thinking Skills approach. Furthermore, this explanation is given in one of the speech bubbles, showing that it formed part of the group’s discussions, suggesting that explanations of this type constituted part of their regular interactions. I also find Harry’s fourth response interesting as it confirms that he was using the other members of his group as sounding boards to confirm his own conclusions about his work. I believe that comments of this type make it very easy to understand why Harry felt so much more confident when working with a group.

This second response is a clear acknowledgement that Harry knows which strategy he requires to solve this particular problem. I believe this constitutes a marked departure from his earlier templates in which he describes working with others to find out which strategies to use; here he knows this himself and is confident enough to say so.

I am optimistic enough to ascribe this to the fact that the Thinking Skills approach was intended to make these processes and decisions very visible to pupils through use of routines such as the debrief, thus avoiding any sense that success in Maths to a supernatural ‘power [rather] than an ability which anyone has the possibility to learn’ (Picker and

[31] Please note that ‘Yous’ is a plural form of ‘you’ commonly used in the Geordie dialect.

Berry, 2001: p. 88).

Also of interest is the illustration of one of the conversations that took place during the lesson between myself, as class teacher, and Harry's group. I am pictured asking what appears to be a singularly unhelpful question: 'Can you think what you [have] done wrong?' Perhaps surprisingly, one group member is shown with a speech bubble replying 'OK, yes', whilst another has a thought bubble with a complicated-looking series of calculations. Yet another pupil has a thought bubble which states 'Now I get it', suggesting that my rather oblique question actually helped the pupils further their understanding. I find this particularly interesting as, although in the first comment listed above Harry expressly states that he believes that discussions with teachers help him to develop his understanding, the conversation he has depicted in fact shows me asking his group to work out for themselves where they made a mistake and why this error occurred, suggesting that they themselves, working collaboratively, have actually been the agents of their own development in understanding, although they perhaps felt more confident as a result of my presence and questioning.

I am inordinately proud of this particular piece of evidence. Upon first reading the literature relating to Thinking Skills it struck me that, in order to fully embrace the approach, an overhaul of the roles of both teacher and pupil were required. This is particularly evident in Hu et al's assertion that 'learning to learn means taking over from the teacher the control and management of your own learning and thinking' (2010: p. 7).

I believe this episode demonstrates that Harry and I have succeeded in altering classroom dynamics sufficiently in order to promote true reflection on the part of the pupils rather than simply taking 'the easier route of accepting unthinkingly what their teacher says' (Watson, 2001: p. 142).

5A.4 May 2012

The final pupil views template was completed about a very practical lesson in which pupils worked in mixed-attaining groups of three or four to investigate which carrier bag was most suitable for me to shop for a Diamond Jubilee street party. The groups first identified strength as the most important characteristic, and then designed an investigation to find the strongest supermarket carrier bag.

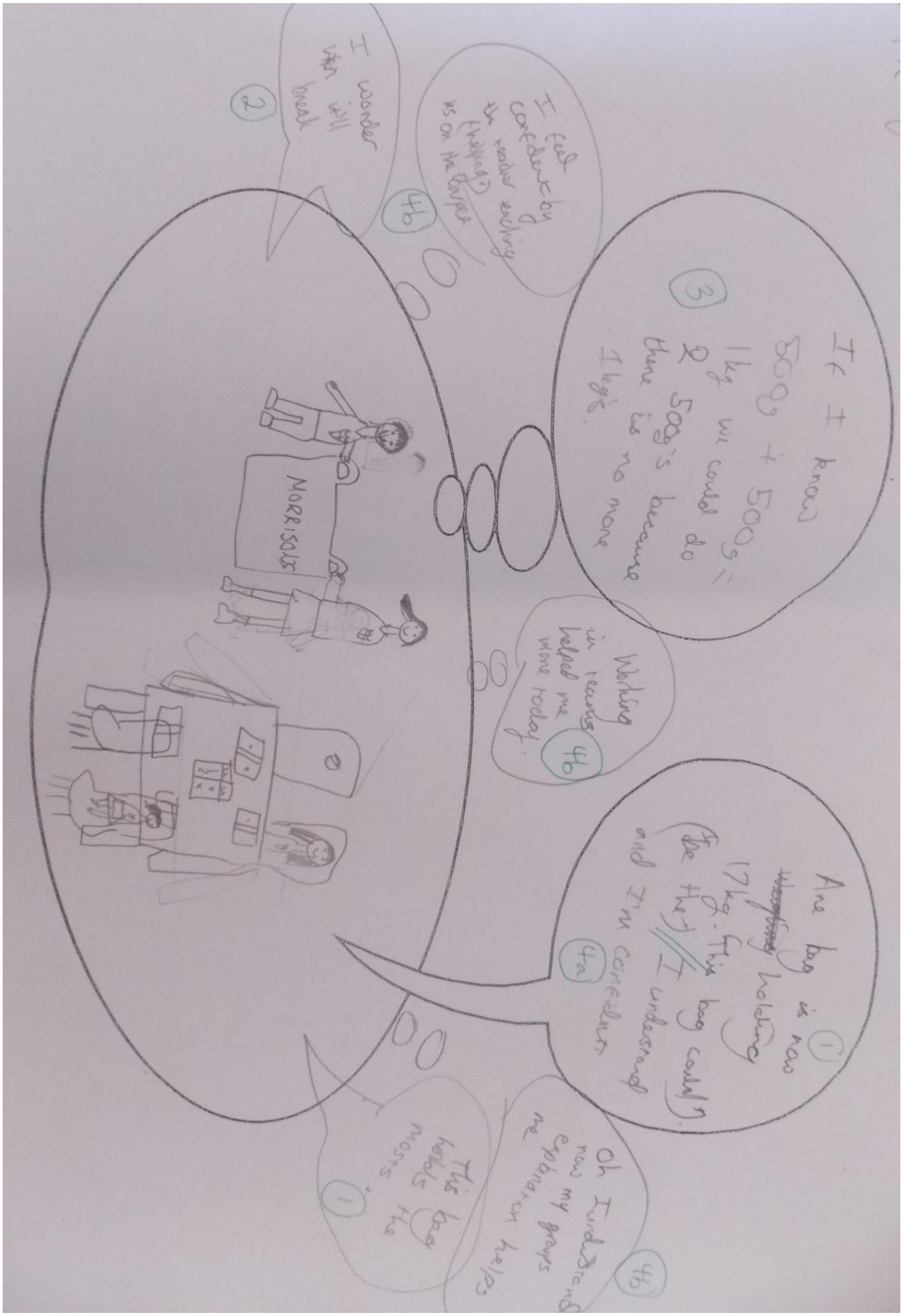


Plate 5A.5 Harry's pupil views template, May 2012

This lesson was more practical than the previous lessons, and engendered a different type of responses. Harry included eight text units on his completed template. Two of these comments contain straightforward recall of details from the lesson: ‘Our bag is now holding 17kg’ and ‘This bag holds most’. However, the remaining six responses are more interesting:

1. ‘I wonder when it will break’.
2. ‘I feel confident by the teacher teaching us on the carpet’.
3. ‘If I know 500g + 500g = 1kg we could do 2 500gs because there is no more 1kgs’.
4. ‘Working in teams helped me more today’.
5. ‘I understand and I’m confident’.
6. ‘Oh I understand now my group’s explanation helps me’.

The first of the text units reveals speculation, a type of thinking associated with the ‘Creating’ level of Bloom’s Revised Taxonomy (Krathwohl, 2002) that has not been evident in any of the templates Harry previously completed. This type of thinking suggests that Harry was beginning to make predictions, and was thinking more deeply about the task ongoing during the lesson. However, this may also merely be a by-product of this type of lesson; the children were asked to find the strongest bag and were taught when carrying out investigations, particularly during Science lessons, to make predictions and hypotheses. Certainly, this task bears a stronger resemblance to our scientific investigations than it does to our customary Maths lessons.

The probable success of this lesson in inspiring thinking of this nature again causes me to question my decision to randomly select lessons for the pupil views templates. This was done in an attempt to improve reliability, yet it would perhaps have been more useful to identify specific lessons so that pupils were asked to reflect upon experiences which were more conducive to the exercise. This again conforms to Pettigrew’s (1988) preference for selecting extreme cases for study where the process of interest is ‘transparently observable’ (p. 275).

Harry's third comment is also of interest as he once again provides an explanation of his reasoning. However, in contrast to the explanation included in the template from March 2012, this explanation in given in a thought bubble, suggesting that it was part of Harry's personal, independent reasoning about the task, and it is unclear whether this was ever shared with the rest of his group. Finally, comments two, four and six once again reiterate Harry's belief that discussing his learning with others helped him to make progress both in his understanding and confidence.

It is interesting that after a notable absence in his second and third templates, it is only in this final template that Harry once again makes explicit reference to his confidence, again highlighting the disparity between his assertions that this particular way of working makes him feel confident and his concept of himself as a learner of Maths as recorded using the S.D.Q.

5A.5 Thoughts

These pupil views templates demonstrate that:

- Harry was metacognitively aware, repeatedly referring to the learning situations in which he felt most confident and successful.

- Comments do not materially change during the data collection period, thus failing to reveal any kind of development in Harry's metacognition, although they do show that he was actively aware of himself as a learner.

- Harry clearly and consistently stated that working in a group helps him to make progress, to understand when he was stuck, and to feel more confident.

This final point is key: such strong statements provide very clear evidence that, for Harry at least, the use of a Thinking Skills approach has indeed achieved what was intended: that, by giving pupils more opportunities to work together, they have developed their mathematical ability and confidence in the subject.

Whilst I was initially disappointed by the non-developmental nature of the responses indicating Harry's metacognition, this should perhaps have been anticipated. Pupil views templates are specifically intended to encourage pupils to reflect upon their thinking and therefore it is to be expected that pupils would do so from the outset. Instead of looking for development on the templates themselves, therefore, it becomes more important to note the changes that took place outside of these: in Harry's book, in his discussions with his group and in his explanations of his reasoning. These are the very developments that led me to select Harry as this exemplar, although sadly they have been recorded only in my observations as teacher-researcher, and therefore are not available for scrutiny by a third party.

In addition, whilst there is no change in the type of metacognitive comments that Harry included on his pupil views templates, his responses from March and May 2012 both contain detailed explanations of his reasoning. This reasoning is shown to take place both in his discussions (March 2012) and in his thoughts (May 2012). This is one of the most lauded benefits of the Thinking Skills approach, acknowledged by Leat and Higgins (2002), Ke and Grabowski (2007), Hu *et al* (2010) and McGrane and Lofthouse (2010), amongst many others. The absence of this in earlier templates can be seen to suggest that it is the Thinking Skills approach that has developed his ability to articulate this reasoning and the frequency with which he does this, providing evidence that Harry has now become familiar and, indeed, skilled in expressing himself in this way as a direct result of working collaboratively and engaging in these discussions with others. This suggests that in this study, too, use of this approach has been successful in developing pupils' written and verbal explanations.

Despite the strong evidence contained in Harry's pupil views templates to suggest his preference for this way of working, and his belief that it was successful in helping him to make progress, I remain concerned about the inconsistency between this, his progress and attainment, and the development of his self-concept in Maths. As we have already seen, self-concept is considered to be one of the most potent factors for pupil achievement, with research suggesting that 'as much as one-third of the variance in achievement can be accounted for by academic self-concept alone' (McCoach & Siegle, 2003: p. 145). As such it clashes strongly with the outstanding academic progress Harry made in Maths, and also with his responses which repeatedly made reference to his increased confidence. This perhaps suggests that there is some other factor at work here. Could it be that his self-concept would have declined even more sharply were it not for the use of the Thinking Skills approach? Or that, despite his preference for this way of working, the Thinking Skills approach was insufficient to counteract his dislike for the subject itself? Or, did Harry consider feeling confident on a day-to-day basis during lessons to be somehow separate from how he viewed himself as a Maths learner?

Unfortunately these are questions to which it is not possible to gain easy answers. Harry is a complex individual and, much as we learned about each other during the two years in which we worked together, it is unreasonable to expect to understand everything, especially deep-rooted aspects of his psyche of which Harry himself may be unaware. I believe that, at this point, it is important to accept that Harry appreciated the Thinking Skills approach. It made him feel comfortable and secure during the lessons detailed above, and he welcomed the opportunity to collaborate with his peers. It is more pressing to determine the extent to which Harry may be considered representative of the focus cohort as a whole. To that aim, I turn to another exemplar: Grace. A study of her responses and reactions to the Thinking Skills approach will form the next section of this chapter.

Chapter 5, Part B: The Case-study of Grace.

'This is much better than working on my own. I think I know the answer.'

Analysis

Grace was – in both personality and learning style – very distinct to Harry, nor, in her academic work, was she as naturally gifted. Grace worked hard, but also found Maths challenging; something that she really needed to think about and work at. Initially, Grace was a rather passive learner, willing to try out strategies which had been taught directly, but considerably less eager to innovate, break down tasks or complex questions for herself, and more reluctant to develop her own approaches to mathematical problems.

Grace therefore provides one final exemplar to represent the focus cohort, in order to ascertain 'how individuals interpret events and experiences, rather than assessing whether or not their interpretations correspond to or mirror the researchers' interpretive construct of 'objective' reality' (Mishler, 1990: p. 427).

Grace was also, particularly at the outset of research, an extremely shy girl. She lacked faith in her own understanding of the mathematical concepts we studied, and, as a result, she was often reluctant to put herself forward during discussions. However, I selected Grace as the focus of this particular case-study because, over the course of the two years during which Grace studied Maths using the Thinking Skills approach, she changed considerably. She blossomed, metamorphosing from a child who was reticent, answering questions only when appealed to directly, to someone who wrangled actively with her group when deciding upon an approach for problem-solving, or who was eager to share the methods that she herself had come up with to tackle a question during a Mental Maths test.

This change renders Grace a particularly interesting case because of the likelihood of a link between her performance in Maths and her confidence and self-concept. This would follow the work of those such as Hoyles (1982) who have documented the fragility of pupils' self-concept in Maths, as well as Hannula (2002) who also found that one pupil assumed a more positive attitude to Maths because she 'more often than before achieved her cognitive goals and therefore her emotional experiences in the class were more pleasurable' (p. 41).

In this new-found confidence, Grace is representative of a small group of pupils – all of whom were, intriguingly, girls – who, initially at least, were rather quiet, hard-working and who could typically be described as working at or slightly above age-expected levels. These girls had a marked preference for Reading and Writing and, at the outset of research, they appeared to have a vague sense of wariness and intimidation of Maths. Yet, by the end of the research process, these girls were confident, enthusiastic and engaged wholeheartedly in the subject. In most cases, these girls had also made outstanding progress, and reached a secure Level 5 in their Key Stage Two S.A.T.s. Could the use of the Thinking Skills approach be responsible for this shift?

In my own experiences of teaching, these girls are typical of many girls who attain highly in Reading and Writing and yet do not quite appear to fulfil their potential in Maths. I have always attributed this to a lack of confidence, and certainly the belief that girls are less confident in Maths than boys is well documented with those such as Nurmi et al (2003), for example, finding that 'boys have remarkably higher self-confidence that girls' (p. 459). It is also possible that this group is representative of those bright girls identified by Dweck (1986) who display 'A tendency toward unduly low expectancies […] challenge avoidance […] ability attributions for failure […] and debilitation under failure' (p. 1043). This is particularly interesting as it may suggest the success of the Thinking Skills approach in altering their mind-set – away from a performance-focused goal-orientated mind-set and towards a learning-focused, mastery-orientation mind-set.

As acknowledged above, despite differences in temperament and learning style, Grace, like Harry, made outstanding progress during her time in Key Stage Two. At the end of Key Stage One, Grace was teacher assessed at Level 2b, the expected level for pupils at the end of Year 2. Throughout Years 3 and 4, Grace made better than expected progress,

This is another reason to support my choice of Grace as an exemplar. Her accelerated progress during Years 5 and 6 is more pronounced than that of Harry, and certainly higher than the national expectation, perhaps making four sub-levels of progress and reaching Level 3a, (one sublevel above the age-expected level) by the end of Year 4. Grace continued to make accelerated progress during Year 5, making two and a half sub-levels of progress during her time in Year 5, and reaching Level 4c+ by July 2012. This progress is particularly important as the national expectation is that pupils make only one sub-level of progress in Year 5, suggesting that the Thinking Skills approach may have had an immediate impact upon Grace's attainment. By the end of Year 6, Grace achieved a Level 5 in the Key Stage Two S.A.T.s, with a combined score of 81% across the two written papers and the Mental Maths test. This means that she made good progress during Year 6 alone, making two and a half sub-levels progress during her final year at West Side School.

suggesting that the Thinking Skills approach may have impacted upon her progress. This would certainly fit with the views of many academics, including Robson (2006) and Hu et al (2010), who agree with Higgins et al (2005) that 'when thinking skills programmes and approaches are used in schools, they are effective in improving pupils' performance on a range of tested outcomes' (p. 3).

Notwithstanding Grace's academic progress, there was one further compelling reason why I chose her as subject for this case-study. One of the most convincing pieces of evidence to suggest the impact of the Thinking Skills approach upon Grace's view of herself as a learner of Maths is the data she submitted relating to self-concept. Grace provides a stark contrast to Harry as her responses to the S.D.Q. indicated that her self-concept in Maths increased slightly during the research period. Indeed, her mean responses increased from 3.7 in October 2011 to 3.8 in July 2013. Whilst this gives a rather small increase of just 0.1, it can nonetheless be considered noteworthy when compared with the acknowledged notion (see Marsh, 1989: p. 418) that self-concept declines during childhood and adolescence, before increasing again during early adulthood. This sense of the possible positive impact of the Thinking Skills approach upon Grace's confidence in her Maths learning is further

As touched upon above, there is a strong link between self-concept and performance in Maths,
This is particularly important in light of the relationship between attitude and achievement found by Ma and Kishor (1997: p. 35), suggesting that the change in Grace's perceptions of herself as a learner of Maths could be responsible for her progress.

strengthened when compared with her responses regarding other dimensions of her self-concept. Several of these decreased considerably throughout research, including Reading and General School which both decreased by a mean of 0.7. For Reading, this meant that Grace's mean responses decreased from 3.8 to 3.1, whilst for General School her responses declined from a mean of 3.7 to a final mean of just 3.0 in comparison with the mean of 3.8 for Maths at the same point at the end of the data collection period in July 2013. This data is shown in Figure 5B.1

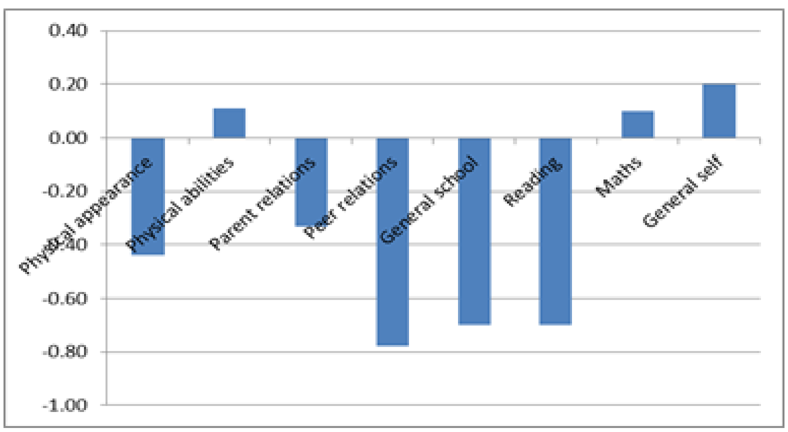


Figure 5B.1 Grace's mean S.D.Q. responses

Sadly, I did not have any of Grace's books to scrutinise for evidence of independent reflection upon her work but I have retained a strong impression of her determination to improve and develop as a mathematician. Furthermore, I believe this may have been more evident in her behaviour during lessons than in any written form. Certainly, her responses on her completed pupil views templates, whilst thoughtful, did not always contain the level of detail included by some of her peers, and, notably, the templates completed by Harry. Whilst Grace completed her first template in considerable detail,

It is curious that Grace, as well as Harry, included substantially more units of text on the first pupil views template than on any subsequent template. This contrasts with the mean from the focus cohort as a whole, which was also highest at this point in the data collection process, but varied only slightly, with a difference of just 1.32 between the highest and lowest means. This may reflect the novelty including ten units of text in comparison with the mean of 5.29 units from the focus cohort as a whole, her subsequent templates were completed more briefly. The templates Grace completed between February and May 2012 included between four and six units of text, broadly in line with the mean from the remainder of the year group. This data can be seen in Table 5B.1.

of being actively encouraged to express an opinion about lessons and learning. However, I believe it is interesting to observe that both Grace and Harry included such a considerable degree of detail on their initial templates, perhaps suggesting an enthusiasm for reflection over and above that felt by the majority of their peers.

