CAN CHILDREN CREATE MIND MAPS AS PLANNING TOOLS FOR WRITING?

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Abstract

Can children create mind maps as planning tools for writing?

This thesis reports an investigation into primary-aged children's ability to learn how to construct mind maps and use these as a tool to support thinking and planning for written tasks. Little research has investigated the kinds of mind map produced by 7–11 year old children, or the impact on an associated written task. It is argued therefore that a closer examination of these claims might shed light on how children learn and use such representations.

An initial exploratory study investigated the ability of children to create mind maps and use them as planning tools for narrative writing. Following this, five experimental studies were conducted exploring how to enhance children's construction and use of mind maps. Two studies were concerned with supporting the construction process independent of a written task and three further studies investigated mind map plans linked to expository writing tasks.

Strategies that improved children's mind map construction were found to be the use of templates, a staged inductive procedure or collaboration using computer software. No overall improvement in children's writing was found when mind maps were used as planning tools, but better structured mind maps were correlated with better written texts. A close examination of items present on mind map plans and included in written tasks revealed that there was more transfer of items from mind maps to texts of better quality.

Findings suggest that children can learn and engage with this kind of representation successfully, however the task environment is particularly influential on the types of mind map produced. It is suggested that representations such as mind maps can be usefully introduced into the primary curriculum as an effective planning tool. Mind maps also create a visible record of planning that can provide an opportunity for focused teacher intervention.

Publications

Cockburn, E, Harrison, C. & Ainsworth, S. (2008) Children Working Collaboratively to Produce Mind Maps as plans for Expository Writing. Paper presented at EARLI SIG2 Meeting Tilburg August 2008

Cockburn, E., Ainsworth, S.E. & Harrison, C. (2007) Boxes and skeletons: scaffolding mind map construction for 7-9 year old children. Paper presented at EARLI conference Budapest August 2007.

Cockburn, E, Harrison, C. & Ainsworth, S.E (2006) Children using Mind Maps as planning tools for non-narrative writing Paper presented at the EARLI Writing SIG Antwerp September 06.

Cockburn, E, Harrison, C. & Ainsworth, S.E (2005) Children's use of mind maps to plan narrative writing: the roles of task and map structure. Paper presented at the EARLI conference Nicosia August 05.

Cockburn, E., Ainsworth, S.E. & Harrison, C. (2004) Can 8-10 year old children use mind maps to help in narrative writing? Paper presented at the EARLI SIG2 Meeting Valencia, September 2004

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Chapter 1: Introduction

1.1 Summary of thesis

This thesis investigates the ability of children to construct mind maps as visual representations for planning writing. In primary school, children are encouraged to plan written work in advance of a written text, but this often results in list structures which are then replicated with little alteration once the writing process begins, as observed in previous research (Bereiter & Scardamalia, 1987). Children tend not to edit or reorganise the initial plan and see the process as one involving repetition rather than as an experimental space to explore and generate a number of alternative ideas.

Providing a different model of planning seemed to offer a way of supporting the planning process and, in addition, provide a scaffold for the type of cognitive strategies that could lead to a more coherent and considered text structure. Mind maps were considered as a possible representation as evidence suggests that graphical representations can be a support for learning (Miller, 2000; McAleese, 1998; Novak, 1984). Advocates of mind mapping such as Buzan (2000) and Caviglioni & Harris (2000), claim that mind maps are closely tied to internal cognitive processes and structures, arguing that the representation is in some way a 'natural' form, making it easily learned. Other authors, such as Jonassen et al. (1998), see such representations as 'mind tools', promoting learning through the operation of the tool, rather than by a teacher delivering direct instruction, and leading to students' engagement with knowledge creation in participatory and meaningful ways. The link to writing was considered because Buzan (2000) specifically recommends mind mapping as a planning strategy for written text.

General assertions notwithstanding, there is little direct research evidence resulting from work with primary-aged children, 7–11 years, to assess the usefulness of such a representation. In spite of this, recommendations for mind maps to be used as part of classroom practice have been incorporated into the primary framework guidance for teachers, specifically in planning for work with Y2, 6–7 year old children (DfES, 2006).

Can children construct mind maps as planning tools for writing?

The six studies that will be reported in this thesis investigated a series of research questions:

1) Can 7–11 year old children create mind maps?

2) How can the construction process be supported?

3) Can mind maps be used as a planning tool to improve written tasks?

4) Is there a relationship between the structure or content of a mind map and the subsequent writing task?

The research was carried out in one suburban primary school, with the participation of children aged 7–11 years from four key stage 2 (KS2) classes over a period of four years.

In the studies reported it was found that although children were able to reproduce the visual form of the mind map, instances of children producing well-structured maps employing grouping and categorising strategies were inconsistent and varied depending on the written task. Following Study 2, a series of investigations developed around devising support strategies to enhance children's construction of fully categorised mind map structures. These included visual prompts in the form of templates and investigations into the effects of peer collaboration on the mind map making task. The relationship between both mind map structure and content and the subsequent written task was investigated in four of the six studies. It was found that there were correlations between mind map structure and content and the quality of the written task.

The findings add to our understanding of how primary-aged children adapt and create mind maps to support written work. The study provides examples of the role this kind of planning plays in the production of some kinds of written texts and examines the possible relationship between the two forms of representation.

1.2 Overview of chapters

The thesis is organised into eight chapters.

Chapter 1 is an introduction and background to the thesis, providing an overview of the researcher's context and motivation to investigate children's use of graphical representations in relation to planning writing.

Chapter 2 is a review of the literature related to the research questions identified in section 1.1. The chapter opens with definitions of various types of node and link diagrams, associated theoretical background and research. Young children's ability to understand conceptual hierarchies is also considered, as this forms a necessary skill in constructing the mind map representation successfully. The context of writing in the primary classroom is reported, with the research that has made an impact on the structure of the curriculum, including cognitive models (Hayes & Flower, 1980) and sociocultural models from the Australian genre theorists (Christie, 1989; Martin, 1985). Research into the planning process for written tasks is considered and finally the possible advantages of using graphical representations to plan written tasks explored.

Chapter 3 discusses the theoretical background and associated methodological choices made in relation to the research questions.

Chapters 4 to 7 contain the studies investigating the impact of using mind maps as planning tools in the primary classroom.

Chapter 4 describes an exploratory study. An explanation is given of the training undertaken by the children participating in the study and the effects of using mind maps during the completion of four written tasks. The chapter describes how the collection of mind maps was analysed and a categorisation scheme developed which captured structural aspects of the mind maps produced. One finding of the study was that the majority of children were positive about the experience of learning to construct mind maps, but it was not clear whether or not mind maps had a beneficial impact on the writing process. Narrative tasks were the focus in this study. Task effects were shown to have a marked impact on the type of mind map produced. Consequently, research focused on expository writing, which might have proved more suitable for this kind of planning tool.

Can children construct mind maps as planning tools for writing?

Chapter 5 reports an experimental study comparing the effects of using discussion or mind maps as planning tools for expository writing tasks. Children worked on two expository written tasks: one planned using a mind map, one planned through discussion with a peer. Results did not show a particular benefit for using a mind map on the quality of written texts planned in this way, but a wide variety of mind maps resulted. Many of these mind maps were relatively unstructured.