Date	Mean number of text units per template	Text units included on Grace's templates
December 2011	5.29	10
February 2012	4.87	5
March 2012	3.97	4
May 2012	4.94	6

Table 5B.1 Text units used by Grace

It is, of course, important to recognise that this apparent lack of detail does not necessarily denote a lack of reflection or careful thinking. This can only be identified through scrutiny of the templates themselves and this will form the next part of this section. As for the templates completed by Harry, each template is accompanied by a description of the focus lesson, as well as an analysis of the responses they contain. Again, it is important to note that these responses should not necessarily be expected to form part of any kind of progression, but rather a snapshot of Grace's thinking about her learning at each of the different points in the data collection process.

It should also be noted that Grace's views, as recorded in the pupil views templates, are shared here in their entirety following the recommendations of Mishler (1990), so that other researchers 'can inspect it and assess the adequacy with which the methods and interpretations represent the data' (p. 437).

5B.1 December 2011

This template was completed about a lesson in which pupils worked in mixed-attaining teams of three or four to solve a range of challenging multi-step word problems for all operations, in a range of contexts including time, money and measures.

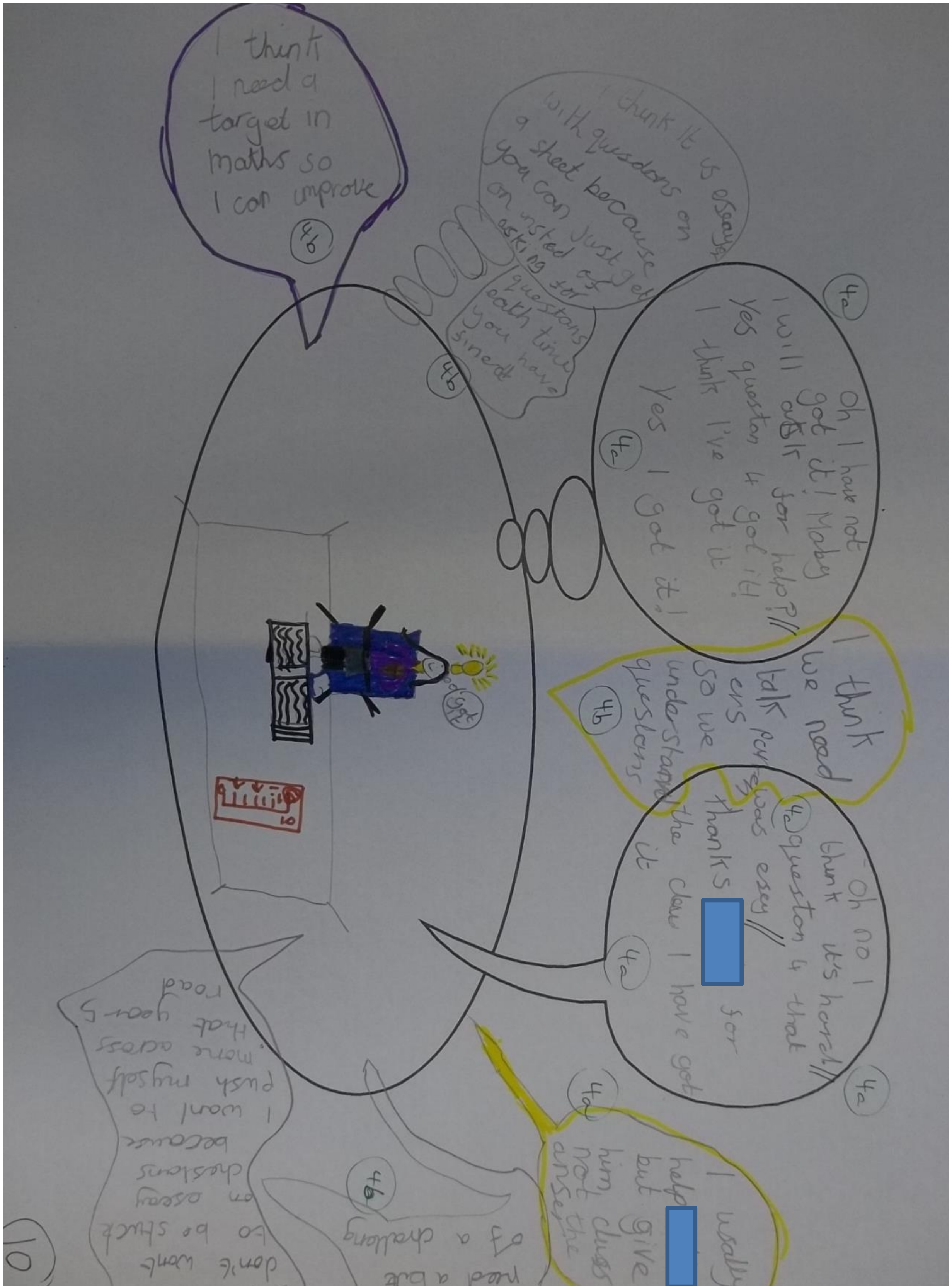


Plate 5B.1 Grace's pupil views template, December 2011

I believe this template is particularly interesting as it was completed in considerably greater detail than those completed subsequently. Each of the ten text units constitutes very clear evidence of Grace's metacognition:

1. 'I think I need a target in Maths so I can improve.'
2. 'I think it is easy with questions on a sheet because you can just get on instead of asking for questions each time you are finished.
3. 'Oh I have not got it! Maybe I will ask for help?'
4. 'Yes question 4 got it! I think I've got it yes I've got it!'
5. 'I think we need talk partners so we understand questions'
6. 'Oh no I think it's hard.'
7. 'Question 4 that was easy'
8. 'Thanks [name] for the clue I have got it'
9. 'I usually help [name] but give him clues not the answer'
10. 'I think I need a bit of a challenge because I don't want to be stuck on easy questions because I want to push myself across that Year 5 road.'

Indeed, I believe that comments such as 'I think I need a target in Maths so I can improve' or 'I think we need talk partners so we understand questions' demonstrate that Grace's reflection upon her learning goes beyond her concrete experience of the focus lesson, and is instead indicative of a more general reflection upon the ways that she learns most effectively, suggesting metacognitive skillfulness.

This proportion of metacognitive comments is encouraging as it suggests that the Thinking Skills approach has been successful in its primary goal of prompting pupils to actively consider the learning process in which they are participating. Metacognitive skillfulness is particularly important in light of the findings of those such as Veenman et al

(2005), who found that 'metacognitive skillfulness is the main predictor of initial learning' (p. 193).

Even more encouraging are the responses which show how effectively Grace appears to be working with her peers. Indeed, I find comments such as 'Thanks Jade for the clue I have got it' and 'I usually help Aidan but give him clues not the answer' extremely interesting because they suggest not only that pupils were discussing their learning together, but that they recognised the importance of developing understanding in themselves and in others, rather than simply trading answers. These comments, together with Grace's explicit explanation that she thinks that 'we need talk partners so we understand questions' echo the responses of Harry at this same, very early, point in research, further suggesting how much the pupils valued the opportunities that the use of the Thinking Skills approach gave them to talk about their learning.

This issue of 'clues' is particularly intriguing as it indicates that Grace (and, presumably her peers, represented here by Jade and Aidan) have the ability to break down problems and identify key knowledge or steps which will enable others to do so. This suggests that pupils were moving far beyond a superficial understanding, towards a deeper and more thorough engagement with the mathematical content involved.

5B.2 February 2012

This template was completed about a game-based lesson on probability during which pupils worked in mixed-attaining pairs to work out the probability that the next card would be higher or lower, inspired by I.T.V.'s 1980s game-show 'Play Your Cards Right'.

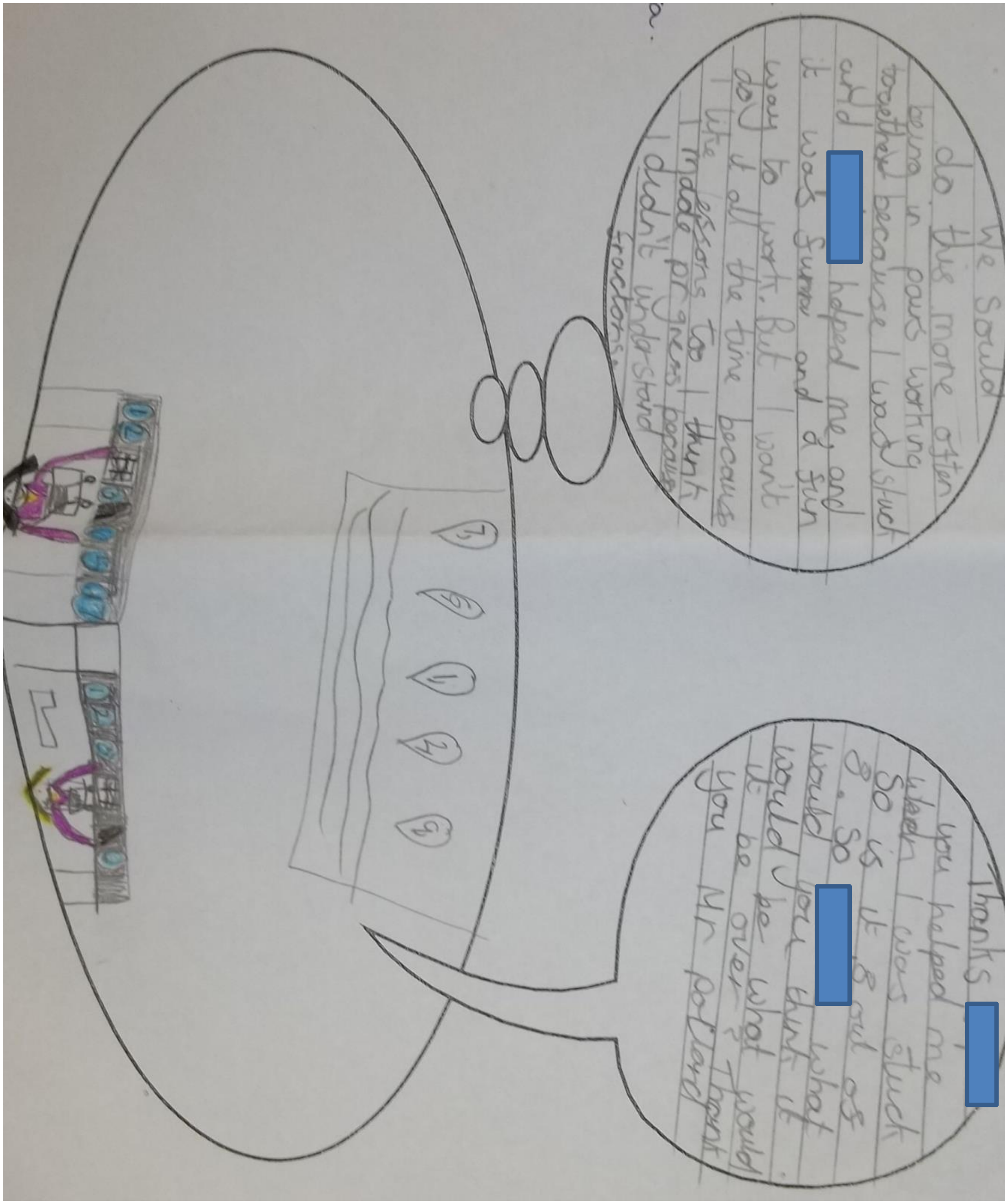


Plate 5B.2 Grace's pupil views template, February 2012

As acknowledged above, this template was completed in considerably less detail than the previous one, containing just five units of text in total:

1. 'We should do this more often in pairs working together because I was stuck and [name] helped me and it was fun and a fun way to work. But I won't do it all the time because I like lessons too.
2. 'I think I made progress because I didn't understand fractions.'
3. 'Thanks [name] you helped when I was stuck so it is 8 out of 8.'
4. 'So [name] what would you think it would be what would it be over?'
5. 'Thank you Mr Poolan.'

It is interesting to note that Harry, too, included just five units of text in his own reflection upon this lesson. This number of text units is broadly in-line with the mean of 4.87 for the focus cohort as a whole. It could be argued that this lesson was not particularly conducive to metacognitive thinking: certainly only the first two of Grace's five comments could be considered reflections on her learning, and these are not as detailed or insightful as the comments from December 2011. However, this does not appear to be true for the focus cohort as a whole, indeed the responses from this point in the data collection process actually contained the highest proportion of expressions of preference for a particular learning style: 39.08%, in comparison with 36.49% in December 2011, 21.37% in March 2012 and just 14.05% in May 2012[32].

Again, this questions whether this was a suitable lesson upon which to base a pupil views template, and challenges my decision to select lessons for the templates randomly. However, it is important to note that if 2/5 (or 40%) of Grace's comments indicate metacognition, this is in line with the proportion of metacognitive comments from the focus cohort as a whole at this point in the data collection process. It must also be acknowledged that as the proportion of metacognitive comments was at its peak at this

[32] This is the combined figure for responses indicating a preference in learning style both with and without a supporting reason. A more detailed analysis of this data can be found in Chapter Four Part C.

point in research, this further emphasises the extraordinary degree of reflection that Grace included in her first template.

It also interesting to note that Grace's three remaining responses each record some of the conversations on-going during the lesson. These provide evidence of Grace's collaboration with her partner, Sophie, and also her interactions with Class 2's Learning Support Assistant, Mr Poolan. I believe that these responses convey the importance Grace has given to her discussions with others, further expressing her belief that talk during Maths lessons has helped her to make progress. This is particularly interesting in light of the competitive, game-like nature of this particular lesson. As I have previously acknowledged during my case-study about Harry, the pupils in the focus cohort interpreted the activity as a contest in which they competed against one another to win the 'game' by working out the most probabilities correctly. This led me to believe that this competitive spirit curtailed their collaboration, as their intentions were not to support one another to develop their understanding for the shared benefit of the team, as in the previous collaborative problem-solving lesson, but rather to beat the other in order to emerge victorious. However, it is interesting to note that Grace, like Harry, has not interpreted the lesson in this manner, but instead demonstrated that she embraced the opportunities for talk provided by the Thinking Skills approach.

This provides further evidence that the children in the focus year group have found the opportunities for collaboration and discussion inherent to the Thinking Skills approach particularly beneficial. This again supports the findings of a large number of academics regarding the relationship between pupil talk and academic progress in general (e.g. Watson, 2001; Leat and Higgins, 2002; Ke and Grabowski, 2007; Hu et al, 2010; McGrane and Lofthouse, 2010) as well as for Maths in particular (Jansen; 2008; Boaler, 2006).

5B.3 March 2012

This template focuses upon a lesson in which pupils worked in a mixed-attaining team of three or four pupils to solve one of the ‘Mathematical Challenges for Able Pupils’ produced by the D.f.E.E. (2000). This challenge required pupils to use their understanding of inverse operations to work out how many of each different type of fish a customer bought with £20.

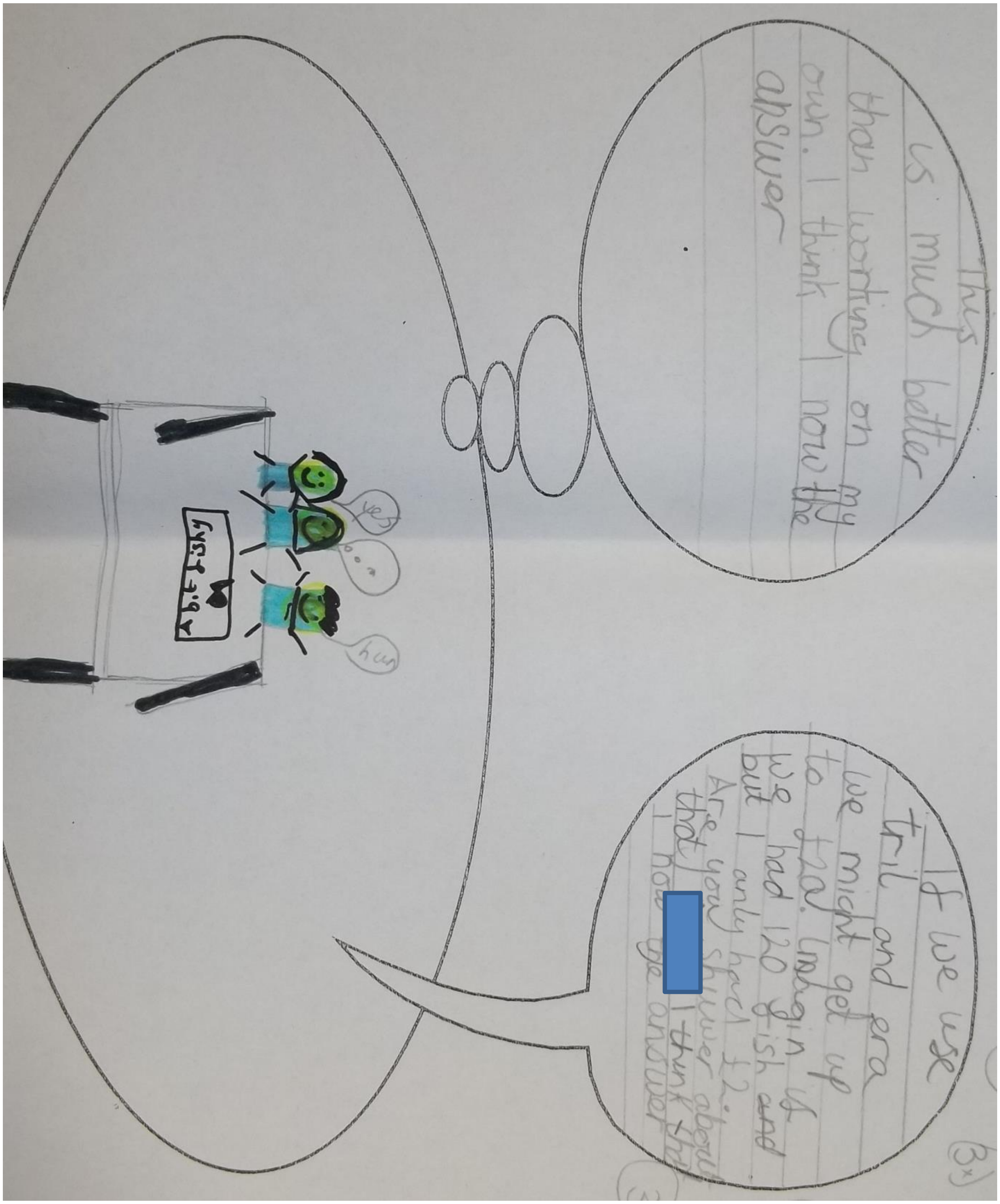


Plate 5B.3 Grace's pupil views template, March 2012

This template was completed most briefly by Grace, containing just four units of text:

1. 'This is much better than working on my own. I think I know the answer.'
2. 'If we use trial and error we might get up to £20.'
3. 'Imagine if we had 120 fish but we only had £2.'
4. 'Are you sure about that [name]? I think I know the answer.'

Responses 1 and 4 once again demonstrate Grace's ability to collaborate effectively with her group and, crucially, her opinion that this form of working is beneficial to her understanding of the lesson. This sense of teamwork is particularly well expressed in the illustration included on this template, of the three teammates together, with smiling faces and their arms in the air, perhaps in triumph or excitement. I find the third of Grace's responses intriguing because, whilst it is completely irrelevant to the task the group has been set, it nonetheless demonstrates that Grace is beginning to move beyond the question in front of her and to speculate more widely about the mathematical content involved. This type of thinking can be classified as 'Creating' using Bloom's Revised Taxonomy (Krathwohl, 2002).

I believe this illustration is potentially important in light of the assertions made by Wall et al (2007), who stress that 'drawing in the faces of the teacher and pupils, adding features of their classroom, or drawing what was on the board in a recent lesson, can help to trigger further reflection' (p. 5). This emphasises the likely veracity and potential importance of the happiness of the figures as another indication of Grace's satisfaction in working with her team.

Responses 2 and 3 are also interesting because of Grace's use of 'we' to discuss her work. This is not the first time that she has done so, but it is certainly the first time that she has used 'we' to describe the approach her group as a whole used during a lesson, perhaps suggesting a shift in Grace's thinking away from 'me' and 'my' work and towards 'we' and 'our' work. It is even possible that this use of language could be

I believe this use of language strongly suggests that collaboration has become embedded into everyday practice, so that working with others has become the norm. This is important as collaboration is one of the principal tenets of a symptomatic of a move towards a more sophisticated form of collaboration in which pupils more thoroughly debate the methods open to them before agreeing upon an approach, although unfortunately this would be difficult to prove conclusively without more detailed records of the interactions between the different members of the groups. I do believe, however, that this kind of interaction is hinted at in the final response included on this template, which shows that the group members felt able to challenge each other's interpretation of the question, and to critically engage with each other to develop the understanding of the group as a whole.

Thinking Skills approach, as 'it is mainly through the mediation of one or more other people that pupils make intellectual progress' (Watson, 2001: p. 143).

5B.4 May 2012

The final pupil views template was completed about a very practical lesson in which pupils worked in mixed-attaining groups of three or four to design and carry out an investigation to find out which carrier bag was most suitable for me to shop for our school's Diamond Jubilee street party. The groups first decided that strength was the most important characteristic, and then designed an investigation to find the strongest supermarket carrier bag.

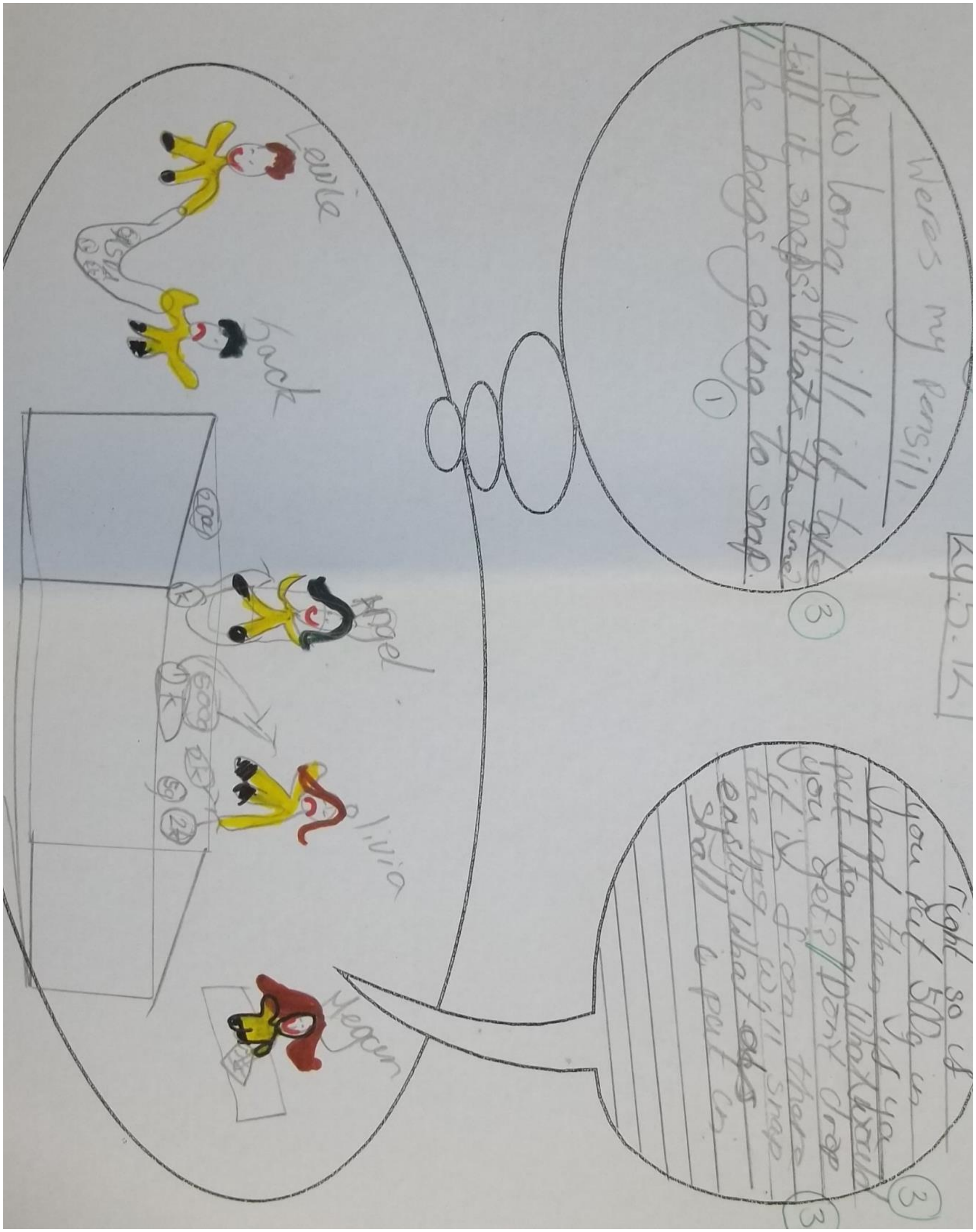


Plate 5B.4 Grace's pupil views template, May 2012

Grace included the following units of text on this template:

1. ‘Where’s my pencil!’
2. ‘How long will it take til it snaps? What’s the time?’
3. ‘The bag’s going to snap.’
4. ‘Right so if you put 500g in and then if you put 1kg in what would you get?’
5. ‘Don’t drop it in from there or the bag will snap easily.’
6. ‘What else shall I put in?’

Noticeably absent from all of these comments is the ‘we’ which featured in her responses about the lesson in March. Nevertheless, there is continued evidence of her collaboration with team mates, suggested particularly in comments 5 and 6 which demonstrate that Grace was involved in both seeking and giving advice relating to the task. Grace also appears to have again engaged in speculation, a form of thinking which relates to the ‘Creating’ level of Bloom’s Revised Taxonomy (Krathwohl, 2002). This is evident in Grace’s second response, in which she wonders ‘How long will it take til it snaps?’ Harry too engaged in speculation during this lesson – although for him, this was the first example of this type of thinking, at least as it was captured using the pupil views templates – and, whilst it does provide evidence that Grace is again beginning to wonder about the task at hand, suggesting a level of curiosity and creative thinking about her work in this particular Maths lesson, I believe that the similarity of this comment to that of Harry strengthens the idea that this type of thinking was a by-product of this type of open-ended, investigative lesson. However, this is not necessarily a disadvantage but rather hints at the success of the Thinking

This certainly undermines my supposition that the use of ‘we’ reflects a shift in mind-set, away from individualistic ways of working and towards a deeper acceptance of collaborative working as the norm. Indeed, Grace’s sixth comment - “What else shall I put in?” - explicitly describes her working and thinking on her own without reference to her group, suggesting that group work has not been as entrenched into everyday practice as I had previously hoped.

On a more positive note, this evidence of Grace’s higher level thinking is encouraging because information learned in this way ‘is remembered longer and more clearly than information that is processed through lower-order, rote memorization’ (Teaching as Leadership, p. 55). Furthermore, Skills approach in encouraging pupils to engage in thinking on a wider level than in lessons of a more passive, traditional style.

'Knowledge obtained through higher-order thinking processes is more easily transferable, so that students with a deep conceptual understanding of an idea will be much more likely to be able to apply that knowledge to solve new problems' (Teaching as Leadership, p. 55).

5B.5 Thoughts

Having considered the responses contained within Grace's pupil views templates, I believe they demonstrate that:

- Grace believed that collaborating with others helped her develop understanding in Maths; this was explicitly stated in three of the four completed templates.

- Templates contain little evidence of reflective thinking. The most obvious examples of this were from December 2011, at the very beginning of research.

I must own to a sense of disappointment. Yes, I believe that Grace was positively affected by the introduction of Thinking Skills approach. Indeed, this is Grace's opinion too, and her belief that collaborating with others helped her to develop understanding in Maths is explicitly stated in three of the four completed templates, in addition to being tacitly implied in her accounts of her group's discussions surrounding their learning. Like Harry, Grace's comments on her learning preferences remain rather similar throughout the research process, repeatedly stating that working with talk partners helps her to feel more confident. This again reinforces the views of the focus cohort as a whole as well as that of a large number of academics, including regarding the role of talk and collaboration in developing understanding both in general (e.g. Watson, 2001; Leat and Higgins, 2002; Ke and Grabowski, 2007; Hu *et al*, 2010; McGrane and Lofthouse, 2010) and for Maths in particular (Jansen, 2008; Boaler, 2006).

In my opinion, this provides very clear evidence that for Grace and, almost certainly, the small group of girls that she has been chosen to represent, feel that they have benefited from the introduction of the Thinking Skills approach in terms of gaining confidence and making academic progress, although development in metacognition may be less easy to determine. However, there is little of the depth of reflective thinking that was so obvious in Harry's responses. It is again disappointing that there is no evidence of a development in Grace's metacognition throughout the course of research. Indeed, it must be noted that the most convincing examples of reflective thinking were from the December 2011 template, at the very beginning of research. On the other hand, it is heartening to know that this opinion is stated consistently throughout the entire data collection process, thus greatly increasing the likelihood of reliability.

Yet, it may be that I am hoping for too much in expecting Grace to record the kind of detailed reflections that Harry did. It is very likely that the Thinking Skills approach did cause Grace to consider her learning in a different light, and certainly I am intrigued by the evidence, demonstrated in the final two templates, of the 'Creating' type of thinking as it is classified in Bloom's Revised Taxonomy (Krathwohl, 2002). Grace did prove to be metacognitively knowledgeable in her awareness that opportunities for talk enabled her to learn more effectively and, whilst there was no sense of metacognitive development contained on the pupil views templates, the Thinking Skills approach must be considered a success for Grace in light of her excellent academic progress and encouraging S.D.Q. data. Most importantly however, in Grace's own words, she considers the initiative to have been helpful to her, and if it succeeded in making her feel even a touch more confident in her own abilities as a learner of Maths, then it must surely be judged a success.

Chapter 6. Discussion and Conclusions

Having explored the data, it remains to make associations between the emergent findings from this study and the existing literature, in order to discuss the extent to which these can be seen to answer the research questions outlined at the beginning of this study. These are: to what are the impacts of a Thinking Skills approach - with particular focus upon classroom talk and development of metacognitive awareness – upon:

1. pupils' progress in Maths, in terms of National Curriculum levels.

2. pupils' opinions of the subject and their own ability to succeed and make progress (academic self-concept).

3. pupils' understanding of the ways in which they learn Maths (the development of metacognition).

In interpreting the data, I am mindful of my intention regarding the purpose of this research. As I subscribe to Hammersley's (2003) definition of practical science, I strongly believe that any knowledge gained as a result of this study is, to some extent at least, dependent on the context in which it was produced. This research thus aims to be informative - to provide information which could be relevant for the audience, without any sense of responsibility, or even the right, to attempt to 'control the way in which people derive practical or policy implications from the knowledge provided, or to try to control what people do on the basis of it' (Hammersley, 2003: p. 18). As a teacher, I would never imagine that, by replicating a teaching method used by one of my colleagues, I would exactly reproduce their educational outcomes. My pupils are different, and I am a different teacher, with my own style of instruction, working within a different set of circumstances, no matter how closely I may try to emulate another. Therefore, I will always achieve slightly different results.

I do not consider this to be a serious limitation of this study: teachers 'do not need to be told what to do. […] But they do know that ideas and people are not of much real use until they are digested to the point where they are subject to the teacher's own judgment' (Stenhouse, 1988: p. 45). I am similarly aware that, because of my position of teacher-researcher, my interpretation of my findings is unavoidably coloured by my own personal experience and interpretation of the learning ongoing in my classroom. However, I believe that, for the purposes of developing my own understanding of my working environment – my own teaching and the pupils I work with – this additional knowledge is an advantage, allowing me to gain further insight into my classroom and the consequences of the introduction of the Thinking Skills approach than would have been possible as an external observer.

From my own reading of the data collected during this investigation, my initial conclusions have been that:

- Pupils' attainment in Maths increased in a number of related areas, including more pupils making better than expected progress - 2.5 sub-levels or above - after the second year of research; an increase in the number of pupils working significantly – two or more sub-levels – above age-expected levels; as well as a rise in the proportions of pupils attaining both the expected level (Level 4) and above (Level 5) in Key Stage Two S.A.T.s tests, in addition to a substantial increase in the mean number of marks obtained by pupils.

- Pupils' opinions of Maths and their own ability to make progress were subject to a positive shift: pupils' responses documented a steady increase in their self-concept relating to Maths throughout the first year of research and this remained constant throughout the second. This contrasts with comparative data from Year 3 and 5 pupils at West Side School, as well as the decline well-documented in the work of those such as Marsh (1989).

- Pupil views templates from the focus cohort as a whole suggest that pupil talk became increasingly focused on discussions about learning throughout the course of research. Pupil interactions shifted away from comments which showed pupils checking answers with each other, and towards increased use of questions and speculation, as well as discussion of strategies for problem solving, suggesting that pupils have increased opportunities to engage in metacognitive reflection with their peers, and the consequent development of metacognitive knowledge and skilfulness.

- Pupil views templates from Harry and Grace, featured in the embedded case studies, suggest that both pupils felt that collaborative group work contributed positively towards both progress and confidence. The fact that both pupils recognised and repeatedly stated this belief demonstrates not only that these pupils embraced the changed form of working introduced as part of the Thinking Skills approach, but also Harry and Grace's understanding of some of the ways in which they learn effectively, and can thus be seen as evidence of metacognitive awareness.

However, in addition to these conclusions - which are very strongly linked to the research questions instituted at the outset of research – further issues of interest have emerged rather more organically from the research process itself, as well as the subsequent data analysis:

1. Whilst the findings of this study indicated an improvement in average pupil progress, attainment, and self-concept relating to Maths, it remains to be further considered whether this effect was consistent across all groups of pupils in the focus cohort.

2. Throughout the course of research, there was an overwhelming impression of the advantages of the opportunities for collaboration and discussion that the Thinking Skills approach afforded pupils, evident in a considerable number of pupil views templates, as well as pupils' more informal feedback to me in the course of lessons or our discussions about learning.

3. My own learning about myself as a teacher and the realities of what truly transpires in my classroom. In analyzing the data resultant from this study, it is necessary to fully interrogate my influence in this. This also has wider implications for practitioner research: what is the impact of individual teachers? How have my

beliefs and values influenced this research, and, of course, the education of my pupils?

4. The nature of evidence. My beliefs relating to this concept have been challenged through the course of this research, as has my understanding of the purpose of research and the issue of transference. I will therefore endeavor to ascertain to what extent the findings of this research may be considered generalizable, and to what extent I will be able to move forward and apply learning from this study.

I believe that these issues are more problematic - taking the form of questions and rather nebulous theories rather than 'findings' or 'conclusions' - and are therefore perhaps better termed 'developments' in my own understanding of teaching and learning as well as research. Furthermore, these final two issues are fundamental, encapsulating the unforeseen consequences of engaging in this research, and link to the unexpected research question emergent from this research: the question of how engaging in this research has affected me as a practitioner and as a teacher-researcher. It is my aim that each of these issues will be discussed here in turn, beginning with the question which perhaps best aims to respond to my initial research questions: just what have been the impacts of the Thinking Skills approach and for whom – if anyone – has it been successful?

6.1 Thinking Skills: beneficial for all?

The question of just who benefits from a Thinking Skills approach features in each of the distinct sections of my Findings chapter. To illustrate: although pupils' rates of progress and attainment increased during the research period, the data suggests that the effect was greater upon middle- and higher-attaining pupils. Contrastingly, the data relating to self-concept revealed that pupils working significantly above and significantly below age-expected levels appeared to become less confident as learners of Maths, whilst all other groups of pupils demonstrated improved self-concept in this area. Finally, it was unclear whether there was a notable difference between the impact of the Thinking Skills approach upon girls and boys: gender biases evident in pupils' self-concept remained consistent throughout the research period as a whole, with girls consistently recording less positive responses to questions than their male peers to each of the eight dimensions measured by the S.D.Q. This issue clearly merits further exploration. The following section of this chapter will therefore endeavour to investigate distinct sub-groups within the focus cohort in order to ascertain whether the introduction of the Thinking Skills approach was indeed beneficial for all.