Further studies were then designed to scaffold the mind map construction process. It was hoped that enabling children to engage in grouping content in advance of producing a written text would in turn lead to improvements in their writing. The following four studies investigated ways of scaffolding the mind map construction process.

Chapter 6 contains reports on two linked studies, both examining scaffolding techniques to improve mind map construction. Study 3 investigated methods for supporting mind map construction using text boxes to elicit content generation linked to an inductive mind map-making process. This showed a beneficial effect on content generation. Study 4 analysed the impact of using templates to support better categorical organisation, which also produced more structured mind maps.

Chapter 7 considers the effects of collaboration on supporting the mind map construction process. Two studies are reported. Study 5 investigated an inductive process together with support strategies such as templates similar to those explored in Studies 3 and 4, comparing the mind maps and writing produced by two groups. One group worked independently and one group worked in pairs to produce a mind-mapped plan for writing. As in chapter 5, the mind maps were constructed to plan an expository writing task. Although collaboration did not appear to improve the structure of the mind maps produced, there was an increase in the quantity of material present on collaborative mind maps. Links between writing and mind maps were analysed.

Study 6 attempted to capture some of the effects of collaboration on computer-aided mind map construction. In this case, where children constructed mind maps starting with branch headings rather than lists of items to organise, collaboration had a positive effect on the structure of mind maps produced and on the quantity of concepts presented. Again, possible links and similarities between mind map and content included in the subsequent written task were analysed.

The results of all six studies are discussed in chapter 8, together with implications for classroom practice and questions for further research.

1.3 Context leading to the studies

The purpose of this section is to describe some of the recent history of literacy education in the UK that lies behind a renewed interest in 'thinking skills' approaches, providing the initial context for the enquiries carried out in this thesis.

The National Curriculum for England and Wales was first introduced with the 1988 Education Reform Act to ensure a basic entitlement for all children in state-funded schools. In order to monitor this provision, national assessment at key periods in a child's progress were introduced and ambitious targets set by government to raise standards of achievement. Following the election of a Labour government in 1997, the statutory national curriculum (DfEE, 1999) was augmented by the non-statutory national literacy (NLS) and numeracy strategies (DfEE, 1998). These provided detailed descriptions of what should be taught and when in these subjects, together with an expectation that in all state primary schools in England and Wales children would receive an hour each day dedicated to the delivery of both literacy and maths. In addition, targets were published for greatly higher national standards in both areas, backed by a rigorous school inspection regime.

Nationally, there was a drive to improve standards, as measured by publicly reported test scores. One outcome of this was a great deal of concentration on literacy and maths in primary schools, often at the expense of other curriculum areas. In a government review of the national curriculum in 1997, the detailed statutory requirements in the programmes of study at key stages 1 and 2 in six foundation subjects were lifted in order to allow schools to concentrate more on the targets for literacy and numeracy. Primary schools were told in 2000 that they could cut back on subjects such as art, PE and music to concentrate on literacy and numeracy. This was a significant departure from ideas of a broad and balanced primary curriculum and was commented on unfavourably by the inspection service. Ofsted's report concluded that enquiry, problem-solving and practical work were most affected (Office for Standards in Education, 2002).

An additional and growing influence from test requirements was also leading to increasingly prescriptive, teacher-led pedagogy. A report commissioned by the government concluded that the main changes brought about by the strategies involved a greater use of whole-class teaching, greater attention to the pace of lessons, and planning based on objectives rather than activities (Earl et al., 2003). The delivery of curriculum objectives was becoming more efficient. The impact on learning as a result of these measures was more problematic and difficult to judge because it appeared more difficult to draw conclusions about the effect of the Strategies on pupil learning than on teaching practice (Earl et al., 2003).

Policies such as these provoked a reaction. Across the education sector, from teachers in schools to academics in colleges and universities, a commitment to a different approach was voiced. This debate involved pedagogical principles concerned less with the delivery of specific content and more with encouraging creativity or developing alternative teaching approaches while remaining concerned to raise standards in literacy and mathematics. When the improvement in standards appeared to stall, the government, with education at the heart of its policies, looked to the research community as partners in the improvement of standards throughout education. In particular, 'thinking skills' approaches acquired government interest and a report by Carol McQuiness (1999) was commissioned, which presented research evidence for the success of a variety of thinking skills programmes.

The government had a stated investment in using research to inform policy; a key element of New Labour's policies on primary school education was its claim that its policies were based on research (Brehony, 2005). This included encouraging practitioner involvement in research, both as continuing professional development for members of the teaching profession and through engaging practitioners and researchers in a closer relationship to raise standards. One measure to accomplish this was the establishing of Best Practice Research Scholarships for teachers to engage in small-scale research projects supported by universities. The research opportunities were based in areas that had a high profile in the standards agenda: for example, improved teaching approaches, work in the area of literacy, maths, behaviour management and the use of ICT.

'Thinking skills' approaches became part of this agenda, an area ill-defined but involving innovative practice, an emphasis on collaborative group work and outcomes that were process- rather than product-based. Claims were made for the success of such approaches, notably work in science education, CASE (Cognitive Acceleration in Science Education) and maths CAME (Cognitive Acceleration in Mathematics Education). There were and are a number of influential researchers, Shayer et al. (2002), Leat & Higgins (2002), Gardner & Hatch (1989), advocating cognitive approaches.

In addition to researchers, charismatic promoters of what were referred to as 'brain-based' approaches, linking pedagogical strategies to discoveries in neuroscience, were having, and continue to have, an influential impact on practice and policy in primary schools. One example of this is the work of Alistair Smith (2001) in the area of 'accelerated learning', noted by Sharp et al. (2008). In reaction to the prescriptive nature of the literacy and numeracy strategies, there was openness to innovative practice. One implication of this was a corresponding responsibility to assess what was practical and effective in terms of children's learning in the classroom.

It was in such a context that my personal research journey began. Specific research training and opportunities were made available to practising teachers through the BPRS scheme. During the second year of this programme, I was given the opportunity to take part in small-scale, classroom-based research in an area of thinking skills, financed by BPRS and supported by the National Union of Teachers and Newcastle University. The grant paid for training, resources and time out of the classroom. My motivation came from a desire to incorporate innovative, research-informed practice into my own repertoire of teaching strategies. Participation in the scheme also presented an opportunity to gain research skills and become involved with a wider community of practitioner researchers.

A variety of pedagogical strategies were introduced as part of involvement in the project, which I found interesting and potentially valuable. My personal interest lay in the way graphical representations – diagrams, graphs, matrices – presented information, and the cognitive skills necessary to comprehend or create such forms. My research focused on mind maps, as this appeared a flexible representation concerned with supporting cognition rather than tied to a particular curriculum area. The representation emphasises a process of conceptual organisation that could be used in a number of contexts and potentially is able to provide visual diagrammatic support for learning as an alternative to text-based linear models.

Inevitably a broad interest had to become more specific and contextualised. As literacy co-ordinator in a state primary school at the time of these studies, I was interested in how mind maps could be used to support improved learning in this area of the curriculum. At the time, 2002, there was national concern over writing standards in schools. Reading was seen to have improved with the implementation of the NLS, but writing standards lagged behind. A more recent report (Ofsted, 2009) still finds writing standards considerably lower than in reading. This was the situation in the primary school where I was employed. Investigating strategies to improve writing was an obvious area for research, and mind maps, used as cognitive tools to support planning for writing, offered a context for introducing this visual representation usefully into the curriculum.