6.1.1 *The relationship between self-concept and attainment*

Consideration of the relationship between attitude and achievement - particularly evident, for example, in Hannula's (2002: p. 42) description of the impact of success upon Rita's enthusiasm and motivation for learning - may lead to the supposition that the higher a pupils' self-concept in Maths, the higher the level of attainment, whether because of the pupils' accurate understanding of their own performance in the subject, or because their self-belief has enabled them to make accelerated progress. Certainly, this belief would also be concurrent with McCoach and Siegle's conclusion that self-concept is one of the most potent factors for pupil achievement, with research suggesting that 'as much as one-third of the variance in achievement can be accounted for by academic self-concept alone' (2003: p. 145), and is even evident in some of the pupils' own responses recorded on the pupil views templates: 'I always understand because I listen and want to learn.' However, whilst pupils may have felt more successful during Maths lessons on a day-to-day basis as a result of peer-collaboration and more frequent opportunities to discuss their learning, this did not necessary translate directly into progress and attainment.

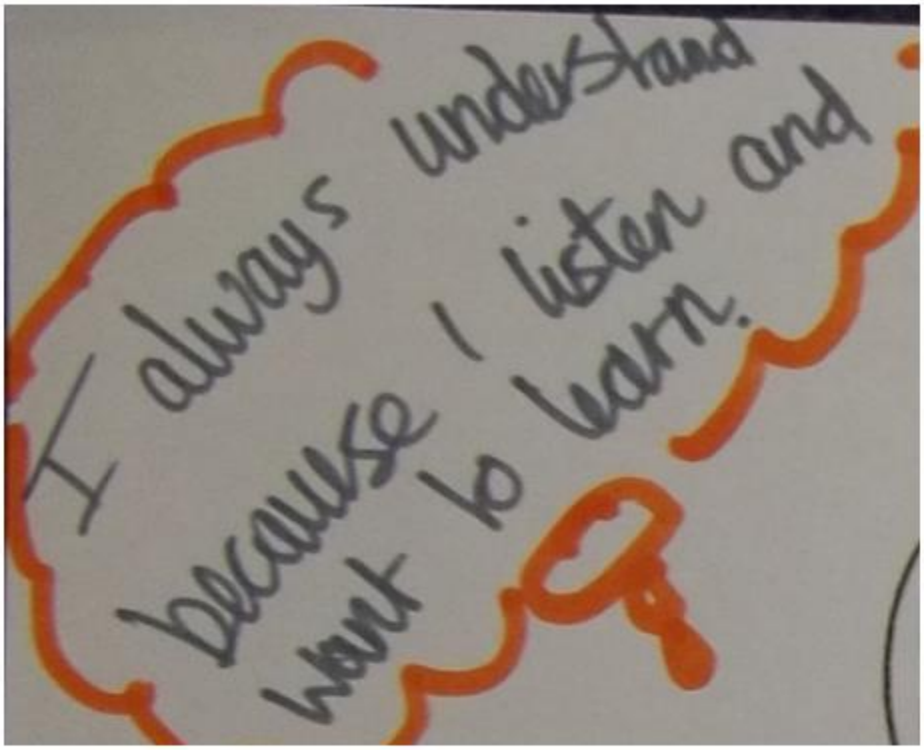


Plate 6.1 A pupil's belief in the importance of motivation in developing understanding

Of the 29 children who shared their self-concept using the S.D.Q. both in October 2011 and July 2013, and for whom all progress and attainment data was available, only seven – five girls and just two boys - recorded an increase of more than 0.4 in their mean responses for Maths. Furthermore, there appears to be no correlation between the increase in self-concept and progress in Maths. For instance, the pupil who recorded the largest increase in self-concept relating to Maths – a mean increase of 1.3 from 2.4 in October 2011 to 3.7 in July 2013 – also made just 2.5 sub-levels of progress during Years Five and Six. This was less than the progress this same pupil had made during her time in Years 3 and 4, and was, moreover, half a sub-level less than the amount of progress expected nationally during this period, in addition to being less than the progress made by the other six children who also recorded a mean increase of more than 0.4 in their self-concept data relating to Maths. Further information about these pupils can be found in Table 6.1 below.

Child	Attainment – end of Key Stage 1	Attainment – September 2011	Progress - Years 3 and 4 (sub-levels)	Attainment - July 2013	Progress - Years 5 and 6 (sub-levels)	Mean increase on S.D.Q.
1	1a	2a	3	3a+	3.5	0.4
2	2c	3b	4	4c+	2.5	1.3
3	2c	3c	3	4b	4	1.0
4	2b	3c	2	4c+	3.5	0.4
5	2b	3a	4	4a+	3.5	0.6
6	2b	3a	4	5b+	5.5	0.9
7	2a	3a	3	5c	4	0.6

Table 6.1 Progress for pupils whose self-concept in Maths increased by a mean of 0.4 or more

These children do not belong to any particular attainment group, but instead span almost the entire range of the focus cohort, extending from Level 3a+ to 5b+ at the end of Year 6. However, interestingly, of these seven children, six made accelerated progress during the research period, progressing by more than the expected 3 sub-levels. Indeed, the mean progress of this particular group of pupils was 3.79 sub-levels during the two year research process, in contrast with 3.29 during Lower Key Stage Two. Nevertheless, whilst it is tempting to suggest that this increase can be attributed to the Thinking Skills approach and the possibility of a reciprocal relationship between an increase in self-concept and improved attainment, it is important to be cautious: this is a slight increase and, whilst this appears positive, it is somewhat lower than the mean progress of 3.98 sub-levels made by the focus cohort as a whole.

It is perhaps unsurprising to note that, of the seven children who recorded a mean increase in self-concept of more than 0.4, just one (or 14.29%) was working at Level 5b or above. This contrasts with the proportion of pupils working at these levels in the focus cohort as a whole: twelve pupils achieved Level 5b or 5a by the end of Year 6, representing 33.33% of the focus cohort, further suggesting the absence of a positive impact of the Thinking Skills approach upon higher-attaining pupils. I therefore wonder whether the data relating to these seven pupils, rather than providing evidence of the relationship between self-concept and academic achievement, could instead suggest that feeling confident on a day-to-day basis was more influential to self-concept than their level of attainment or test performance. This would be rather heartening, suggesting that pupils may value their success at learning for learning's sake, rather than for an increase in National Curriculum level.

I also wonder whether it is possible that a change in mind-set could be responsible for this alteration. I believe it likely that a Thinking Skills approach, with its focus upon learning and progress, would encourage pupils to adopt a learning-focused, mastery-orientation mind-set, as opposed to a performance-related, goal-orientation mind-set which seeks merely to measure ability through improved test scores. It is therefore perhaps relevant to note that Dweck (1986) believes that these patterns are not rooted in ability, although they do have a profound effect upon the acquisition and application of cognitive skills when faced with challenges in learning. This could account for the fact that this group of pupils – those whose self-concept has undergone the greatest change during the course of research – are working at diverse levels of attainment. Could it be that these pupils are those who have most embraced the shift in focus – away from placing value on test scores and the number of ticks on a page – and towards an emphasis on learning, developing and strengthening their own understanding of the concepts studied?

If we are to accept that a shift in mind-set is responsible for the changes in self-concept recorded for this particular group of pupils, there is one specific piece of data which challenges this: the decrease in self-concept recorded for pupils working significantly above and significantly below age-related expectations. Dweck (1986) argues that learning goals focus children on effort as 'a means of utilizing or activating their ability, of surmounting obstacles, and of increasing their ability. Not only is effort perceived as the means to accomplishment, it is also the factor that engenders pride and satisfaction with performance' (p. 1043). Yet, if this particular group of children had adopted this mind-set, then surely participation in more challenging tasks, as well as regular opportunities to reflect upon their own learning and progress should not have hampered their perception of themselves as learners, but rather enhanced it? I wonder whether, instead, this decrease in self-concept does not suggest that these pupils remain goal-orientated and that, therefore, the increase in the level of complexity of tasks has encouraged them to see themselves and their own mathematical ability, in a less positive light? This is, of course - as well as the other suggestions proposed here - purely a hypothesis. Not one of these propositions could be proven without further exploration of pupils' attitudes and values, however I believe that they are certainly of interest, and would merit further investigation.

6.1.2 *The impact upon middle-attaining pupils*

As outlined in the Findings of this thesis, attainment data revealed an increase in the number of pupils working significantly – two or more sub-levels – above age-expected levels, suggesting that the Thinking Skills approach may have impacted most strongly upon middle-attaining pupils. This is consistent with the work of Hu *et al* (2010), who found that the effects of their 'Learning To Think' initiative 'were concentrated in students in the middle band of initial ability' (p. 1), or McGuinness (2006) who found that 'Children with moderate to high developed abilities benefited most' (p. 3). This is also interesting in light of the S.D.Q. data which charted an increase of 0.77 in the mean responses regarding self-concept in Maths for pupils working at age-expected levels. Could it be that the Thinking Skills approach impacted upon pupils working at age-expected levels and that this is evident in progress and attainment data as well as that relating to self-concept?

Certainly, this is the case for Grace. At the end of Key Stage One, Grace was assessed to be working at Level 2b, the national expectation for a child at the end of Year 2. She made accelerated progress during Years 3 and 4, making four sub-levels of progress (slightly above the three sub-levels of progress usually expected during this period) and thus reached Level 3a by the end of Year 4, one sub-level above the age-expected level. During Upper Key Stage Two, Grace fared better again, making four and a half sub-levels progress across the two-year research period. Across the research period, Grace had thus shifted from a pupil working at - or slightly above - age-related expectations, to one working significantly above the expected levels of attainment. Her self-concept for Maths also increased slightly, from a mean of 3.7 in October 2011 to 3.8 in July 2013.

At the end of Year Four, there were seventeen pupils in the focus cohort working at Level 3b or 3a, either at, or slightly above, age-related expectations. Progress and attainment data for these pupils can be seen in Table 6.2.

Child	End of Key Stage 1	July 2011	July 2012	July 2013	Progress between end of Years 4 and 6 (sub-levels)
1	2a	3b	3a	4c	2
2	2c	3b	3a+	4c+	2.5
3	2b	3b	4c	4b+	3.5
4	2b	3b	3a+	4c+	2.5
5	2b	3b	4c	5c+	5.5
6	2a	3a	4b	5c	4
7	2a	3a	4b+	5c	4
8	2a	3a	4a+	5a	6
9	2a	3a	4b+	5c	4
10	2a	3a	4b+	5c	4
11	2b	3a	4b+	5c	4
12	2a	3a	4a+	5b+	5.5
13	2b	3a	4b+	5b	5
14	2b	3a	4b+	4a+	2.5
15	2b	3a	4a+	5b+	5.5
16	2a	3a	4a	5b	5
17	2b	3a	4c+	5c	4

Table 6.2 Progress and attainment of pupils working at Level 3b or 3a at the end of Year 4

The mean progress made by this particular group of pupils was 4.09 sub-levels across Years 5 and 6, considerably more than the national expectation of 3 sub-levels during this period as well as the 3.75 sub-levels of progress made by the focus cohort as a whole. This perhaps suggests that the impact of the Thinking Skills approach upon this group of pupils was somewhat different to the focus cohort as a whole. However, when considering the five pupils working at the age-expected level (3b) at the end of Year 4, this picture is less encouraging. These pupils made a mean of 3.2 sub-levels progress during Years 5 and 6, somewhat lower than that made by the focus cohort as a whole, suggesting that it is those pupils – like Grace - who were working slightly above age-expected levels prior to beginning research (at Level 3a) for whom the benefits were most marked. These pupils made a mean of 4.5 sub-levels progress during the two-year research period, 50% greater than the amount of progress expected nationally during these year groups.

Of the 17 pupils listed above, S.D.Q. information across the research period as a whole was available for 16. This data is represented in Table 6.3 and has been colour-coded for ease of interpretation, with red denoting a decrease, and green indicating an increase, in self-concept.

Child	October 2011	June 2012	July 2013	Difference
1	3.5	3.4	3.2	-0.3
2	2.4	3.8	3.7	+1.3
3	3.0	3.1	3.3	+0.3
4	3.3	3.2	3.0	-0.3
5	3.9	N/A	N/A	N/A
6	3.6	3.4	3.8	+0.2
7	2.6	3.0	3.2	+0.6
8	4.0	4.0	3.9	-0.1
9	3.4	3.7	3.6	+0.2
10	3.2	3.5	3.5	+0.3
11	4.0	3.9	3.8	-0.2
12	4.1	4.1	4.2	+0.1
13	3.3	3.0	2.8	-0.5
14	3.2	4.0	3.8	+0.6
15	3.2	3.8	4.1	+0.9
16	4.0	4.0	4.2	+0.2
17	3.7	3.7	3.8	+0.1

Table 6.3 S.D.Q. data for pupils working at Level 3b or 3a at the end of Year 4

The changes in self-concept of this group are mixed; of the 16 pupils for whom self-concept data was available throughout the research period as a whole, with five pupils recording a decline in self-concept in Maths, and the remaining eleven recording an increase. On average, responses increased by a mean of 0.21 between October 2011 and July 2013, considerably greater than the mean increase of 0.09 for the focus cohort as a whole. However, the mean self-concept of this group had a lower starting point from that of the focus cohort as a whole – 3.41 compared with 3.53 – and therefore it is interesting to note that this larger increase served to bring this group in-line with all pupils, with both groups recording a mean self-concept of 3.62 in July 2013.

When considering the children working at Levels 3b and 3a separately, the picture becomes rather more confusing. In contrast to the progress and attainment data, the four pupils working at Level 3b at the outset of research for whom S.D.Q. data was available, recorded the most positive change, with self-concept increasing by a mean of 0.25, from 3.05 in October 2011 to 3.3 in July 2013. However, it is interesting to note that this end-point was nevertheless lower than the mean of 3.62 for the focus cohort as a whole. In contrast, the self-concept of pupils working at Level 3a at the end of Year 4 increased by a mean of 0.2, from 3.53 in October 2011 to 3.73 in July 2013, an end-point higher than the mean for the focus cohort as a whole.

I believe this data demonstrates that, although there are positive changes for this group of pupils throughout the research period, these are not straightforward, and nor is there an obvious correlation between improvement in attainment and self-concept. Therefore, although the data suggests that the impacts of the Thinking Skills approach were indeed most potent for middle-attaining pupils, I believe that it also perhaps implies that the approach affected different aspects of pupils' experiences of Maths for different groups of pupils, again emphasizing the uniqueness of pupils and the many varied ways in which pupils can be influenced by a sole set of circumstances.

6.2 The impact of collaboration and opportunities for discussion

Whilst considering pupils' self-concept relating to Maths, I was particularly struck by how considerably the increased opportunities for discussions about learning impacted upon pupils' enjoyment of lessons, as well as their confidence in the subject. Throughout the research period, large numbers of pupils recorded comments on their learning such as "Working in a group helped me today" both in their books and on pupil views templates. Furthermore, in an informal survey, 100% of pupils said that they thought they made more progress working as part of a group than alone. This view is also evident in the case-studies included in this thesis: the pupils featured – Harry and Grace – both very clearly and consistently stated that working in a group helped them to make progress, to understand when feeling stuck, and to feel more confident. For Harry, responses of this type accounted for almost half of his total responses: 11 of the 23 – or 47.83% - text units referred to his belief that ‘Working in teams helped me more today’. For Grace, comments of this nature represented 24% of her total responses, a substantial proportion, albeit considerably fewer than Harry.

I wonder if the value which pupils appeared to place upon collaboration and discussion, and their corresponding avowal that ‘I also feel confident because members of my table kept me right’, is not, at least partly, responsible for the increase in self-concept relating to Maths evident in the S.D.Q. data. I believe that there are several possible explanations for this, not least of which is that there is ‘safety in numbers’, perhaps combined with the logical assumption that ‘two heads are better than one’. This view is supported by Ke and Grabowski (2007), who suggest that ‘group learning helps to remove students’ frustration’ and that ‘it is not only a source for additional help but also offers a support network’ (both p. 250). Further to this, Jansen (2008) suggests that small group discussions ‘may be less threatening than whole-class discussions. Some of the students who mentioned feeling threatened during whole-class discussions also described a reduced sense of threat when talking at their tables’ (p. 44). This implies that, by providing pupils with the opportunity to work more regularly in small-group situations, pupils may feel more confident in sharing their opinions and asking questions to further their understanding.

I believe that, central to the success of collaboration in raising pupils’ confidence, is the increased opportunities for talk that this provides. The importance of discussion featured prominently in the literature relating to Thinking Skills. Several academics, including Watson (2001), Leat and Higgins (2002), Nichols (2006), Ke and Grabowski (2007), Hu *et al* (2010) and McGrane and Lofthouse (2010), all emphasise the significance of opportunities for discussion and collaborative working in the development of understanding, suggesting that ‘by verbalizing their reasoning [pupils] accept reasoning at a higher level than they start out with’ (Hu *et al*, 2010: p. 5). Similarly, Jansen (2008) and Boaler (2006), in their work specifically relating to Maths, also stress the positive effect that talk is likely to have upon the development of mathematical understanding. Furthermore, McGrane and Lofthouse (2010) describe talk as ‘a vehicle through which metacognition develops. Metacognitive talk thus generates the potential for a feedback loop, which has the potential to raise attainment' (p. 94), linking to Hattie and Timperley's (2007) conclusion that feedback has an average effect size of '0.79 (twice the average effect)' placing it 'in the top 5 to 10 highest influences on achievement' (both p. 83).

Put simply: I believe that, as a result of increased opportunities for collaboration, and therefore talk, during Maths lessons, pupils engaged more frequently in discussions about their learning, as is evident in the increased percentage of text units representing these on the pupil views templates. Consequently, I believe pupils developed a shared-understanding of mathematical concepts, thus prompting them to feel more confident in their own ability to succeed, as is evident in the S.D.Q. data measuring self-concept. I believe this is particularly important given the likelihood of a 'reciprocal relationship' (Sammons *et al*, 2008c: p. 10) between self-concept and attainment, thus suggesting that, because pupils felt more confident in their own abilities as mathematicians, they approached work with a more positive attitude and were more successful when completing mathematical tasks, thereby leading to the increase in pupil progress and attainment evident both in my teacher assessments and in the S.A.T.s tests completed at the end of Key Stage Two. Pupil talk can thus be seen as a common element which connects each of the three research questions investigated in this study, and which, it is appears likely, has had a considerable impact on the successful outcomes of the Thinking Skills approach upon each.

In the light of this evidence, it is perhaps unsurprising that opportunities for discussion were so frequently mentioned by pupils. This is particularly interesting in light of Jansen's assertion that pupils 'who believed participating during Maths class discussions helped them learn were more likely to talk conceptually about mathematics' (2008: p. 37). This perhaps suggests that pupils' beliefs about the benefits of engaging in discussion may have created a form of self-fulfilling prophecy: pupils believed that discussing strategies for learning would enable them to become more successful learners, therefore they engaged in these discussions more frequently and with a greater determination to develop their own conceptual understanding, thereby developing their understanding. Whilst this is purely a hypothesis based upon my perception of the feelings of my pupils, it certainly fits with the increased percentages of discussions included in pupil views templates throughout Cycle 1, from 18.92% in December 2011 to a peak of 40.46% in March 2012 and 37.08% - almost double the initial percentage - in May 2012.

This question of talk merits further investigation. I feel that, in this study at least, whilst I have recognised that talk is essential to the positive outcomes of the Thinking Skills approach, I have been unable to distinguish between the different kinds of dialogue ongoing in our classroom: which were most prevalent, whether this was subject to a shift throughout research, and whether it is possible to determine which of these different talk types hold most potential for the development of teaching and learning. It was, initially, my intention to investigate the types of talk used by the focus cohort – as well as the adults working with them – more closely, however this was unfortunately beyond the scope of this study. Whilst I set out to record, and then transcribe, the lessons featured in the pupil views templates (one per half term during Cycle 1), I quickly realised this was not practical. Each lesson took several hours to transcribe even before attempting analysis, and I did not have access to equipment which may have allowed me to record, and therefore later compare, different conversations ongoing within our classroom. Nevertheless, I am intrigued to know to what extent – if indeed any – classroom talk developed during the research period.

I would, for example, have been interested in further analysing pupil talk in relation to the dialogical framework proposed by Mercer which identifies three different types of talk or 'social modes of thinking (Wegerif & Mercer, 1997: p. 53) – disputational, cumulative, and exploratory – each of which 'represents a way in which participants in a dialogue can engage in the joint construction of knowledge' (Wegerif & Mercer, 1997: p. 53). Certainly, my impression is that teacher-talk decreased dramatically, making way instead for increased pupil demonstrations and explanations on both a whole-class and group level. Furthermore, there is some evidence, recorded in the conversations included on the pupil views templates, that there was an increase in the number of questions and speculative comments during pupils' interactions, perhaps suggesting an increase in the use of exploratory talk. There was also a decline in the use of evaluative comments such 'This is easy' or 'This is hard', and an increase in the representation of discussions surrounding learning and strategies, rather than simply asking for answers.

I believe this notion of talk links closely to the work of Hattie and Timperley (2007) on the power of different types of feedback, concluding that 'Those studies showing the highest effect sizes involved students receiving information feedback about a task and how to do it more effectively. Lower effect sizes were related to praise, rewards, and punishment' (2007: p. 84). This is precisely the sort of feedback which is used in a Thinking Skills approach: that which relates specifically to learning and to the critique of strategies directly linking to pupils' work. However, I would be extremely interested to find out to what extent talk of this nature is used in a Thinking Classroom - how it develops, to what extent it is used in Teacher-pupil talk, as well as pupil-pupil talk - and whether this can be linked to developments in pupils' motivation, engagement, and self-concept, as well as progress and attainment in my own classroom.

6.3 The 'teacher effect'

There are, of course, further factors which may have also contributed towards these gains. One possible explanation is the small class sizes of the focus cohort. The focus cohort contained just 36 pupils, with classes of just 17 in Class 1, and 19 in Class 2. This was a substantial reduction from the 50 pupils in this same year group during their time in Year 4, after which numerous pupils left West Side School to join middle schools in a neighbouring local authority. The number of pupils in the focus cohort was also smaller than the 44 pupil – 22 per class – in the 2011 – 2012 Year 6 cohort. The impact of smaller class sizes upon attainment is well documented, with an average effect size of 0.12 (Hattie & Timperley, 2007: p. 83). Certainly, my own impressions, having taught children in both of these year groups, is that this reduction in class sizes – although it was relatively small (5 for Class 1 and just 3 for Class 2) resulted in a classroom which felt calmer and less crowded. I felt as though I was able to spend more time with each of the children in the focus cohort, and that, as a result, I had a deeper understanding of the pupils themselves, as well as their learning needs.

I believe that it is also likely – and perhaps rather obvious to those who work closely with children and recognise how inextricably pupil outcomes are linked to their own commitment and determination – that the pupils themselves influenced the results of this investigation. Indeed, Hattie (2003) believes that pupils 'account for about 50% of the variance of achievement. It is what students bring to the table that predicts achievement more than any other variable' (p. 1). This relates to the notion of self-concept, as well as pupils' motivation for learning. This aspect of pupils' experiences of Maths was, of course, an important element of this research, linking to my hypothesis that the introduction of a Thinking Skills approach would encourage pupils to become more actively involved in their learning, thereby increasing not only their understanding of the learning process, but also their progress and attainment. However, I believe that it is also important to acknowledge the potential positive impact resultant from involving pupils in this research as co-researchers, which Kellet (2005) believes may form a 'virtuous circle of increased confidence and raised self esteem resulting in more active participation by children in other aspects affecting their lives' (p. 11). Yet, because I believe this formed an integral part of the creation of the Thinking Classroom, I consider this to be part of the Thinking Skills approach: an indirect consequence of this research.

It is also possible that my own role as both teacher and researcher influenced the outcomes of this investigation. Meta-analysis of interventions in education have shown that the average effect size of having a teacher is 0.42, in contrast to 0.25 for pupils' development without the benefit of any teaching (Hall & Higgins, 2005: p. 1). Whilst these effect sizes sare both lower than the 0.5 which Hattie (2004) considers the minimum for an intervention to be accepted as educationally significant, Hattie nevertheless believes that teachers account for around 30% of the variance in achievement, writing that it 'is what teachers know, do, and care about which is very powerful in this learning equation' (2003: p. 2).

In considering teacher effectiveness, Hattie (2003) specifies several characteristics of what he terms 'expert teachers'. These include the flexibility to bring new interpretations to problems within each individual classroom context as well as the use of feedback to assess and then further develop hypotheses on learning. I believe that, as a result of engaging actively in the research process, many of these characteristics have necessarily been incorporated into my classroom practice. Certainly, Hattie's depiction of teachers of this nature describes professionals who spend a large proportion of their time 'trying to understand the problem to be solved as opposed to trying out different solutions. Experts are more likely to monitor their ongoing solution attempts, checking for accuracy, and updating or elaborating problem representations as new constraints emerge' (p. 6). To my mind, this is a very appropriate description of a teacher-researcher, and it is therefore perhaps reasonable to consider that the very act of undertaking an investigation within my own classroom context may have influenced pupil outcomes.

It is similarly important to consider the likelihood that my own, deeply held convictions regarding the potential benefits of the Thinking Skills approach were conveyed to my pupils during the course of research, together with the possible impact this may have had. Hall and Higgins (2005) reasoned that 'Mere compliance is less likely to engage and enthuse pupils the level of belief and commitment felt by the teacher and (instantly) picked up upon by the children helps us to understand the greater success of 'early adopters' and the low impacts of 'roll-outs' (p. 9). Hall and Higgins term this 'authenticity', and believe that this 'relates to fidelity not only of implementation but also fidelity to context: a reflective understanding of an innovation not as 'A Good Thing' but relevant to the needs of learners in particular places' (2005: p. 9).

Yet, I believe that this still does not reflect the reasons why my position as teacher may have influenced research in its full complexity. I was privileged to teach the focus cohort for two successive academic years, in addition to teaching many of them during their time in Year 2, some two years prior to the beginning of research. We knew each other well and had a strong working relationship, which strengthened and developed further over the two-year research process. Certainly, I felt that, because of the different and more equal nature of the Thinking Classroom the relationship between the pupils and myself was distinct to that I had established with any previous class. However, I believe that it is also important to acknowledge that I feel that this bond was also stronger than any I have succeeded in establishing since working with the focus cohort. This leads me to believe that it was not solely the nature of the Thinking Classroom that affected our relationship and, therefore, research, but that it was likely the unusually long period of time that we worked together – certainly for two and, for many of these pupils, even three – of their seven years in primary school.

Nevertheless, whilst these circumstances may well have impacted upon pupils' experience of Maths learning, I believe it may be reasonably assumed that the Thinking Skills approach at least contributed towards these gains. This is particularly likely when considering that there have been noticeable changes for each of the aspects of teaching and learning which it was hypothesised would be most affected by the introduction of an approach of this nature – supported by the literature relating to this subject. Certainly, this would be my conclusion, as an active participant in the changing classroom that the focus cohort and I succeeded in creating during the two years of this study, as well as, most crucially, the conclusion of the pupils themselves, who, time after time during informal discussions regarding lessons, in comments on their learning in their books, and in their responses on pupil views templates, stated that working in this way enabled them to both feel more confident and to make greater progress in their learning.

6.4 Epistemological shifts during this study

This notion of the impact that my own involvement in this research has had upon its development, and eventual outcome links closely to this idea of the 'teacher effect'. In undertaking this research, I am very conscious that, in addition to anything that I may have discovered about the impact of a Thinking Skills approach upon pupils' experiences of Maths, I have also learned a great deal about my own beliefs as a teacher-researcher. Indeed, I believe that the shift and development in my thinking ultimately became so profound that it constitutes a further, fundamental, aspect of this research, so that it has come to represent, for me, an additional research question which must, of course, be addressed in this final chapter of this thesis. I believe that my learning in relation to this hidden research question can be divided into three principle, interrelated categories:

1. my understandings of how research should be conducted, including the selection of key methods and data collection tools, as well as the involvement of the pupils themselves;

2. the nature of evidence;

3. the purposes for which the outcomes of research should be used.

I will therefore summarise my learning in relation to each of these key areas in an attempt to document the development of my thinking as a result of engaging in this research.

6.4.1 *Implications for research design and process*

At the outset of this research, I believe that, although I, of course, identified myself as a teacher-researcher, I had a very different understanding of what exactly this meant. Quite honestly, I believe that I thought that I would work – as far as possible - as an objective, impartial researcher, albeit within the context of my own classroom. Upon reflection, I believe that this was because my understanding of what it is like to conduct research has been predominantly influenced by the articles and accounts I have read, almost all of which have been exclusively written by external researchers. Indeed, I believe I am yet to come across an account written exclusively by a teacher-researcher (although this may, perhaps, say more about my own reading than about the availability of research of this nature). Yet, over the course of the five-year journey during which this research has been planned, conducted, and recorded, I have come to a very different understanding. Being a teacher-researcher is distinct to being an external, for example university-based, researcher, in terms, not just of the perspective gained upon the research as it progresses – from working 'inside' the research context, as an integral element of this rather than as an external observer – but also of the more varied and competing goals for research, the degree of power and control it is possible to exert over the research design, as well as the relationships it is possible to develop with the pupils themselves.

It is important to note, of course, that this distinct role brings both advantages and disadvantages. Indeed, I think that it is important to clarify that I do not believe that working as a teacher-researcher necessarily produces 'better' research than a university-based researcher, but merely that it is very different, and that my initial attempts to carry out the role of a more distanced researcher were naïve, and revealed a lack of understanding of the different species of research available to draw from in carrying out my own investigation. For example, my position within the research context had a profound influence upon the research design of this study and, indeed, upon my willingness to adapt research according not only to findings as they emerged from the data, but also to best suit my understanding of the needs of the pupils themselves.

This willingness led to a substantial alteration to my original research design, from a fairly straightforward, linear structure, encompassing a single year of research, to a much more messy and complex structure in which the initial findings spawned a second cycle of research, during which further data was gathered to investigate the impact of the Thinking Skills approach upon progress and attainment. In addition, my growing faith and confidence in my own interpretations of the realities of the Thinking Classroom also led me to incorporate embedded case studies into this research in order to further investigate pupils' experiences of teaching and learning as these were recorded using the pupil views templates. In short, I have learned the importance of following my instincts, and, because of my role as a teacher-researcher, working within the research context, I believe that I was in the fortunate position to be able to take greater advantage of these hunches – evident both in my interpretations and in my initial reading of the data – to adapt research in order to more fully explore particular avenues of research as and when they emerged.

In adapting and responding in this manner to findings and areas of interest from this study as they emerged, I believe that this research can once again be seen as related to the notion of practical science, defined by Carr (2007), as it arises from recognition of the nature of education – rather than of research – and, as a result, would 'not seek to improve the rationality of education by infusing practice with knowledge it had itself methodically produced but by enabling practitioners to rationally examine their practice on the basis of their own reflective inquiries' (p. 282). Therefore, rather than seeking to produce knowledge about education, this research seeks to cultivate the ' kind of self-knowledge that enables practitioners to identify the unquestioned assumptions and irrational beliefs sustaining their practice and, by so doing, enables them to evaluate their practice on the basis of a coherent and clearly articulated educational point of view' (Carr, 2007: p. 282).

I also believe that, in the context of this study – which relates to developments in teaching and learning specifically as a result of an increased focus on metacognition, or thinking about thinking - it is particularly relevant to consider the role of the teacher as a metacognitive role model. Throughout this research, I repeatedly stressed to my pupils the importance of evaluating their learning and progress. It is surely unsurprising, then, that I came to ‘practice what I preach’. It became natural for me to openly discuss my own learning – both in terms of essay writing and university-based study, as well as my more practical, context-based learning about the teaching and learning ongoing in our classroom – with my pupils.

Like Wall (2014), I believe it was a ‘natural progression for the community to become not just about the children sharing their experiences and asking questions about their own learning, but about the teachers’ experiences also’ (p. 4), describing both successes and failures and thus creating a more equitable classroom environment in which teacher and pupils can both be seen as learners, albeit it at different points on their life-long learning journey. This shift in thinking was extremely important as, through the establishment of this area of common ground – through the positioning of myself as a fellow learner – the children ultimately became more interested and engaged in the research process. This led to their increased involvement so that the children themselves eventually became co-researchers, a shift which I tried to incorporate into this thesis by adding the embedded case studies so that the perspectives of the pupils themselves became a more integral element of this research, allowing them to express their own views, in their own words.

6.4.2 *The question of evidence*

The extent to which the changes evident in the data can be seen as attributable to a particular change in practice, or even as the natural consequence of my own interest in a particular aspect of teaching and learning relates back to the notion of evidence and even, ultimately, ‘truth’. Many education researchers appear to search for objective truths which can then be ‘translated into rules for action’ so that ‘the only thing practitioners need to do is to follow these rules without any further reflection on or consideration of the concrete situation they are in’ (both Biesta, 2007: p. 11). However, I am well aware that, in addition to the data collected throughout this research, much of what has led me to reach the conclusions outlined in this chapter has been heavily supported by my own understanding of my pupils, their reactions, and the dynamics of the classroom and learning environment we established together. This changing understanding of the nature of evidence was an important element of my professional learning as a teacher-researcher, with my personal beliefs and preferences shifting from a subconscious bias towards quantitative methods towards a more interpretivist, qualitative approach.

This issue, relating to the context-dependent nature of knowledge as well as my developing understanding and acceptance of the ways in which practitioners use the findings generated from educational research, has come to be extraordinarily important to me. Although, at the outset of research, I already acknowledged the uniqueness of educational settings – and even, of each individual class within every single one of these settings – I believe that I nevertheless fell into the trap recognised by Stenhouse (1988), who stresses that 'The variability of educational situations is grossly underestimated' (p. 44). Like Stenhouse (1988), I believe that knowledge is heavily dependent upon its context: I obtained this set of results, with these particular pupils, at this specific time. They have been described here to detail my own conclusions about my individual context, but also so they may be used as a starting point for any other practitioner seeking to create similar – although not identical - results in response to a similar need.

Through engaging in this research, I have come to have increasing confidence – and indeed, ultimately, a passionate belief in the importance of – my own interpretations and instincts as a teacher-researcher. I am the person who is immersed, day-in and day-out, within the classroom; who spends more than thirty hours each week with the pupils; and who is ideally placed to sense nuances in pupils' responses to teaching and learning, nuances which may not be fully captured through more conventional means. In short, I have come to believe that to deny my own interpretations of the classroom amounts almost to the neglect of one of the most potent forms of information about the research context. I now recognise how lucky I have been, in conducting this research, to have been so totally absorbed in it: my position as teacher-researcher has lent me a position and a perspective that would have been inaccessible to an external researcher, and I believe that the research that I have thus been able to detail in this study has, as a result, been richer than would otherwise have been possible. Under these circumstances, and particularly given my beliefs regarding the purposes for which the findings of this research should be used – in that it should be informative rather than educative – I believe that any decrease in objectivity is a small sacrifice to make in return for the insight which my position gave me into the development of the Thinking Classroom that the pupils of the focus cohort and I succeeded in creating together.

I therefore believe it is crucial that the more 'objective' data featured in this investigation is situated alongside the descriptions of our particular context: the perceptions of me, as teacher-researcher, and, fundamentally, my pupils. To some extent, this was always an integral element this research, and is visible in many of my decisions, such as the use of pupil views templates, which allowed children to express their own opinions and experiences, thereby opening up dialogue about teaching and learning. This study could never have been wholly objective or 'scientific', I am too bound up in it: it is extremely personal to me, and something which I feel passionate – and indeed highly emotional – about. Ultimately, this study was never about pupils elsewhere, or even future pupils and my future teaching. This research was always about ensuring the best possible learning experiences for the focus cohort, and arose directly in response to their specific needs, and whilst I will certainly use elements of the Thinking Skills approach investigated here in the future, with other groups of pupils, their needs – and therefore the intervention delivered – will never be replicated exactly, nor would I expect the outcomes be exactly the same.

I also believe that it is important to acknowledge that the choices I made at the outset of research are not necessarily those I would repeat if I were to begin this research again. Whilst I had sound reasons for each of the choices I made with regard to the selection of data collection tools, with the benefit of hindsight, I realise that these may not have been sufficiently nuanced to capture the realities of the Thinking Classroom in all of their complexity. The use of National Curriculum levels, for example, whilst readily available and facilitating comparison with pupils nationwide, nonetheless were designed to chart pupils' progress in a range of mathematical skills, and, as a result, were, perhaps, not best-suited to capturing any development in children's mathematical understanding.

Similarly, I believe that the selection of the S.D.Q. may again reflect my previous subconscious bias towards quantitative methods and data. Upon reflection, I believe that greater insight could have been gained by supplementing this data with further information about the children's feelings in relation to their self-concept in Maths. For example, it would perhaps have been interesting to the children more actively in discussion to more clearly ascertain their understanding of self-concept and even to involve them in designing an alternative strategy for documenting any shift in their self-concept relating to Maths. Indeed, I cannot help but feel that this research would have been greatly enhanced by involving pupils more widely in the selection of the data collection tools used, not only through the development of their understanding of the research aims and processes which I believe would have been the logical consequence of expanding pupils' role as co-researchers, but also in terms of gaining further insight into their perspectives and thought processes. Unfortunately, however, this realisation has come too late for this research, nevertheless I believe that it constitutes an important element of my professional learning as a teacher-researcher. I am extremely intrigued by its potential, and hope that I may be able to explore this further in future.