To summarise, assertions for the effectiveness of mind maps had been made both by Buzan (2000), who claims to be the originator of the form, and influential figures such as Alistair Smith (2001). Both recommended a range of strategies to improve children's learning, including the use of visual representations. The NLS recommended the use of diagrams for planning tools (DfES, 2006), but there was little or no research to support the efficacy of such representations in this area. The ambition of this work was to investigate whether mind maps could be constructed by primary-aged children and whether they would find them an effective support for planning written tasks.

Chapter 2: Literature review

2.1 Introduction

The central focus of these studies is an investigation into primary-aged children's ability to construct mind maps as a planning tool for writing. This chapter will look at the research findings in the relevant areas, which include node and link diagrams, writing, planning and the use of graphical representations to support learning.

Mind maps, as a type of node and link diagram, have been recommended for use in the classroom by authors such as Buzan (2000) and Smith & Call (2001). However, there appeared to be little research into young children's ability to construct or make use of this particular form of representation. A search of the Educational Resource Information Centre (ERIC) and the British Education Index (BEI) databases resulted in a total of 45 articles referring directly to mind maps. Most of the articles (29) were recommendations or guides to using mind maps as part of a teaching repertoire, in many cases for older students at college or university level; a further four articles had used a mind map in the body of the text as a way of presenting information. Three articles recommended mind maps as research tools. Two of these analysed developing understanding or reflection during a course of university study (Hendry, 2009; Lim, 2003), the other looked at mixed research methods and the use of mind/concept maps as an aid for semi-structured interviews (Wheeldon, 2010).

The remaining studies reported were concerned with the learning outcomes of using mind maps, but again tended to involve older students. Four looked at improved recall in students (Salzburg, 2008; Abi & Adb, 2008; Venter, 2001; Peterson, 1998). One study looked at collaborative learning and knowledge construction supported by mind maps in teacher education (Naykki & Jarvela, 2008). In all, only two studies were linked to writing production. In one, secondary students with learning difficulties made notes to form mind maps from information presented on CD Rom software (Mahlamaki & Kallio, 2000). Another earlier study with college students (Malloy, 1987) described a teaching strategy which employed a number of integrated techniques, including mind maps, which were introduced to organise ideas for a written task. As this brief summary shows, reading that recommends using mind maps in classroom pedagogy is relatively plentiful but research to evaluate impact is much less evident.

Little research relates directly to the impact of using mind maps with young children or the possible benefits of using mind maps as a tool to plan written tasks. This chapter continues with some definitions of mind maps and other forms of node and link diagrams, continuing with a discussion about some of the theoretical background associated with these types of diagram.

2.2 Definitions

Mind maps were chosen to investigate whether children's cognitive processes could be supported and influenced by this form of visual representation. Buzan (2000), who is often credited with developing the form, claims that mind maps are an expression of 'radiant thinking' and a 'key to unlocking the potential of the brain' (p. 59). Caviglioni & Harris (2000), who promote a virtually indistinguishable representation called a model map, claim that such maps are a way to help students become 'better thinkers' (p. 10).

Mind maps are a graphical representation providing an outline of a given domain. This consists of a central concept surrounded by a series of related branches, each branch structured as a tree diagram. Kress & Leeuwen (2006) would describe such diagrams as conceptual, rather than narrative and concerned with classification rather than representing unfolding actions or a process of change. Information on the mind map is expressed in short phrases or single keywords, or in some cases by symbols or icons. Figure 2.1 is an illustration of the mind map form as described by Buzan (2000). As previously mentioned, specific research investigating the ability of young children to construct these diagrams is difficult to find. This is further complicated by the fact that there are many other similar node and link diagrams and terms are often used interchangeably for subtly different representations.

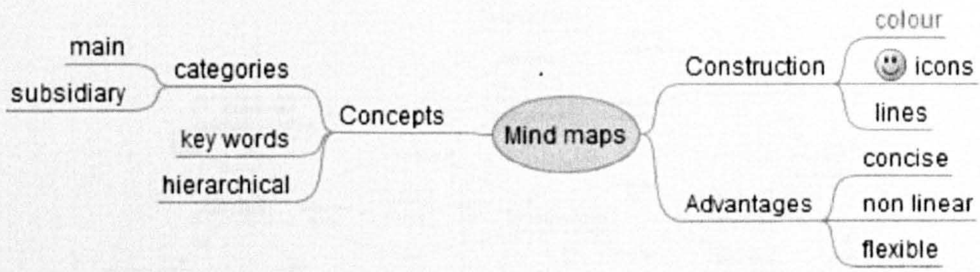

Figure 2.1: Features of mind map illustrating principles described by Buzan

One such term is 'graphic organiser'. Graphic organisers are diagrammatic versions of text often used to aid reading comprehension. Developed during the 1970s, these were structured overviews that simplified text to show keywords and an outline of the underlying structure. These were usually presented by the teacher and formed a pre-reading activity (Dunston, 1992). Later this was developed to be a post-reading or supplementary activity. Graphic organisers use many of the elements present in mind maps, namely spatial organisation, keyword structures and hierarchical organisation (Anderson & Armbruster, 1991, 1987; Alvermann & Boothby, 1986; Alvermann, 1981). The term 'graphic organiser' is now used to categorise a wide variety of visual representations that can be used to promote understanding, including node and link diagrams (Horan, 2002).

A particular confusion exists between mind maps and concept maps, with the terms often used interchangeably. Concept maps are a similar type of node and link diagram which also use categorisation and hierarchy. On a mind map the relationship between items is generally conveyed by the underlying tree diagram structure. This is not the case on a concept map where nodes tend to be linked by lines containing a preposition to state the specific nature of the link between concepts. Each node may become a hub for a series of other related concepts; see figure 2.2.

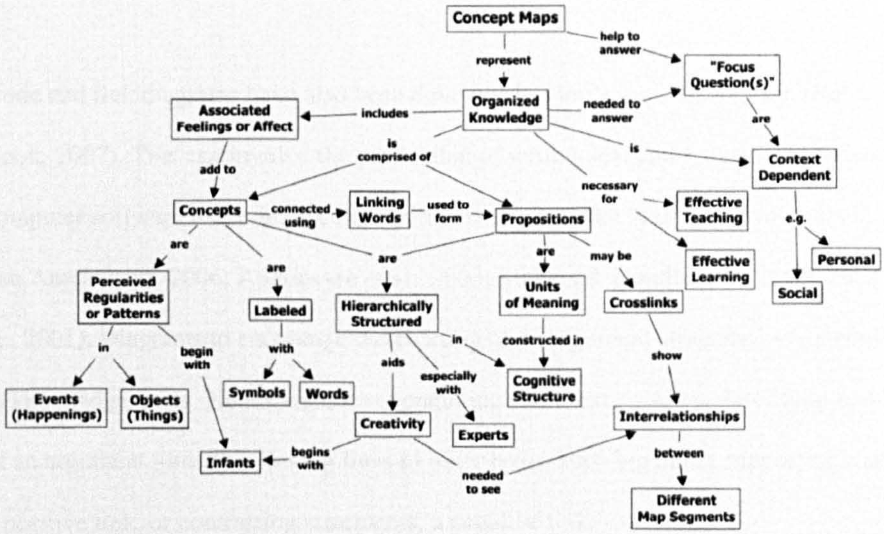

Figure 2.2: Features of concept map (Novak & Canas, 2006)