6.4.3 *How research should be used*

It is also important to recognise that my developing understanding about my own reasons for conducting this research – particularly the audience for which it is intended and what I perceive to be the purpose of any 'evidence' resulting from it – have strongly influenced what I now consider to be 'truth' and 'evidence'. This has principally come about through my own increasing familiarity with literature and the findings of other educational research and then, crucially, how I have used this to develop my own practice. In the 'Research Design and Methods' chapter of this thesis, I referred to Biesta's view that 'we do not use 'old' knowledge to tell us what we should do; we use 'old' knowledge to guide us first in our attempts to understand what the problem might be and then in the intelligent selection of possible lines of action' (2007: p. 16). I immediately recognised the wisdom of this, and the resonance with my own beliefs about the purpose and focus of educational research; my responsibilities as a teacher; as well as my understanding of the nature of continuing professional development and how this should be achieved.

Yet, I believe that I had still somewhat missed the point. Whilst accepting that I would only ever consider previous research to be informative, using it as a starting point - one which would need to be adapted, tested and evaluated in response to the needs of my own pupils, within my own classroom – for my own experimentations, I did not truly question the types of evidence which I would find most useful. I believe that I still thought that ‘evidence’ would come in quantifiable measures: sub-levels of progress, improved test scores, and increased attainment. What I did not recognise was something that I have long done – along, I believe, with the vast majority of my colleagues in the education profession – that I regularly accept the anecdotes of my teacher friends, my colleagues in the staff room or during staff meetings, or even feedback from fellow teachers in periodicals such as the Times Educational Supplement (T.E.S.) and use these, too, to explore ways of developing teaching and learning within my classroom. And all this without demanding to investigate the progress and attainment data for the pupils in the care of these other professionals! My gradual acceptance of this, led to perhaps the most obvious departure from my initial research plan: the inclusion of the case-studies of Grace and Harry. However, it has also profoundly influenced my beliefs surrounding my obligations as a teacher-researcher, freeing me from any sense that I must seek to persuade readers that the research outlined in this study is ‘right’ and that they must therefore attempt to emulate it, but rather allowing me simply to accept that my ‘only obligation and right, in this context, is to seek to correct any misrepresentation of the knowledge supplied’ (Hammersley, 2003: p. 18).

This position has also strongly influenced my understanding of where I, personally, will go from here; what I will do with the knowledge I feel I have gained from undertaking this study. What I will most take away from this research, is not the statistics relating to the increased proportions of children making two or more sub-levels of progress, or even my understanding of the pupils’ changing language, evident in their pupil views templates, in their discussions about the learning. Rather, what will stay with me are my recollections of the pupils’ responses and reactions to the Thinking Classroom that we created together, as well as my bone-deep sense of the fundamental nature of involving pupils in collaboration, classroom talk, and discussions around thinking and learning. For me, these are the essential ingredients of a Thinking Skills approach, and aspects of teaching and learning which I have long believed are essential to instilling the skills and motivation necessary to inspire pupils to become effective learners. However, the accompanying discussions about my own learning, and the dawning recognition I believe that resulted in my pupils really understanding that learning is not just something which takes place in schools, between the hours of 9am and 3:30pm, were also crucial. Developing a sense of community in us all - adults and children - as learners had a profound effect on classroom dynamics and attitude, and is certainly an atmosphere which I will seek to recreate, develop and enhance throughout the remainder of my teaching career.

6.5 Avenues for further exploration

A great number of questions have arisen in the course of this research which merit further investigation. Not least amongst these is the notion of taking the findings from this research forward and exploring how the effects of the Thinking Skills approach used in this study can be used to develop the learning experience of future pupils, not just in Maths, but also expanding into other curriculum areas. This issue of transference has truly highlighted to me the wisdom of Stenhouse's observation that 'The variability of educational situations is grossly underestimated' (1988: p. 44). Indeed, I have found that even I – who am, of course, intimately acquainted with each and every detail of the research carried out in the course of this study – have encountered issues in using these methods again even within the same school, with a similar cohort of pupils. Not least of these is the dependence of this knowledge, the knowledge described in this thesis, upon its context. Whilst I deeply value the Thinking Skills approach and have a profound belief in its advantages, the needs of each successive cohort is different, and requires an approach tailor-made to suit its own individual circumstances. Whilst I strongly believe that this will include a Thinking Skills approach – involving collaboration, talk and reflection upon thinking and learning – it will never be exactly the same as the intervention delivered to the focus cohort detailed here.

I am also extremely interested in investigating the impact of longer term use of a Thinking Skills approach. In Boaler and Staples' (2008) research at Railside School, for example, it was only after the second year of research that the impact of the Thinking Skills approach upon attainment became evident, suggesting that gains made by the focus cohort may have continued to develop and gain strength if research had been extended into a third year. Contrastingly, however, there is a risk, identified by Hall and Higgins (2005), that

‘Innovations effects wear off fast […] this may be because of automation by the teacher and the less targeted nature of each repetition, the changes in each cohort of students which could lead to greater divergence over time or simple boredom’ (p. 10). I was extremely fortunate in being able to work with the focus cohort for two successive academic years, however I am well aware that this is not the norm and that, therefore, in order to investigate the extent to which long term use of a Thinking Skills approach may influence pupils’ learning, it must be embedded across the school, ensuring continuity of approach and the establishment of a school-wide culture for Thinking Skills, rather than simply in isolated classrooms.

Correspondingly, I am intrigued about the potential advantages of introducing a Thinking Skills approach in Maths lessons at a much younger age, particularly with relation to pupils’ self-concept in Maths. This is primarily because I wonder whether by the age of 10, when pupils begin Year 5, pupils’ views are already largely entrenched. Certainly, Demo (1992) believes that by age 5 or 6, pupils ‘regularly judge their positive and negative qualities and possess a fairly coherent, hierarchically organized, core or “baseline” self-concept’ (p. 309). Pupils’ ability to compare their own performance and abilities with those of others continues to develops through the ages of 7 or 8, at which stage ‘self-evaluations and self-attributions of autonomous, efficacious activity, and experiences facilitating the sense of self as an active, causal agent in one’s environment, are the most important processes for children’s developing self-theories’ (p. 310) until later in childhood, by ages 9 to 11, pupils have ‘advanced inductive reasoning and improved classification abilities’ which ‘generate reorganized ways of thinking and refined abilities to compare one’s own performances with those of children who are similar on evaluated dimensions’ (both Demo, 1992: p. 310).

Taking this into account, it is probable that, by Year 5, pupils have been self-evaluating and developing their self-concept relating to Maths for several years and it is reasonable, therefore, to expect that any major shift may take a correspondingly lengthy period to develop. Furthermore, it is possible that the influence of external factors – discussions at home or evident in society more widely – may impact upon pupils’ perceptions. It is, for example, relatively commonplace to hear parents casually share their reassurances that they do not expect their children to do well in Maths because they themselves hated it, or 'were useless at it' than it would ever be for Reading or Writing and I believe it is therefore reasonable to assume that failure in Maths is somehow more acceptable than in other curriculum areas. What would be the impact of introducing a Thinking Skills approach at a younger age? Would a longer exposure to this form of working be necessary to challenge and to overcome this bias? Or would a wider change in the perceptions of our society at large be needed for this?

My fascination with the questions raised around self-concept in Maths are strengthened by the data, examined earlier in this chapter, from the eight children who recorded an increase of more than 0.4 in their mean responses relating to their self-concept relating to Maths. This increase in self-concept did not appear to correspond directly to an improvement in progress or attainment. Given the link between self-concept and achievement evident in the work of McCoach and Siegle (2003), Butler-Por (1993), and McLeod & Cropley (1989), among many others, I believe this raises questions about whether the data relating to these eight pupils could therefore suggest that feeling confident and successful on a day-to-day basis, in the course of our daily Maths lessons, was more influential to pupils' self-concept than was their level of attainment or performance in tests. This is purely a hypothesis however I believe that it merits further investigation.

Finally, I am interested in further exploring the question of talk; specifically the types of talk which hold most potential for raising levels of pupils' self-concept, levels of engagement and attainment. As I have outlined above, I believe that this links closely to the work of Hattie and Timperley (2007) on the power of feedback, with 'Those studies showing the highest effect sizes involved students receiving information feedback about a task and how to do it more effectively' (p. 84). I believe that this is precisely the kind of talk which a Thinking Skills approach aims to develop, and I would therefore like to further investigate the talk ongoing in my classroom in order to ascertain to what extent talk of this nature is used both by me, as teacher-researcher, as well as my Learning Support Assistant, and, crucially, by the pupils, as well as how this develops in response to the prolonged use of a Thinking Skills approach, and whether it can be linked to increased self-concept, engagement and pupils' levels of progress and attainment.

6.6 Conclusions

Having considered all of the information gathered in the course of this research – including, crucially, that obtained from my own impressions as teacher-researcher, as well as from the three different data collection tools employed here – I find that my belief in the efficacy of a Thinking Skills approach is confirmed. I believe that the data relating to progress and attainment, self-concept, and metacognition – my children's active engagement with their learning, or their thinking about thinking – demonstrates the positive impact of the approach. This has, perhaps, not been as marked as I would have liked, or indeed, as I expected at the outset of research, however I believe that it is evident nonetheless. Much more than this, however, and more important to me, as a teacher, than any of the individual data forms that I have employed to try to capture and record the different aspects of my pupils' experiences of Maths, is the indescribable – and certainly unmeasurable – sense that this was, for my pupils, a positive learning experience.

This was something I could *feel* over the two years during which this research was carried out. From the stunned silence following the introduction of a task when I instructed my pupils simply "Off you go" to the times during Cycle 2 when they would regularly shout 'Challenge' at me because I had - usually unintentionally - made a mistake, or when they would tell me that they had a different, or sometimes even a 'better' way to solve a given problem, the research period contained a marked shift in our relationship so that, ultimately, I honestly felt that 'learning' was not something I was trying to 'do' to them, but was a pathway that we were exploring together, and that I had succeeded in escaping Holt's incredibly negative picture of education with pupils as

> 'convicts in a chain gang, forced under threat of punishment to move along a rough path leading nobody knew where and down which they could see hardly more than a few steps ahead. School feels like this to children: it is a place where they make you go and where they tell you to do things and where they try to make your life unpleasant if you don't do them or don't do them right' (1964: pp. 37 – 38).

My ideas surrounding just what constitutes a Thinking Skills approach have also been subject to a gradual shift since this research was begun. Whilst I have never considered Thinking Skills to be something which can be 'done' simply by completing a relevant activity, I must admit that if I encouraged my pupils to 'plan, describe and evaluate their thinking and learning' (Higgins *et al*, 2005: p. 1) then I would succeed in helping them to develop their skills in thinking, as well as their thinking about thinking. However, having worked with the focus cohort for two years, I see that our attempts to create a Thinking Classroom went far beyond simple debriefs about specific lessons and methods. Whilst I still believe it is true that, to be successful, a Thinking Skills approach must involve each of the essential characteristics identified during the review of the literature - a supportive classroom environment, the active participation of the pupils, the teacher acting as a facilitator rather than instructor, opportunities for collaboration and pupil talk, open tasks, and review of the strategies used to complete these – something still more is wanting.

For me, these elements may well provide the substance of a Thinking Skills approach, yet I have come to believe that they do not completely capture its spirit. A Thinking Skills approach has become, for me, synonymous with my beliefs on how education, in general, should be. Like a thread, this is woven throughout each and every aspect of education, colouring my views on:

- how learning should take place (with collaborative groups made up of pupils with different skills and experiences working together to solve challenging problems);

- what skills it should encompass and how these should be developed (focusing upon the development of pupils' independence and creativity, their ability to ask their own questions and make predictions, reflecting upon their learning to develop metacognition);

- the goals and values that we – both myself and my pupils – should value (adopting what Dweck (1986) terms a mastery-orientated mind-set, focusing on learning and progress, instead of a goal-orientated mind-set, prioritizing measurable outcomes in terms of test scores and the numbers of ticks on a page);

- the language used in classroom interactions (with a focus on open questions, the explanation of reasoning, and a more equal balance of teacher and pupil talk);

- and what a classroom – including, crucially, the relationship and power dynamics between teacher and pupils – should feel like (a community of enquirers where, as for Wegerif (2010), 'the right answer to every big questions is: 'I don't know, let's investigate it together' (p. 2).)

In short, Thinking Skills has become my philosophy for education. As a result, moving forwards from this study I know that the Thinking Skills approach will continue to colour my own interpretations, values, and priorities within my classroom. However, when reflecting upon the outcomes of this study, it is also necessary to think more precisely about the specific questions and issues identified by this research in order to further consider how my own personal practice will be more explicitly affected. For example: will it be possible to gain similar results? How can I use this research to further develop and enhance teaching and learning in my own classroom? What outcomes can I then reasonably expect to gain for my pupils?

6.6.1 *What next?*

In the course of this thesis, I have argued that each classroom is unique, and that research should therefore take the form of case-studies, detailing the consequences of particular actions in a specific context. Nevertheless, once generated, how should this research be used? Pring maintains, 'uniqueness in one respect does not entail uniqueness in every respect' (2000: p. 258). Therefore, although pupils and classrooms are undoubtedly different, there will be similarities which may enable the application of aspects of knowledge to a new context. Biesta explains that 'What ''old'' knowledge does, in other words, is help us approach problem solving more intelligently. Yet, the proof of the pudding always lies in the action that follows' (2007: p. 16). I believe that this is key: it is what we do with the knowledge we have gained that counts. This research thus should be considered informative, rather than educative: it aims to provide a starting point, a place from which I can build upon what I have learned in order to further develop the teaching and learning ongoing within my own classroom. However, here I believe that it is important for me to admit that, in this quest, I have already hit a snag. I have taught two classes since the focus cohort – one Year 4 class at West Side School, and one Year 6 class within a new working context.

In teaching the Year 4 class, I believe that we were able to create a Thinking Classroom akin to that which the focus cohort and I created together. During this year, I became aware, once again, of the significant advantages of being able to teach a class for two successive years: whilst this Year 4 class and I were able to make headway into developing effective collaboration, and metacognition through pupils' active consideration of their learning, by the end of the academic year, the habits of reflection, challenge, and questioning were - quite logically - not as well established as they had been with the focus cohort after two years, and I believe it to be quite possible that, if confronted with a different teaching and learning style in their next year of primary school, many children would forget much of what we had discussed together.

The next academic year brought a more formidable change. In September 2014 I took up a new role, in a new school, within a different local authority. This move, my first since qualifying as a teacher in 2007, has emphasized the uniqueness of each individual school. This school is designated as 'Outstanding' by Ofsted and deservedly so. My new school has its own policies and expectations; a clear framework within which teachers and pupils are expected to work. My new colleagues are exceptionally hard-working, eager to embrace innovation, and provide an incredibly high standard of teaching and learning for the pupils in their care. Yet, because of the new Ofsted focus upon progress over time, it has been deemed necessary to impose a rather rigid structure.

A potent example of this is the expectation that pupils must record in their individual exercise books on a daily basis, as opposed to the thrice-weekly expectation at West Side School. Whilst, on the surface, this may appear to be a simple change, it has had several repercussions for reproducing the ways of working used in this research. For example, I found that one of the most effective means of encouraging pupils to collaborate effectively was to provide a single pen, forcefully encouraging them to work together. I also allowed pupils to record their group work on paper, rather than in exercise books, as I found that this allowed them to focus on their working, and to experiment less hesitantly with different methods, as well as to repeat and make corrections more freely, without fear of restrictions or concerns regarding the presentation of their work. I therefore feel that the expectation of daily recording at my new school is hampering the development of collaboration between my current class, which in turn restricts the talk which I believe is essential to the development of shared understanding, and improvements in the articulation of pupils' explanations and reasoning.

Like the teacher described by McGregor and Gunter (2006), I am forced to conclude that the expectation 'of pupils having to write everything to be learned was constraining' and even that 'writing limits thinking' (both McGregor & Gunter, 2006: p. 42), or, that, as Holt (1964) explains 'When you have acres of paper to fill up with pencil marks, you have no time to waste on the luxury of thinking' (p. 277). Yet this is, now, precisely what I must do. I have tried, of course, to find some happy way of combining my own understanding of the conditions most conducive to learning with the realities of my current working context – recording work using photographs, photocopied examples of work, and the pupils' own descriptions of their thinking and reasoning – however I am yet to stumble upon any form which I feel allows my pupils to discuss their learning to the extent that we did at West Side School. This, therefore, remains a priority for me in terms of adapting and developing my immediate practice, and ultimately the teaching and learning ongoing in my current classroom. Instead, regular scrutiny of pupils' books keeps us all focused upon the quality – as well as the all-important presentation – of work in pupils' books. The pupils are rightly proud of the work that their books contain, but this means that we are all less willing to experiment lest we make a mess of the pristine records of their 'learning'.

Perhaps most depressingly of all, working in Year 6, as I now do, I am embroiled in the necessity of preparing my children for S.A.T.s. I teach them the skills of sitting tests and of working independently. I talk to them constantly about levels and sub-levels and, although I try to emphasise the importance of progress at their own level of attainment, within a culture of seemingly endless repetition of tests and practice tests, it is surely inevitable that they should come to prize performance goals, rather than the mastery-orientated mind-set which I believe most conducive to real learning. It is, perhaps, surprising that I find this position markedly different from my work with the focus cohort, the second year of which, after all, also took place in Year 6, under this same system of S.A.T.s and of preparation for them. However, I believe that an important difference can be found in the fact that, with the focus cohort, the intense period of preparation for S.A.T.s began in February 2013, and thus lasted for around 3 and a half months of the two year research period. At this point, I had already taught the focus year group for one full academic year, and for four months of Year 6, and therefore our mode of working – the Thinking Classroom and, most crucially, the focus upon learning rather than performance – was relatively well established. In contrast, at the time of writing, I have taught my current Year 6 class for seven months. In this new working context, the intense preparation period for S.A.T.s has also begun somewhat earlier – in January – therefore constituting three of these seven months, or almost 43% of my time with this particular class.

Unfortunately, I believe that this period of preparation for S.A.T.s is unescapable, regardless of a teacher's (and of course pupils') specific context. I recently read a short piece by Michael Rosen, former Children's Laureate, entitled 'Guide to Education' which perfectly encapsulates the narrow rigidity of being 'right' in our current education system. Rosen gives the following example: 'The apples are growing on the tree. What is growing on the tree? If you say, 'leaves', you are wrong. It's no use you thinking that when apples are on a tree there are usually leaves on the tree too. There is only one answer. And that is 'apples'. All other answers are wrong' (2015). I very much agree with this sentiment: in the course of this research I have read about the benefits of giving children many different ways of being successful, I have investigated this in my own classroom, and I believe – emphatically – that it is true: that it is beneficial both for pupils' self-concept, their academic attainment, and, perhaps most crucially, for their skills of creativity and resilience in problem solving. Yet, I am not permitted to follow this belief. The current education system which is the day to day reality both for me, as a teacher, and - disappointingly, heart-sinkingly - for my pupils requires me to instil in my pupils that the answer is ''apples', not 'leaves'' (Rosen, 2015).