Another similar representation is a knowledge map (O'Donnell et al., 2002; Lambiotte & Dansereau, 1992), where again there are nodes joined by labelled and usually directional links. In the case of a knowledge map, a suggested vocabulary of linking words is often provided. Some linking words can be domain specific, while others are more broadly used (eg part, type, example). However, the resulting diagram looks very similar to a concept map,see figure 2.3

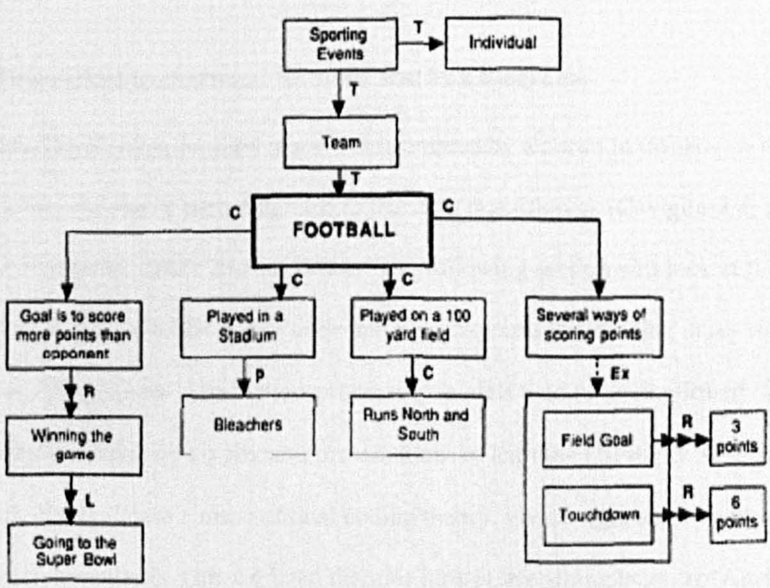

FIG. 1. Example of a typical knowledge map and link types. T, type; C, characteristic; P, part; R, results in, L, leads to; Ex, example.

Figure 2.3: Knowledge map taken from Weigman et al. (1992)

Node and link diagrams have also been developed as tools for collaboration (Ralston & Cook, 2007). This can involve the production of written text and typically now uses computer software to facilitate collaboration over networks (van Amelsvoort et al., 2008: van Amelsvoort, 2006; Andriessen et al., 2003; Suthers & Hundhausen, 2003, 2002; Bell et al., 2001). Diagrams to encourage the charting of an argument structure have a similar form to knowledge maps. Nodes are boxes containing short text passages describing one aspect of an argument joined by linking lines to other boxes showing either supporting statements, a positive link, or contrasting statements, a negative link.

The aim, common to all these node and link structures, is to show both relevant concepts and the relationships between them. Lohse et al. (1994) created a classification of visual representations identifying 11 categories including graphs, tables, time charts and networks. Arguably node and link diagrams would meet the criteria for inclusion in the 'network charts' category. These show relationships between components using lines, arrows, proximity, similarity or containment. Such diagrams assist in the organisation of knowledge (Reed, 2010; Jonassen et al., 1993) and inferences can be made from the spatial arrangement of components (Kress & Leuuwen, 2006).

2.3 Theoretical background for node and link diagrams

Introducing children to mind maps was prompted by a desire to investigate the claims promoting the use of such diagrams to teaching practitioners (Caviglioni & Harris, 2002, 2000; Margulies, 2002; Buzan, 2000;). The following section will look at the theories most commonly related to the use of node and link diagrams for learning in research-based studies. Three visual information-processing models tend to be implicated in the contribution made by graphical representations to learning (Nesbit & Adesope, 2006; Vekiri, 2002). These consist of dual coding theory, visual argument hypothesis and conjoint retention hypothesis. Other related theories look at deepening learning (Ausubel, 1968) and active strategies which involve the learner in representing developing knowledge (van Drie et al., 2005; Novak & Gowin, 1984).

2.3.1 Visual information-processing perspectives

Dual coding theory

The visiospatial aspect of node and link diagrams combined with text can be said to make use of both verbal and visual modes of memory resources. Paivio's (1990, 1986) dual coding theory suggests that visual material and verbal material are processed in different but interlinked areas of memory code. This theory implies that verbal and visual material can be processed simultaneously, using different cognitive resources, thus strengthening information retention and transfer. This concept has been used to explain the effectiveness of learning from pictures combined with speech or text (Mayer, 2001) and could be implicated in learning with node and link diagrams, as their form incorporates both textual and spatial elements.

Visual argument hypothesis

For the purpose of the work presented in this thesis, the visual argument hypothesis as reported by Vekiri (2002) has provided the most relevant theoretical framework. This term was introduced by Waller (1981) to explain how graphical representations convey information. According to this theory, diagrams such as charts, graphs, maps and tables require less cognitive transformation than text, as information is transmitted visually through the spatial arrangement of components. Larkin & Simon (1987) refer to this as 'perceptual enhancement'. When compared to representations based on linear text, diagrams aid information search processes by enabling learners to use automatic perceptual processes to extract relevant information (Irani et al., 2001). Making similar inferences from sentential text can involve the holding of information in working memory while reading through text to make links to other related concepts. Diagrams group related information together spatially making connected information easy to perceive (Dansereau & Morland, 1998; Chmielewski et al., 1998).

Scaife & Rogers' (1996) review of the use of graphical representations to support learning also makes links to the visual argument hypothesis. This argument claims that diagrams can be used to externalise elements of a problem-based task. Diagrams can be used as 'external cognition'. Visual representations aid problem-solving by externalising part or all of a problem. This allows elements to be manipulated and relationships directly perceived, freeing the learner to concentrate less on holding relevant information in the limited resource of working memory, and focus more on analysis and problem solving.

Conjoint retention hypothesis

Conjoint retention hypothesis links both dual coding theory and visual argument hypothesis. Kulhavy (Verdi & Kulhavy, 2002; Kulhavy & Stock, 1996) suggests that structural and feature information benefit retention and recall of textual information. Research carried out in relation to geographic maps and verbal presentations has shown the combination of the two led to improved recall of information. This could have implications for concept/mind maps where the mental model of a spatial frame could improve the indexing and retrieval of concepts, especially with the addition of icons alongside text to portray the concepts presented (Nesbit & Adesope, 2006).

In summary, node and link diagrams, seen as a subset of graphical representations, can be useful in exploiting visual perception systems to show and explore relationships between concepts more efficiently than sentential text, and can provide support for complex tasks by acting as an external extension of memory.

2.3.2 Deepening learning

Writing and research specifically concerning node and link diagrams often begins with reference to the learning theories of Ausubel et al. (1968), who emphasised that in order for deep learning to take place, new learning needed to be connected to previous knowledge structures through a process of assimilation. In his view, meaningful learning could only come about when three conditions were met: the first was clear instruction using relevant examples from the learner's experience; the second involved relevant prior knowledge, which must be assessed and activated in some way; the third involved the motivation of the learner to integrate new learning into existing structures, rather than be content to merely memorise new procedures or information. Ausubel et al. (1968) recommended the use of advance organisers to support learning, which emphasised the key features and structures of new information. However, these organisers were text-based rather than diagrammatic in nature.