This should not in any way be read as a criticism of the incredibly dedicated teachers and education professionals of either West Side School, or my current working context. Without exception, they are passionate about ensuring that they deliver the best possible education experience for the children in their care, and work extremely hard in their attempts to achieve this aim. The initiatives mentioned above – the daily recording and preparations for S.A.T.s – are merely the means that these schools – and, I am sure, many, many like them - try to ensure the best possible outcomes for their pupils. Instead, this is a criticism of how our success is judged, the measures of attainment both of our pupils and of the standards of education in schools, and the resulting implications for schools, implications which I believe are all too often to the detriment of learning.

Nevertheless, although I have encountered difficulties in my attempts to make use of the learning resultant from this study, this does not alter the fact that it has fulfilled its purpose in terms of being informative. Although I have been unable to recreate the Thinking Classroom depicted here, there have, nevertheless, been elements of practice which I have been able to implement: the use of collaborative Maths teams, the emphasis upon talk and explanation, and even the use of pupil views templates to gain insight into my pupils' thinking. I will, of course, continue to seek ways of marrying my own beliefs regarding what is best for the pupils in my care with the day-to-day realities of our current education system, however, I must admit that I am yet to find a ready solution. Still, my own understanding of teaching and learning relating to Maths has developed as a consequence of engaging in this research and, regardless of the limitations of any working context that I may experience from now on in my career, my learning remains with me: an integral part of me as both a teacher and a researcher.

6.6.2 *A capacity for change?*

Having worked on producing this study now for upwards of five years, I feel a certain sense of finality now that the writing of it has come to a close. I am positive that this investigation has made me a better teacher – better informed, more reflective, and more confident to experiment and to explore. Nevertheless, I feel that the future of this research is confined to the four walls of my own classroom and, perhaps, by extension, that of my year group partner with whom I share planning and the occasional discussion on pedagogy, in a very localised manner, about how best to deliver the content of a specific lesson. Beyond that, I fear it is destined to be confined to a shelf in some dusty corner of a library. Indeed, I wonder whether it would not be fair to comment that conversations more broadly involving pedagogy are surprisingly rare, at least in the two schools I have worked in during my eight years in the teaching profession. In this respect, at least, I fear that we have moved on little from Dewey's assertion – made more than 85 years ago, that one of the 'saddest things about […] education is that … the successes of [excellent teachers] tend to be born and die with them' (1929, p. 10, cited by Hiebert *et al*, 2002: pp. 11 – 12).

That is not to say that teachers are not interested in developing practice – of course we are – but time to interact with other teachers is limited due to the constraints of planning and marking which take up so many hours outside of the 9am – 3:30pm school day. With so much to accomplish, the concrete tasks that we are bound to complete take precedence over the 'luxury' of debates and discussions regarding how to improve teaching and learning. This is perhaps all the more surprising because both West Side School and my current working context have a strong belief in the benefits of sharing expertise, as well as in the experimentation and exploration of how to improve practice, and have provided opportunities for teachers to work together to develop their practice through mutual observations and discussions. Yet these happen infrequently – at most once each term – and, on these occasions, we work to try to solve small problems in our day to day teaching. Opportunities to learn about new approaches to pedagogy are rare, usually occurring only on perhaps one training day per year and yet, even at these points, mention of research evidence is noticeably absent, although, of course, I assume that these initiatives have enjoyed previous success in order for them to be considered worthwhile, and therefore have presumably have been subject to some research – whether formal or informal.

I have met with remarkable lack of interest, and occasionally incredulity, at my own inclination to persevere with research. Although the head teachers I have worked under have necessarily been aware, in very general terms, of my research, at no point have any questions been asked, or interest shown, in the findings of this research and how these could be used to develop teaching and learning more widely within school. Whilst I hope that I am not so arrogant as to suggest that my research is more important than that produced by countless other researchers in schools and universities across the world, I am surprised that this research, conducted in a working context that we share, and relating to the education of pupils that we all know extremely well and care for profoundly, has not inspired at least a passing interest, enough to spark even one or two brief inquiries or discussions. Does this suggest a lack of faith in the research that I, a lowly teacher rather than a lofty academic working in a university have produced, or does it suggest, perhaps more worryingly, that there is a sense that educational research is not immediately relevant to the realities of the classroom.

My personal opinion is that there is the sense of a gulf between the world of schools and the world of education research. To illustrate: I asked the 20 teachers at West Side School whether they consulted research articles to support their own practice. Of the 19 teachers who responded, the overwhelming majority – 78.95% - responded that they did not[33]. Of course, this is a very limited snapshot, however I believe that this statistic nevertheless suggests that, regardless of how research is conducted, who it is conducted by, and for whom, much of it fails to reach teachers. Hiebert *et al* believe that 'Teachers rarely draw from a shared knowledge base to improve their practice' (2002: p. 3), however I disagree: 94.74% of the teachers considered above responded that they regularly used resources[34] aimed at sharing ideas between teachers. I believe, instead, that the problem lies in the form that research is produced and disseminated, as well as in, what Gunter *et al* (2001) describe as 'an anti-intellectual culture in education which is positioning researchers and theorists as exotic and irrelevant' (p. 27).

Hierbert *et al* (2002) propose a number of possibilities for facilitating the dissemination of research including the generation of case literature in which teachers could read case-studies of teaching approaches used in different contexts; the use of video to provide 'concrete examples of instructional practices that avoid much of the ambiguity of written descriptions' (p. 8); or the creation of 'digital libraries linking video examples of teaching,

[33] This information was obtained through an informal survey of the 20 practitioners working in West Side School. Responses can be found in Appendix C.
[34] Examples cited included the 'Times Educational Supplement', union magazines, and the 'Primary Resources' website.

images of students' work, and commentary by teachers and researchers, all integrated around shared topics' (p. 8). However, whilst some aspects of this vision have already come to pass – for example there are numerous websites dedicated to the sharing of ideas and many of these, as we have seen above, appear to be well-used - this still requires teachers to obtain and read the research generated. It is too similar to our current system and, therefore, constitutes a large change in teaching culture, requiring commitment – and, crucially, motivation and a sense of purpose - from teachers over an extended period of time in order to become successfully embedded.

Instead, I cannot help but feel that this sense of the distance between the findings of educational research and the realities of our classrooms is perhaps well justified. As I have outlined above, I often feel an enormous sense of frustration because I feel that the realities of our current education system require me to act in a way which I do not believe best serves my pupils' education. In this view, I am by no means alone. Gunter *et al* (2001), for example, argue that 'Creative pedagogy, through which teachers have the capacity to exercise professional courage over learning processes and needs, is being reworked into target setting and auditing and so by its very nature can only pay lip service to educational values' (p. 26).

Similarly, Williams and Wegerif (2006), complain that

> 'It is one thing for the government to exhort teachers to teach for thinking and to offer principles to guide them, it is quite another to change the way that teaching is done. It may be, for example, that teachers use recommended strategies and tasks without really being clear about what they should be working towards […] Sometimes, too, teachers feel discouraged when new initiatives are introduced in an educational culture which is, in general, coercive' (p. 81).

For me there is a great discrepancy – perhaps more akin to a gaping chasm – between the rhetoric of politicians and the reality of our schools, or at least, the reality as I have experienced it in West Side School and in my current working context. Whilst politicians argue that ‘Freedom for schools works’ (Cameron, 2011), they have simultaneously increased and tightened strategies for monitoring and assessing schools, forcing them to work within ever more rigid parameters. For myself at least, I feel that, until we have a system which trusts teachers and schools, thereby allowing them more freedom to prioritise learning over accountability, I fear that real change is likely to be difficult and slow to achieve.

6.6.3 *Practitioner research – a worthwhile venture?*

Despite all, I cannot – or perhaps, at least, will not – conclude that engaging in this research has been futile. It has not. Instead, it has been truly transformative both in terms of my classroom practice and - perhaps even more crucially - in terms of my beliefs about education. Undoubtedly, there have been two types of learning resultant from this study: one about the pupils of the focus cohort – their experiences of Maths and how these were influenced by a Thinking Skills approach. However, there has also been the learning about myself – about pedagogy and about my beliefs as both a teacher and teacher-researcher - that I perhaps did not expect – or at least underestimated – even up until the point when I began to write this final chapter. Yes, I have learned about my beloved pupils in the focus cohort. During this research I gained incredibly precious insights into their understanding of Maths, their thought processes and their determination to develop and improve as learners. However, these pupils have now gone. At the time of writing, they are at the end of their time in Year 8, and are – I have no doubt – continuing to think and question and develop as learners on the next stage of their educational journey.

What remains is my learning about myself. Whilst this may sound – and probably is – inherently selfish, I have already acknowledged that I believe this research is probably confined to me. What, then, was its value? Why was it worth spending every single school holiday for more than five years thinking and researching and writing? I believe that this research is distinct to that existing elsewhere in the literature for several different reasons. The most obvious of these is that this is the story of a unique case, telling the tale of the specific impact of the Thinking Skills approach featured in this investigation, implemented by me, as teacher-researcher, upon the 36 pupils in the focus cohort. Further to this, however, this research has employed several data collection tools – encompassing both quantitative and qualitative forms of data – in an attempt to more fully document the richness of pupils' experiences of Maths and how these are influenced by the introduction of a Thinking Skills approach than has perhaps been possible elsewhere. This is not to suggest that this research is in anyway superior, but rather that, because of my position as teacher-researcher, it is told from a different perspective, one situated from within the context which is the subject of research. Whilst this has, of course, had profound implications for the objectivity of this study, I believe that the addition of this distinct perspective is useful simply because it is 'other', providing an alternative to existing viewpoints, thereby helping to provide 'multiple ways of seeing and hearing, multiple ways of making sense of the social world, and multiple standpoints on what is important and to be valued and cherished' (Greene, 2008: p. 20).

The very process of engaging in this research has helped me in so many ways. Unquestionably, engaging in research became a form of continuing professional development. Through engaging with the literature, I developed my understanding of issues pertaining to the teaching and learning of Maths: potential pitfalls and strategies which may alleviate these. Through the constant reflection necessary for practitioner research, I also spent more time considering the Maths curriculum and how to teach this, improving my subject knowledge. In this way, I succeeded in overcoming the fear I felt when confronted with the prospect of delivering the Upper Key Stage Two Maths curriculum, developing confidence not only in my understanding of the curriculum, but also in terms of giving myself permission not to know the answers, but to say to my pupils, like Wegerif (2010), 'I don't know, let's investigate it together' (p. 2).

There is absolutely no doubt in my mind that this research made me a better teacher, not just of Maths, but in general. In May 2012, an Ofsted inspector judged my Maths lesson to be 'Outstanding', as did my head teacher in the course of several observations as part of our Performance Management cycles. From someone who, since becoming a teacher, has felt that Maths was an area for development, I also became Maths Subject Leader in September 2013, a role which was particularly crucial as this year saw the introduction of a new National Curriculum, with profound repercussions for teaching and learning. However, more than this - than these external validations - I could *feel* that I was better able to meet the needs of my pupils, and could tell during lessons – that intangible moment when you can almost see the 'light-bulb moment' as pupils grasp a particular concept - that I was more proficient in supporting them to develop mathematical understanding. Although I am unquestionably struggling to implement my learning from this research in my current working context, this does not render this knowledge useless. This learning remains with me – irrespective of context and current working conditions - and I hope this simply means that I have a better understanding about pedagogy and how children learn, which will better equip me to teach within the realities of our imperfect education system.

More than this, this research has given me the encouragement and the confidence to come to terms with my beliefs about education, and I have been almost surprised by the strength and passion with which I have embraced these views. These encompass not just my beliefs about pedagogy, but also more philosophical concerns surrounding the nature of evidence, the purposes of research, and even the very reasons behind the educational practices ongoing within my classroom. Ultimately, regardless of whether or not I succeed in building upon the findings of this study by continuing to develop teaching and learning through use of a Thinking Skills approach, this research has enabled me to better understand myself both as a teacher and as a teacher-researcher, and I believe that this learning is capable of transcending contexts, and thus perhaps constitutes the most immediately useful outcome of this study.

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Appendices

Appendix A. Examples of planning

	Introduction Can be oral/mental	**Objective(s)** And **Main teaching input including vocab and resources**	**Main Activity** Including any differentiation	**Plenary/Mid pleanaries**	**Assessment for learning**
Wednesday	Mark final 10 questions from Mental Maths paper A. **Objective:** Identify, visualise and describe properties of rectangles, triangles, regular polygons and 3-D solids; use knowledge of properties to draw 2-D shapes and identify and draw nets of 3-D shapes **Activity:** Testbase questions about nets. T. to take notes for APP evidence.	**Resources:** Testbase questions for starter, rulers, protractors, next step challenge questions on paper for children to stick in their books if appropriate. **Key vocab:** vocab for 2D shapes - trapezium, parallelogram, scalene, isosceles, regular, irregular, etc. **Main Objective:** Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false Identify, visualise and describe properties of rectangles, triangles, regular polygons and 3-D solids; use knowledge of properties to draw 2-D shapes and identify and draw nets of 3-D shapes **Main Teaching Input:** Recap rules for drawing different shapes (draw a line of a set length, measured with ruler. Then measure the correct angle using the protractor. Draw the next line – measuring the length carefully. Repeat until the shape is complete). Class 12: ask Erin to model this as she has worked particularly effectively this week. Children to share any difficulties they have experienced, as well as strategies for overcoming these.	**H.A. and M.A.** Children to review their work from the past 2 days and to draw a trapezium and isosceles/scalene triangle, labeling their properties. **Next step challenge:** Can you draw a trapezium with a perimeter of 12cm? (Children should write a sentence to demonstrate their understanding of the properties of a trapezium – area for development from yesterday!) **L.A. and S.E.N.** Children work in a group supported by the teacher to address misconceptions from previous 2 days teaching and make any necessary corrections. **Next step challenge:** Discuss true or false statements as a group, referring to the properties of the shapes as evidence to support their answers: • All quadrilaterals have parallel sides. • All triangles have a right angle. • All quadrilaterals are regular. (Assessment opportunity: do L3 children understand this term?) • All 2D shapes have angles that total 180 degrees. Children did not get onto this activity today – use tomorrow for main activity. **JF to work 1-1 with SW** Identify and describe the properties of basic 2D shapes (triangle, square, rectangle, circle, pentagon).	Discuss: Tell me some facts about rectangles. What is the same about a square and a rectangle? What might be different? Is it possible for a quadrilateral to have exactly three right angles? Why not?	**APP:** **L4:** recognise and name most quadrilaterals, e.g. trapezium, parallelogram, rhombus **L3:** identify the shapes which have all edges the same length and all angles the same size from a set of mixed shapes and begin to understand the terms 'regular' and 'irregular' **Lesson Review:** 12: children worked well. Improved knowledge of the properties of these shapes, particularly the trapezium. Some children still need to practice using a protractor as they are not careful enough when lining this up, however all understand the principle of using a protractor to measure angles.

Thursday	**MO Objective:** Identify, visualise and <u>describe properties</u> of rectangles, triangles, regular polygons and 3-D solids; use knowledge of properties to draw 2-D shapes and identify and draw nets of 3-D shapes <u>use mathematical terms such as horizontal, vertical, congruent</u> (same size, same shape) (L4 APP) <u>understand 'parallel' and begin to understand 'perpendicular' in relation to edges or faces</u> (L5 APP) **Activity:** Give children on each table slips of paper with different vocab for shapes. Parallel Perpendicular Congruent Horizontal Vertical Children to work with their tables to discuss the definitions. Children to identify places in the classroom we could place this word. Children to review and challenge if appropriate. Tell the children that I will be listening for them to use these terms if it is appropriate in their learning today.	**Resources:** A3 sheets with different quadrilaterals, statements, properties resource sheets, smart notebook screens. **Key vocab:** parallel, perpendicular, congruent, horizontal, vertical, rhombus, trapezium, rectangle, right angle, angle, square, parallelogram. **Main Objective:** <u>Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false</u> **Main Teaching Input:** In books children write 'I have been learning to'. Tell the children that we will complete this at the end of the lesson. Display 'true or false'. Discuss: what types of questions can you expect today? Discuss success criteria together: focus on the importance of the use of examples to support answers and referring to the properties of shapes in explanations. Give an example of a statement. Work through this together. Model writing an effective explanation. Give children the opportunity to edit and improve as appropriate.	<u>**H.A. and M.A. (L4 children)**</u> FOCUS ON QUADRILATERALS – GAP IDENTIFIED DURING TUESDAY'S TEACHING. Display a selection of quadrilaterals. Children to talk to a talk partner: what are the names of these quadrilaterals? How do they know? Children look at the definitions of the different quadrilaterals and label the shapes <u>**all**</u> the appropriate shapes on their sheets which match these definitions. Discuss: what do children notice? **Children must realize that some shapes have more than one mathematical name).** T. to provide mini-plenaries as appropriate. <u>**Next step challenge:**</u> Children work through statements. Are these true or false? • All quadrilaterals are rectangles. (F) • Every quadrilateral which has parallel sides is a trapezium. (F) • All quadrilaterals with four equal angles are rectangles. (T) <u>**L.A. and S.E.N.**</u> Discuss true or false statements as a group, referring to the properties of the shapes as evidence to support their answers: • All quadrilaterals have parallel sides. (F) • All triangles have a right angle. (F) • All quadrilaterals are regular. (Assessment opportunity: do L3 children understand this term?) (F) • All 2D shapes have angles that total 180 degrees. (F) <u>**JF to work 1-1 with SW**</u> Properties of shape game. "I can feel a shape, it has 4 corners. What could it be?" etc (triangle, square, rectangle, circle, pentagon). SW to record notes on Jack's progress.	I have been learning to… Discuss: what have we learned today? How have we made progress? Share ideas and thoughtshower. Children write their own title to describe their own learning and traffic light.	**APP:** <u>**L5:**</u> classify quadrilaterals, including trapezium <u>and kite</u>, using their properties, e.g. number of parallel sides <u>**L4:**</u> recognise and name most quadrilaterals, e.g. trapezium, parallelogram, rhombus understand properties of shapes, e.g. why a square is a special rectangle <u>**L3:**</u> identify the shapes which have all edges the same length and all angles the same size from a set of mixed shapes and begin to understand the terms 'regular' and 'irregular' **Lesson Review:** 12: children worked well to label the different quadrilaterals with their names. This took the majority of the lesson, so children only explained their reasoning about the 1st statement. LA children were quite shaky in their knowledge of the properties of different triangles and quadrilaterals despite our work this week. However, they are confident when discussing the meaning of regular and irregular.

Friday	Children write their 'I have been learning to' title in their books. **MO Objective:** Identify, visualise and describe properties of rectangles, triangles, regular polygons and 3-D solids; use knowledge of properties to draw 2-D shapes and identify and draw nets of 3-D shapes **Activity:** Consolidation of yesterday's lesson. Display the partially concealed shapes. Children to discuss with talk partners: what could this be? What can it not be? Refer to properties to support answers. Repeat.	**Resources:** mathematical dictionaries, smartboard screens, challenge statements. **Key vocab:** parallel, perpendicular, tetrahedron, faces, edges, prism, etc (vocab for 3D shapes). **Main Objective:** Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false Identify, visualise and describe properties of rectangles, triangles, regular polygons and 3-D solids; use knowledge of properties to draw 2-D shapes and identify and draw nets of 3-D shapes **Main Teaching Input:** Tell the children that we will be answering statements about 3D shapes today. On tables, children to discuss and thought shower properties which they may need to refer to during today's lesson. Emphasise the importance of using correct mathematical vocabulary. Tell the children that we will be building on the work they have done this week by reasoning about the properties of 3D shapes. Display copies of the children's work. Discuss the good features of each explanation. Use this to generate success criteria for the lesson.	**H.A. and M.A. (L4 children)** • All cubes are cuboids. • All 3D solids have six or more faces. • A tetrahedron is a pyramid. • All prisms have 3 times the number of edges as the 2D shape of which they are the prism (e.g. hexagonal prism has 6 x 3 edges). **Next step challenge:** Can you write your own statement to challenge another member of our class? **L.A. and S.E.N. (L3 children)** Children work as a group to discuss the following statements. Children use 3D shapes to support their answers. **T.** to monitor and support as appropriate – questioning to support independent explanations. • All 3D shapes have 6 faces (F). • All 3D shapes have straight edges (F). • All 3D shapes have perpendicular edges (F). • All 3D shapes have parallel edges (F). **JF to work 1-1 with SW** Properties of 3D shapes game. "I can feel a shape, it has 4 corners. What could it be?" etc (triangle, square, rectangle, circle, pentagon). SW to record notes on Jack's progress.	Children discuss their learning during this lesson. How have we made progress? Share ideas and thoughtshower. Children write their own title to describe their own learning and traffic light.	**APP:** **L5:** reason about shapes, positions and movements use examples and counter-examples to justify conclusions **L4:** understand properties of shapes, e.g. why a square is a special rectangle **L3:** classify 3-D and 2-D shapes in various ways using mathematical properties understand a general statement by finding particular examples that match it **Lesson Review:** 12: children worked extremely well to prove/disprove their statements. Children wrote clearer explanations today – better use of diagrams and bullet points to clarify answers.

Wednesday	**MO Objective:** Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false **Activity:** Odd one out. 3, 7, 13, 4 (prime numbers) 8, 20, 88, 16, 25 (multiples of 4) Children discuss which of the numbers are the odd ones out, giving reasons to support their answers.	**Resources:** smartboard screens, calculators for LA. **Key vocab:** product, multiple. **Main Objective:** Explore patterns, properties and relationships and propose a general statement involving numbers or shapes; identify examples for which the statement is true or false **Main Teaching Input:** Children record their title of 'I have been learning to' into their Maths books. Organise the children into mixed-attaining pairs. Pose the challenge – **Using the numbers 2,3,4,5 and the x symbol, what is the largest product you could make?** Children to discuss the strategies they will use to find the biggest product: how will you know that you've found the biggest product? How can you prove it? Create a list of rules/'remember tos' to clarify the challenge – record on the board Tch to give class the first rule: you must use each number once. Children to come up with other rules for the activity. Include: -When you have found the answer keep it a secret -Discuss with children on your table before asking a teacher if you are stuck - you can work in pairs but don't need to List of rules to remain on the board throughout the lesson to support pupils in their working. 	All children to work in pairs on normal maths tables. L.S.A. and T. to ask why chn are working in this way and ask q.s to support their questioning but NOT give suggestions. **S.E.N.** Lower ability group to be given a calculator to use to do x calculation. T. to work with this group. Have prompt questions available for children to look at if they are stuck. **Have you tried doing a TU x TU?** **Have you tried doing 342 x 5?** **What is the largest 3-digit number you can make?** **What is the largest 2-digit number you can make?** Stop after 10mins. Would anyone like to share with the class the calculation you started with and why? Which multiplication method did you use? Why? Draw on examples of children who are showing evidence of being systematic in their recording and thinking. Children continue to tackle the challenge. After 5 mins – quick plenary – **who can explain how they've changed the way they work?** (If no child has changed their strategy show them how Humphrey has started to work out the answer.) Children to continue working.	Children write their answer on a post it note and stick on the display board. Children to write the calculation and the answer which they think has given them the largest product. Prompt questions to be displayed on the board for children discussing their work: How do you know this is the largest product? How did you prove your answer? Children go to different tables and share answers. Pull children together as a class and share what they have found out. Children cast their vote using the post-it note they have written on: I think that HTU x U will give the biggest product. I think that TU x TU will give the biggest product. Discussion. How do you know?	**APP:** **L5:** organise their work from the outset, looking for ways to record systematically identify more complex patterns, making generalisations in words and begin to express generalisations using symbolic notation use examples and counter-examples to justify conclusions **L4:** organise written work, e.g. record results in order check their methods and justify answers identify patterns as they work and form their own generalisations/rules in words **Lesson Review:** 11 and 12: taught by KP.

Appendix B. Example of a self-help strategies list compiled with the Focus Cohort

If you are stuck try to:

1.	Don't give up.
2.	Try again!
3.	Read through the question carefully at least twice!
4.	Use things around you (times tables, vocabulary, etc) to help.
5.	Ask other people on your table.
6.	Draw diagrams and pictures to help you think about what you need to do.
7.	Estimate what you think the answer will be (do you need a bigger or smaller number?).
8.	Trial and error.
9.	Use RUCSAC.
10.	Underline key words and information.
11.	Read the end of the question too to check that you've done all of the steps.
12.	Check the working wall to see if there is anything there to help you.
13.	Use the inverse to help you check your answers.
14.	Concentrate!
15.	Use the methods that you know (including drawing your own number lines).
16.	If one method isn't working, try a different one!
17.	Ask your Maths partner.
18.	Think about the number facts and fact families that might be able to help you.
19.	Identify the calculation you need before you try to work anything out!
20.	Ignore any distractions.

Appendix C. Proportions of teachers who use research evidence

In order to further investigate my hypothesis that teachers do not read educational research, I used informal survey methods to ascertain the views of the 19 teachers working in my primary school context. The findings of this survey can be seen in the table below.

	Yes	**No**
Do you read educational research?	4 (21.05%)	15 (78.95%)
Do you use websites and other resources to share ideas?	18 (94.74%)	1 (5.26%)

Appendix D: Consent Letter

This appendix includes a copy of the consent letter which was shared with parents prior to beginning research in September 2011. The school letterhead has been removed from this form to preserve anonymity. It is also important to note that the letter describes the use of 'a range of methods, including questionnaires, interviews, opinion lines, and drawings', and that these are not necessarily the methods which were ultimately used in this study.

This is primarily because this letter was written at the outset of research. Although I did indeed use questionnaires (in the form of the S.D.Q.) as well as children's drawings (featured on the P.V.T.s), at this very early point in research, the methods which would be used to investigate the impact of the Thinking Skills intervention had not yet been finalised. It is for this reason that I deliberately included the phrase 'a range of methods including'. I hoped that this would permit a certain degree of flexibility, enabling me to adapt data collection to best suit the needs and preferences of my pupils. With hindsight, this slight ambiguity – and the freedom it facilitated - was very necessary for the shifting and developing nature of this research.

Dear parents,

This year I will be investigating pupils' experiences of learning Maths. This is part of some education research which I will be carrying out, and which will eventually be submitted towards my qualification as Doctor of Education.

The aim of this is to improve teaching and learning by listening to the opinions of the children themselves. It will not affect *what* is taught in Maths, but it should effect *how* lessons are delivered by helping me to plan lessons which are more closely tailored to what the children themselves want, hopefully encouraging more active participation in the subject.

For this, I will be asking pupils about their experiences using a range of methods, including questionnaires, interviews, opinion lines, and drawings. All opinions will be given confidentially, and no names of children will be used. Children are also free to choose not to let me use their opinions in my research as each piece of information is gathered, although I hope that, once they see that their opinions are influencing the way that Maths is taught, they will share their views voluntarily.

If you would like any further information on this investigation, I would be very happy to discuss it with you. Just ask! ☺ If you would **not** like your child's opinions to be included in this research, please complete the form below and bring it into school by Friday 7th October.

Many thanks!
K. Mulholland.

I would **not** like ………………………………… opinions to be included in this investigation.

Signed………………………………………………………… Date………………...

Appendix E. Pupil Views Template Data

A further example of the coding used to analyse pupil views templates. This data is from Term 2b, and analyses the comments used in five of the templates completed by Class 2.

Template number	**Comment number**		Causal connectives	Use of questions	Speculation	Easy / hard	Progress	Preference for a learning style	Preference for a learning style with reason	Evidence of collaboration	Recalling steps in working out / learning
1	1	This is much better than working on our own. I think I know the answer						Y		Y	
	2	If we use trial and error we might get up to £20.						Y			Y
	3	Imagine if we had 120 fish but I only had £2.			Y						Y
	4	Are you sure about that Billy, I think I know the answer		Y						Y	
2	5	You would not do that! This is wrong!									
	6	What is she talking about it does not make sense								Y	
	7	Are you sure?		Y						Y	
	8	No, no you are not doing it right								Y	
	9	Jez start helping!								Y	
3	10	I wonder if you could use more than one method			Y						
	11	There must be more than one method in this question			Y						
	12	You could do the ratio for this problem									Y
	13	What would the ratio be for this question		Y							
	14	It might be 2!									Y
4	15	This is so more easy because when I'm stuck my team can explain and help me work the problem out	Y						Y		
	16	Now I get it									
	17	Well I know that if we use the inverse that could help us figure out what amount of each fish was bought from £20									Y

	18	Being in a group helps me and I can say what I think						Y			
	19	Yous is this it?		Y							
	20	Can you think what you've done wrong?		Y						Y	
5	21	Can we use trial and error?		Y						Y	
	22	Why don't we do the inverse?		Y						Y	
	23	Why do we this? I don't get this.		Y						Y	
	24	Well we could do £20 – 1.80 – 1.40!									Y
	25	That'll equal 8 goldfish and 4 angelfish!									Y
	26	We could do this because we can count how many goldfish and angel fish there is	Y							Y	

Appendix F. Original paper version of the S.D.Q. used by the focus cohort

The Self-Description questionnaire, or S.D.Q., was developed by Marsh, Smith and Barnes (1983) to analyse self-concept in preadolescents and adolescents. This particular version was designed in 1992.

SDQI®

INSTRUMENT

All information supplied will be kept strictly confidential								

Your Name______________________________ **Circle one: Boy Girl**

School______________________________ **Grade**______ **Age**_____

Teacher______________________________ **Date:**_______________

PLEASE READ THESE INSTRUCTIONS FIRST

This is not a test - there are no right or wrong answers.

This is a chance to look at yourself. **It is not a test.** There are no right answers and everyone will have different answers. Be sure that your answers show how you feel about yourself. **PLEASE DO NOT TALK ABOUT YOUR ANSWERS WITH ANYONE ELSE.** We will keep your answers private and not show them to anyone.

When you are ready to begin, please read each sentence and decide your answer (You may read quietly to yourself as I read aloud). There are five possible answers for each question - "True", "False", and three answers in between. The numbers 1 to 5 are next to each sentence, for each of the answers. The answers are written at the top of the page, above the numbers. Choose your answer to a sentence and circle the number of the answer you choose. You may only choose one answer. **DO NOT** say your answer out loud or talk about it with anyone else. Before you start there are three examples below. A student named Bob has already answered the first two examples to show you how to do it. In the third example you must choose your own answer by circling the number.

1 False	2 Mostly False	3 Sometimes false, sometimes true	4 Mostly True	5 True

SOME EXAMPLES

A. I like to read comic books. 1 2 3 4 5

(Bob circled the number 5, which was the answer "TRUE". This means that he really likes to read comic books. If Bob did not like to read comic books very much, he would have answered "FALSE" or "MOSTLY FALSE").

B. In general, I am neat and tidy. 1 2 3 4 5

(Bob answered "SOMETIMES FALSE, SOMETIMES TRUE" because he is not very neat, but he is not very messy either).

C. I like to watch T.V. 1 2 3 4 5

For this sentence you have to choose the answer that is best for you. First you must decide if the sentence is "TRUE" or "FALSE" or somewhere in between. If you really like to watch T.V. a lot you would answer "TRUE" by circling the number 5. If you hate watching T.V. you would answer "FALSE" by circling the number 1. If your answer is somewhere in between then you would choose one of the other three boxes.

Please do not leave any statements blank. If unsure, please ASK FOR HELP.

 1

Please **circle the number** which is the **most correct** statement about you.

	Statement	False	Mostly False	Sometimes false, sometimes true	Mostly True	True
01.	I am good looking....................................	1	2	3	4	5
02.	I am good at all **SCHOOL SUBJECTS**...........	1	2	3	4	5
03.	I can run fast..	1	2	3	4	5
04.	I get good marks in **READING**......................	1	2	3	4	5
05.	My parents understand me............................	1	2	3	4	5
06.	I hate **MATHEMATICS**............................	1	2	3	4	5
07.	I have lots of friends................................	1	2	3	4	5
08.	I like the way I look..................................	1	2	3	4	5
09.	I enjoy doing work in all **SCHOOL SUBJECTS**.	1	2	3	4	5
10.	I like to run and play hard...........................	1	2	3	4	5
11.	I like **READING**..	1	2	3	4	5
12.	My parents are usually unhappy or disappointed with what I do..	1	2	3	4	5
13.	Work in **MATHEMATICS** is easy for me.........	1	2	3	4	5
14.	I make friends easily.................................	1	2	3	4	5
15.	I have a pleasant looking face.......................	1	2	3	4	5
16.	I get good marks in all **SCHOOL SUBJECTS**....	1	2	3	4	5
17.	I hate sports and games.............................	1	2	3	4	5
18.	I am good at **READING**.............................	1	2	3	4	5
19.	I like my parents......................................	1	2	3	4	5
20.	I look forward to **MATHEMATICS**...............	1	2	3	4	5
21.	Most kids have more friends than I do............	1	2	3	4	5
22.	I am a nice looking person...........................	1	2	3	4	5
23.	I hate all **SCHOOL SUBJECTS**.....................	1	2	3	4	5
24.	I enjoy sports and games.............................	1	2	3	4	5
25.	I am interested in **READING**.......................	1	2	3	4	5
26.	My parents like me....................................	1	2	3	4	5
27.	I get good marks in **MATHEMATICS**.............	1	2	3	4	5
28.	I get along with kids easily..........................	1	2	3	4	5
29.	I do lots of important things.........................	1	2	3	4	5
30.	I am ugly..	1	2	3	4	5

	Statement	False	Mostly False	Sometimes false, sometimes true	Mostly True	True
31.	I learn things quickly in all **SCHOOL SUBJECTS**…………………………………………	1	2	3	4	5
32.	I have good muscles………………………………..	1	2	3	4	5
33.	I am dumb at **READING**………………………....	1	2	3	4	5
34.	If I have children of my own, I want to bring them up like my parents raised me……………………	1	2	3	4	5
35.	I am interested in **MATHEMATICS**……………	1	2	3	4	5
36.	I am easy to like………………………………….	1	2	3	4	5
37.	Overall, I am no good……………………………..	1	2	3	4	5
38.	Other kids think I am good looking………………	1	2	3	4	5
39.	I am interested in all **SCHOOL SUBJECTS**……	1	2	3	4	5
40.	I am good at sports……………………………….	1	2	3	4	5
41.	I enjoy doing work in **READING**……………….	1	2	3	4	5
42.	My parents and I spend a lot of time together……	1	2	3	4	5
43.	I learn things quickly in **MATHEMATICS**…….	1	2	3	4	5
44.	Other kids want me to be their friend……………	1	2	3	4	5
45.	In general, I like being the way I am……………	1	2	3	4	5
46.	I have a good looking body………………………	1	2	3	4	5
47.	I am dumb in all **SCHOOL SUBJECTS**………..	1	2	3	4	5
48.	I can run a long way without stopping………….	1	2	3	4	5
49.	Work in **READING** is easy for me………………	1	2	3	4	5
50.	My parents are easy to talk to……………………	1	2	3	4	5
51.	I like **MATHEMATICS**………………………….	1	2	3	4	5
52.	I have more friends than most other kids……….	1	2	3	4	5
53.	Overall, I have a lot to be proud of………………	1	2	3	4	5
54.	I am better looking than most of my friends……..	1	2	3	4	5
55.	I look forward to all **SCHOOL SUBJECTS**…….	1	2	3	4	5
56.	I am a good athlete………………………………..	1	2	3	4	5
57.	I look forward to **READING**…………………….	1	2	3	4	5
58.	I get along well with my parents…………………	1	2	3	4	5
59.	I am good at **MATHEMATICS**…………………	1	2	3	4	5
60.	I am popular with kids of my own age…………..	1	2	3	4	5

	Statement	False	Mostly False	Sometimes false, sometimes true	Mostly True	True
61.	I can't do anything right………………………….	1	2	3	4	5
62.	I have nice features like nose, and eyes, and hair..	1	2	3	4	5
63.	Work in all **SCHOOL SUBJECTS** is easy for me………………………………………………	1	2	3	4	5
64.	I am good at throwing a ball……………………	1	2	3	4	5
65.	I hate **READING**……………………………….	1	2	3	4	5
66.	My parents and I have a lot of fun together………	1	2	3	4	5
67.	I can do things as well as most other people……	1	2	3	4	5
68.	I enjoy doing work in **MATHEMATICS**………..	1	2	3	4	5
69.	Most other kids like me…………………………	1	2	3	4	5
70.	Other people think I am a good person…………	1	2	3	4	5
71.	I like all **SCHOOL SUBJECTS**……..………..	1	2	3	4	5
72.	A lot of things about me are good………………	1	2	3	4	5
73.	I learn things quickly in **READING**……………	1	2	3	4	5
74.	I am as good as most other people………………	1	2	3	4	5
75.	I am dumb at **MATHEMATICS**…..……………	1	2	3	4	5
76.	When I do something, I do it well………………	1	2	3	4	5

Thank you

Appendix G. Original pupil views template

Below is a copy of the blank pupil views template used by the focus cohort. It was given to pupils on A3 paper to maximise space for pupils to record their experiences of lessons. Pupils were also encouraged to add their own speech and thought bubbles in order to customise their templates as far as possible.