Influenced by these principles, Novak & Gowin (1984) developed a more diagrammatic advance organiser in the form of the concept map in an attempt to promote deep as opposed to rote learning, initially linked to science education. In Novak &Canas' view (2006), concept mapping enables meaningful learning by scaffolding the integration of new learning with existing structures. The act of mapping makes explicit the relationship between new and existing knowledge. Through this process, misconceptions can be exposed, enabling change either through the learner independently recognising errors or by focused teacher intervention. To produce a concept map there has to be a re-representation of knowledge held by the learner, which will be instrumental in deepening understanding. As a result of this, many research studies investigating concept mapping techniques have focused on improving the understanding of scientific concepts (Kinchin & Hayes, 2000; Horton et al., 1993) or assessing students developing scientific knowledge (Novak & Gowin, 1984).

A similar case is made by Jonassen et al. (1998), who distinguish node and link diagrams as 'mind tools' (p. 24). The argument would be that students engaged in working with these representations are scaffolded to think differently about content in a given domain. McAleese (1998a) sees the concept map as a reflective tool and an aid to the construction of knowledge. Jonassen (1998) uses the term 'semantic networking' (p. 26) for computerised concept mapping and in his list of suggested programs there is no distinction between mind maps and concept maps. Both genres of node and link diagram are grouped together as providing a stimulus to engage with content at a structural level, exploring links and relationships between concepts. Research into the use of diagrams to aid learning through argument (van Amelsvoort et al., 2008; van Drie et al., 2005) also stress the overview provided by a node and link diagram to assist the deepening of argument and support for collaboration.

A number of studies have found positive effects for node and link diagrams. Research by Holly & Dansereau (1984) found that university students who studied using node and link diagrams performed significantly better on both multiple choice and essay questions than a control group who did not use this technique to learn material from the course. Chang et al. (2002) found an improvement on text comprehension through the use of concept mapping. Positive effects for comprehension were also found through text-based concept mapping by Nathan & Kozminski (2004), working with secondary school pupils.

In summary, it can be argued that concept maps and mind maps aim to engage the learner in cognitive processes that have the effect of deepening understanding in a given domain. The advantage of diagrammatic representation facilitates the understanding of deeper structural relationships between concepts. Representing a given domain in this way also invites the learner to make links between new and prior knowledge and may usefully chart the development of more accurate or increasingly sophisticated levels of understanding. The learner is engaged in active strategies to support deeper learning.

2.3.3 Assessing learning

A complementary view would hold that the node and link diagrams constructed by learners give a representation of the knowledge held. This view has led to concept/mind maps often being used as research tools to evaluate students' changing understanding about a topic (Hendry, 2009; Lim, 2003) The ImpaCT2 project (Harrison et al., 2000) employed node and link diagrams to assess changes in children's understanding of networked technologies. The terms 'mind map' and 'concept map' are used interchangeably in this reported study (Pearson & Somekh, 2000). There was no guidance to organise concepts in hierarchical or categorised groupings and children were encouraged to use icons linked by lines rather than text. In practice many children chose to organise their map content and to label their images using keywords. The resulting diagrams proved a rich source of data, which researchers used to make judgments on children's developing understanding of networked computer systems over time by comparing one set of maps with another set constructed towards the end of the study.

Although MacAleese et al. (1998), who describe the concept map as a 'mirror of the mind' (p.5), hold the view that the construction of a node and link diagram gives a unique insight into the knowledge held by its creator, they also put forward the case that mind map construction leads to knowledge creation by its author. Constuctivist theories (Duffy & Jonassen, 1992) would suggest that the knowledge expressed through articulation may have been developed as part of the process, rather than be a reflection of knowledge already present. Furthermore, applying the rules of a concept or mind map grammar places a limitation and constraint on concepts included, as concepts may be known but not integrate well into the developing representation. Asked to construct an alternative kind of external representation, a student may demonstrate a new and different level of internal cognitive understanding. Relationships between internal and external representations are complex and difficult to identify (Scaife & Rogers, 1996). Zhang (1997) argued that external representations are not simply inputs and stimuli to the internal mind, but that cognitive activity is guided, constrained and even determined by them.

In response to the potential benefits described, the main aim of the studies reported in this thesis was to introduce children to a flexible representation that would encourage them to structure information in an organised form, which could then be used in a variety of ways to increase and represent understanding.

2.4 Learner characteristics

It is recognised that careful consideration of the learner is also an important factor in the effectiveness of graphical representations.

Studies investigating the use of graphical representations have often focused on older children or young adults (Naykki & Jervela, 2008; van Amelsvoort et al., 2008). One of the aims of the studies reported was to investigate the ability of young children to construct these kinds of representations. Mind map branch structure relies on the ability of the author to work with conceptual categories or class names (Medland, 2007; Kress & Leuuwen, 2006). Working with children as young as 7 years old in the studies, there was a concern that children of this age would be unable to group content in order to construct the tree diagram structure at the heart of this representation. Work in this area (Deneault & Ricard, 2005; Greene, 1994) strongly suggests that children are able to 'read' and make inferences from class inclusion hierarchies. This ability increases with age, but 7 year old children have demonstrated an understanding of information presented with four levels of hierarchy. In order to construct a simple mind map it is preferable that there is an understanding of at least three levels of structure: the main concept or subject of the map, a number of superordinate categories linked to that concept, and some examples of the superordinate categories. This level of categorisation creates grouped information. Given that research with graphical representation acknowledges that interpretation of representations is not the same as production (Ainsworth, 2006; Cox, 1999), it was felt that the question of whether children could produce these diagrams independently was, at the outset of the research, unanswered.

Research suggests that mind maps may be a useful tool for encouraging the expression and development of concepts in an ordered form, which can aid the learner by showing the underlying structures of a given domain. The categorised structure may be within young children's ability to read; however, there is little systematic research looking at the ability of primary-aged children to construct mind maps using classification and hierarchy. This led to the first research question:

1) Can 7–11 year old children create mind maps?

2.5 Supporting mind map construction

Mind maps were a novel form of representation for the all participants originally involved in these studies. It was recognised that this needed consideration. Representations must be practised for proficient use (Erkens et al., 2005; McKendree et al., 2002; Alvermann & Boothby, 1986). Ainsworth (2006) points out that novel representations provide a challenge for learners. As well as understanding the way the representation is constructed and being familiar with the form in which information is represented, the learner must also be aware of how the representation relates to the knowledge domain. In the case of these studies, children had to learn not only how to read and construct a mind map, understanding how concepts on a mind map were categorised and hierarchically organised, but also needed to be able to relate the representation as a document to inform a further written task.

In order for children to successfully engage with a new representation, supportive strategies could be considered. Wood et al. (1976) speak of 'scaffolding' learning, defining this process as enabling a child to 'carry out a task or achieve a goal which would be beyond his unassisted efforts' (p. 90). This can be seen in relation to the Vygotskian concept of the zone of proximal development (ZPD). Vygotsky defined ZPD (1978) as 'the distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers' (p. 86). Scaffolding involves recruitment, motivating the learner to take part in an activity and contingent support as the task is underway. As part of the learning process, children may need a variety of scaffolded or supportive strategies. Simplification of the task can also be seen as a way of scaffolding, in addition learning and procedural scaffolds can be provided (Azevedo et al., 2003), with the ultimate aim of developing self-regulation strategies in the learner. The aim is to gradually reduce the level of scaffolding as the learner becomes proficient.

More recent developments in the learning sciences also consider the use of tools and artefacts as scaffolds to support learning, often linked to the development of educational software. Sherin et al. (2004) have developed a theoretical framework designed to assess the relative effectiveness of learning artefacts seen as scaffolds. In this case scaffolds are described as 'physical objects designed by some individuals to support the learning of other individuals' (p. 388). This framework accepts that scaffolds may remain in place as the analysis of relative effectiveness proceeds, though the ultimate aim would be the removal or fading of support as the learner gains more expertise. This interpretation of scaffolding can also be recognised in the work of Wray & Lewis (1997), designing writing frames as a tool to assist in understanding the text features of a particular genre.

Collaboration with a peer was also seen as strategy to support learning. Co-operative and collaborative learning has been investigated in a range of contexts (Dillenbourg, 1999).

Research into co-operation also makes claims for improved learning outcomes, but this implies that participants co-operate over a task while having individual responsibility for a defined element of the task (Slavin, 1996, 1985; Johnson & Johnson, 1987). However, some benefits can be seen to be common to both collaboration and co-operation. In situations where group working is involved it would be difficult to be sure that during collaboration some aspects of co-operation have not entered the task, with participants defining roles for themselves while engaged in collaborative activity. Collaboration has been shown to change both the process and outcomes of learning (Dillenbourg, 2002; Wood & O'Malley, 1996; Crook, 1994; Brown, 1992; Scardamalia & Bereiter, 1991). Crook (1994) suggests that collaborative working achieves improved learning through the social processes of articulation, conflict resolution and co-construction:

- **Articulation** is the process of explaining concepts and understanding in a manner that makes this clear for both the speaker and listener. This process may necessitate clarifying concepts that may not have been consciously formulated before the attempt to express them, aiding learning for both the speaker and listener. The receptive partner may also benefit in listening to a process of thought rehearsed by the speaker articulating their understanding.

- **Conflict resolution** comes about through the discussion resulting from conflicting ideas or understandings. Attempts to bring a greater clarity to opposing positions or to persuade a partner of a particular view may clarify thought and bring new understanding. This might also result in efforts to reach a mutually satisfying compromise. Framing arguments to justify or elaborate concepts can lead to deeper learning (Andriessen, 2006; van Drieet al., 2005; Wood & O'Malley, 1996).

- **Co-construction** is another possible mechanism implicated in the efficacy of collaboration, where groups working together in a problem space strive to achieve a mutually perceived solution.

These social processes would appear to offer positive support for learning and many primary classrooms are arranged to facilitate group work. However, in spite of this apparent commitment to group working, studies investigating children's typical discourse in groups in the classroom found that often the level of actual collaboration was poor (Barron, 2003; Webb & Mastergeorge, 2003; Mercer et al., 1999). Relational aspects were found to be an important part of successful collaboration. Placing individuals in groups has to be carefully managed in relation to the task requirements (Blatchford et al., 2007). As Dillenbourg (1999) states, there is a low predictability of specific types of interaction in collaborative working. Conditions can be set up, but it is difficult to ensure the right task environment or to be sure that personalities will be compatible. Barron (2003) has shown that to ensure success all members of a group need to concentrate attention on the problem space; without this, the benefits of shared perspectives, increased monitoring of understanding and the offering of explanations are compromised. Behavioural issues such as dominance, unwillingness to listen to colleagues' views, lack of persistence and self-focused thought trajectories were evident in unsuccessful groups (Barron, 2003). By contrast, successful groupings were able to engage with all ideas presented and maintain a focused participation in the joint problem space.

Mercer (1999) also found that group work could be dominated by a particular individual, which could lead to little or no contribution from other members of the group, restricting the possible advantages of articulation. Conflict was certainly found to be a factor, but the discussion remained at the level of disputation, where solutions were not mutually agreed or sought, leading to little evidence of co-construction activities. Mercer's (1999) aim was to encourage 'exploratory' talk, where children engaged with each other's ideas in a critical and constructive way. Scaffolding and support for collaboration through a particular, focused and explicit programme of study was found to be beneficial in securing learning gains.

Other studies that found benefits for group work in primary classroom settings also provided structures to support collaboration. One such example, reciprocal teaching techniques (Palincsar & Brown, 1984), had specific routines and procedures to support productive discussion within the group. After a period of teacher modelling, children took on the role of group leader in turn, prompting discussion through prediction, question generation, giving summaries and clarifying misunderstandings or particular vocabulary. Studies like this show that collaboration has the potential to provide a powerful support for learning, but that the process of collaboration itself needs to be structured in some way and groupings carefully managed.

Collaboration can lead to creative conflict, but other research has found a tendency for convergence, the development of shared knowledge and understanding (Fischer & Mandl, 2005; Salomon & Perkins, 1998; Roschelle, 1992). Children involved in a problem-solving activity together may co-construct knowledge through turn-taking and building on mutual understanding rather than argumentation, though this is facilitated if there is an explicit co-ordination of the learning partners' role in the task. Successfully completing a shared representation is no guarantee of a cognitive change in either participant in the collaboration. Fischer & Mandl (2005) showed convergence during the process of collaboration using a graphical representation, but shared knowledge was the exception rather than the rule in the subsequent written task which formed the outcome measure in their study. The effect of collaboration led to agreement during the construction process, but knowledge sharing was not strong as a result.

Another possible benefit for collaborative diagram construction could be a tendency for paired working to generate more abstract representations. A study by Schwartz (1995) explored how collaboration changed representation construction, finding that children working in pairs to solve a multiple constraint satisfaction problem produced more abstract representations than those working individually. This could assist children in finding suitable subject headings for branch headings on mind maps, where more abstract language needs to be employed.

In summary, the literature suggests that various forms of scaffolding can support learning; this can be in the form of process, artefacts such as frames, and grouping strategies such as collaborative working. Consequently these considerations lead to the second research question:

2) How can the mind map construction process be supported?

2.6 Task characteristics

The effectiveness of any representation for learning is also dependent on its suitability for a given task (Zhang & Norman,1994). Diagrams need to accurately discriminate the most salient information to represent, which in turn is dependent on the task being supported (Reed, 2010). In some cases, too much accurate detail can be a distraction from the primary learning goal. Di Sessa (2004) has found that young children of 11–12 years have an understanding of what makes a good diagram, which includes showing relevant information, being compact, precise and easy to explain, meeting conventional expectations, and obeying the rules of correspondence. Many of these qualities are discussed by Scaife & Rogers (1996), who stress ease of production and also collaborative construction and the possibility for cognitive tracking when notes can be made on existing diagrams to support cognitive offloading. In addition to investigating the ability of children to construct mind maps, the research questioned the ability of young children to use these diagrams as a tool to plan a written task. This involves a particular task environment discussed in section 2.7.

2.7 The task environment; cognitive and social perspectives of writing in the primary classroom

The focus of this study was on the ability of children to construct mind maps; and, as has been stated, a variety of research avenues were open. Studies investigating the impact of using diagrams such as story maps or graphic organisers to improve comprehension of texts had shown benefits (Garadill & Jitendra, 1999; Baumann & Bergeron, 1993; Alevermann & Boothby, 1986; Reutzel, 1985). It was recognised that studies looking at young children's construction of mind or concept maps were limited and that while studies connected to reading comprehension existed (Nathan & Kominsky, 2004; Chang et al., 2002; Guastello et al., 2000; Gallagher & Pearson, 1989), there was little looking at the impact node and link diagrams might have on the writing process (Nesbit & Adesope, 2006). This provided the task environment to investigate children's learning with mind maps.

The research was carried out within the constraints of the existing writing curriculum in English primary schools. The present primary school curriculum in England and Wales places a great deal of emphasis on developing confident and expressive writers. Children at the end of the primary stage of education are expected to have a flexible writing style and should be able to develop their ideas in sustained and interesting ways for the purpose of the reader (DfEE, 1999). Locating the research in this area combined research objectives with pedagogical concerns linked to genuine writing tasks as outlined by the National Literacy Strategy (DfEE, 1998).

2.7.1 The challenge writing presents to children

As explained in chapter 1, improvements in literacy standards have been perceived as rising since the introduction of the National Literacy Strategy for England and Wales (DfEE, 1998). However, improvements in reading scores were outstripping those for writing, which was, and continues to be, a cause for concern (Ofsted, 2009). The third research question relates to mind maps providing a planning tool that could facilitate an improvement in children's written work.

Writing in the context of the school classroom is regarded by many children as an onerous and often unpleasant task. Vygotsky (1962) recognised many of the reasons for children finding the transition from oral production to text production a difficult process. Talking is a social activity; children can be engaged in conversation from a very young age, encouraged and supported by adults and peers in continual day-to-day interaction. Writing is largely a solitary activity (Torrance et al., 2007) and is attended by the need for specialised tools and a particular level of concentration. Spoken language has the advantage of immediate feedback, together with a number of supporting cues aiding communication supplied by gesture, tone and pace. By contrast, writers have to use more abstract forms of gesture through punctuation and register, which take time and practice to master, while feedback is delayed, meaning that a writer needs both metacognitive awareness and empathic imagination of audience to construct effective communication.

Lack of immediate feedback presents only one of many initial problems for young children embarking on the process of becoming writers. Initial attempts to communicate in writing also involve the development of fine motor skills necessary for holding and operating writing tools or operating keyboard and mouse. There are further challenges in understanding the complex English spelling system and the appropriate language forms for each particular genre of written text.

Attempts to improve writing standards in schools in England and Wales have been influenced by both cognitive and social models of writing development, embodied in the literacy strategy guidance disseminated to primary schools (DfES, 1997). Both of these perspectives have provided a context for the studies presented in future chapters.

Cognitive models of writing seek to understand the often concurrent process demands involved in producing written text. Hayes & Flower (1980) saw writing in terms of a problem-solving activity and constructed a model of writing to explain the cognitive processes at work (figure 2.4).

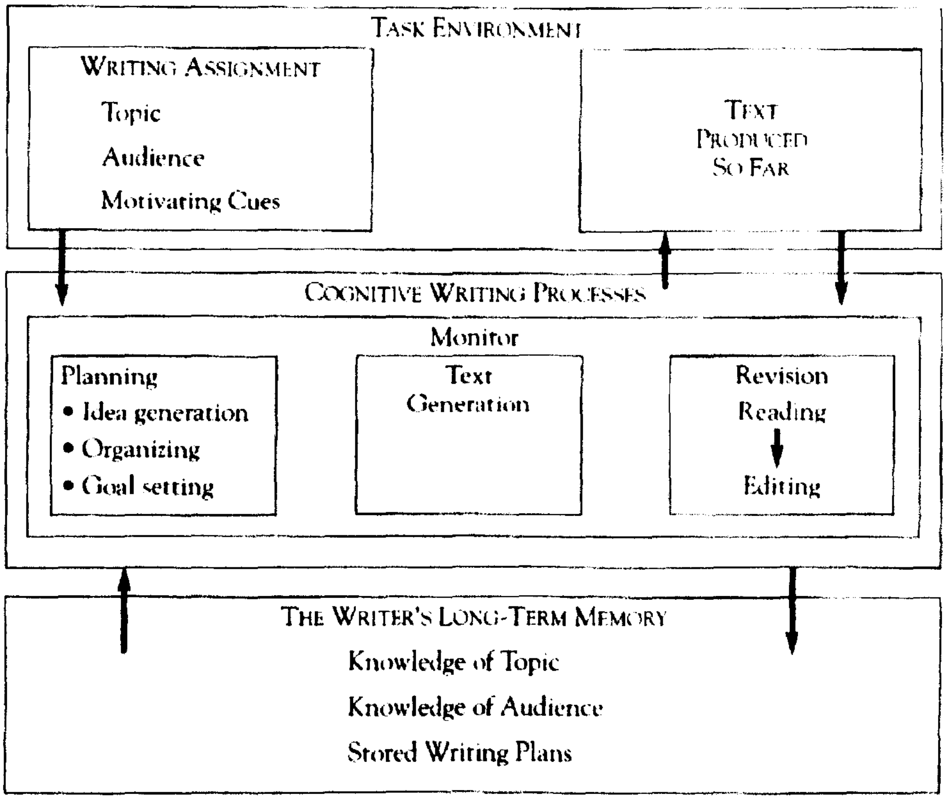

Figure 2.4: The Hayes–Flower model, 1980, redrawn for clarification

The main processes identified are referred to in this model as planning, text production and revision. All these processes work in concert with internal long-term memory searches and external cues from the developing text and the task requirements. The revised model in figure 2.5 shows these complex relationships with regard to two aspects, the task environment and the individual, emphasising that the processes are interlinked and there is no clear chronology between these processes in writing. On this diagram, planning is subsumed into reflection, which impacts on and is in turn influenced by text production and revision.

The model identifies the multiple and simultaneous demands placed on a writer. These are identified as: accessing memory for suitable content; choosing appropriate vocabulary in order to express that content; and working within the conventions of spelling, sentence construction and punctuation. In addition, texts must be organised according to recognised conventions of genre and structured to be coherent locally and globally in a harmonious fashion, in order to communicate clearly and appropriately to the understanding of a given audience. Consequently, it is not surprising that Hayes & Flower (1980: p. 33) describe the position of a writer as being on 'full-time cognitive overload'.

In order to alleviate some of this overload, the complex and iterative process of writing has been simplified into the constituent phases to simplify tasks for the novice writer. A model which emphasises the three elements – planning, text production, revision – has been and continues to be encouraged in the primary school curriculum. This became known as the 'process' approach (Calkins, 1986; Graves, 1983). A recent review by the English Review Group into successful classroom practice found that the writing process model was beneficial and mentions extensive planning as one of a number of strategies to improve children's writing (Andrews et al., 2006). Finding an appropriate planning strategy would appear to offer teachers and children a means to support improved written texts.

The Hayes model also emphasises a need in the writer to understand the genre forms in which the writing style is located. This links to the learning theories expressed by the Australian genre theorists whose work is explored in section 2.7.2.

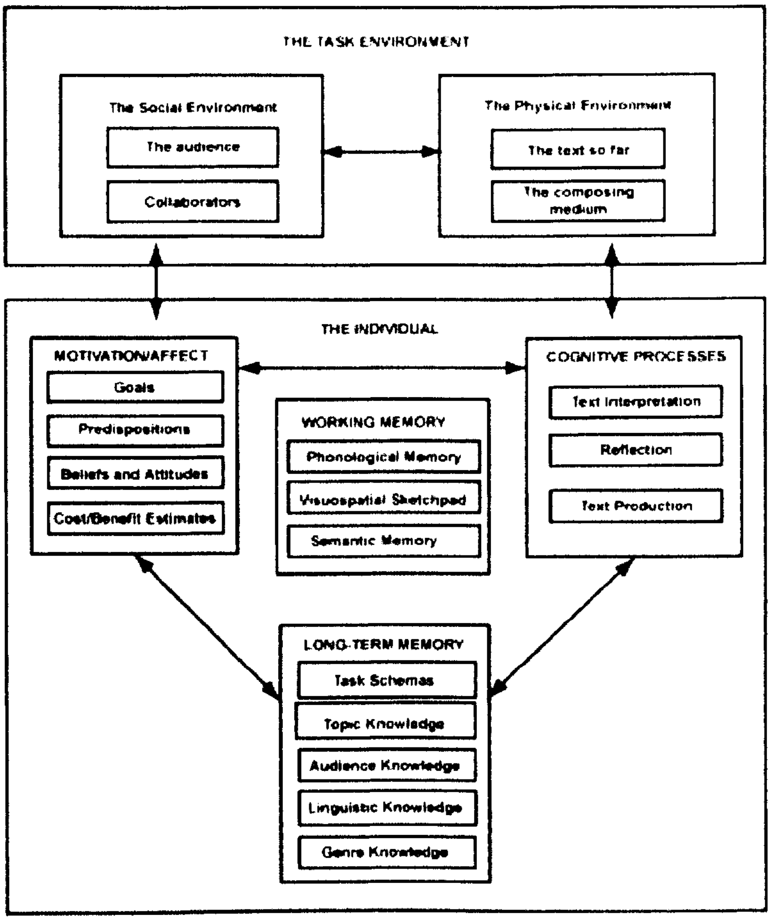

Figure 2.5: Hayes' (1996) revised model of writing process

2.7.2 Genre theory and text types

A cognitive perspective is only one influence on current writing pedagogy. Concerns with the forms and uses of written language in a sociocultural setting have led to another influential approach in primary classrooms.

Research in the late 1970s and early 1980s into the writing curriculum offered in primary schools found that children were not engaging with a range of text types: there was an emphasis on narrative and personal texts, while non-fiction genres were neglected (Martin & Rothery, 1980). This could be said to leave children ill-equipped to deal with the writing demands of a literate society where much of the day-to-day writing tasks concern non-fiction genres.

Australian genre theory looks at writing as a social practice, where certain forms or genres are privileged by society and fluency in these genres is necessary to obtain access to the tools of democracy (Cope & Kalantzis, 1993; Christie, 1989; Martin, 1985). Children have a right to be literate in a range of forms respected by the society in which they live in order to access employment and acceptance as educated individuals. This is the purpose behind 'genre theory'; social inclusion is dependent on knowing the rules and being able to work within them. Texts both written and spoken arise from 'particular social situations and their specific structures' (Kress & Knapp, 1992). Learning a new genre bestows access to 'new realms of social activity and social power' (Cope & Kalantzis, 1993: p. 7). Writing is explained explicitly through identifying appropriate organisation and language structures (Halliday, 1985). Knowledge about how written language works to convey meaning necessitates an explicit understanding of grammar, not as an immutable system of rules but as an expectation given the text type and audience. There is an emphasis on understanding the specialised features of different text types in order to be able to recreate genre forms effectively.

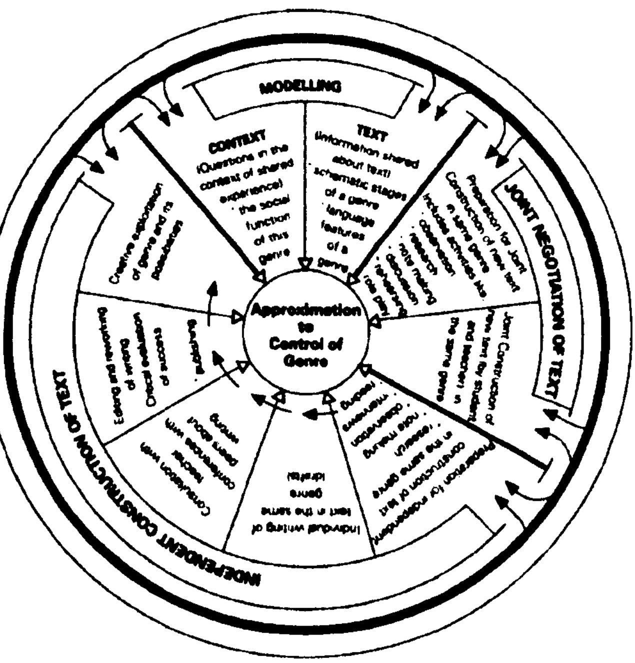

Figure 2.6: Teaching sequence (source: Macken et al., 1989, cited in Cope & Kalantzis, 1993)

Genre theory is evident through the NLS (DfEE, 1998), which recognises a range of text types and recommends teaching specific non-fiction genres in addition to forms of narrative and poetry. This is accomplished through a version of the wheel sequence outlined in figure 2.6. Children are 'immersed' in a text type, analysing features and gaining an insight into grammar and vocabulary before attempting to construct a text in a similar genre. This independent phase can also be scaffolded by the use of writing frames (Wray & Lewis, 1997) or lists of expected 'success' criteria. Once texts are completed, the evaluation is carried out by peers and/or teacher checking against the criteria.

Giving children experience of reading and writing in a number of genres has widely been accepted. The challenge for policy makers was to decide on the relevant text types to incorporate into the curriculum and on the teaching strategies needed to support children's progress. Various categories of text type suitable for classroom instruction have been identified by different theorists. Lunzer et al. (1984) identified ten text types commonly found in secondary school text books for students. These comprised: narrative, which included biography as well as fictional storytelling; structure or mechanism; process; principle; theory; problem-solutions; historical situation; classification; instructions; and theme. Strategies to improve children's comprehension of these text types included the use of diagrams to re-represent the information contained in the text. These could be flow diagrams, networks and tree diagrams depending on the text type structure.

Identifying text types and teaching strategies to support understanding were also developed by Meyer (1982). She identified five discourse types which could be used to facilitate both text comprehension and planning for writing. These were comparison, description, response, antecedent/consequent, and time/order. Ninth grade students were trained to understand texts organised around these principles; there were gains in comprehension and the skills were also relevant to informing the composition of texts. One strategy to improve comprehension of non-fiction texts was to construct tree diagram plans of the content. Comprehension was improved and some students then used the tree diagrams in their own writing. Meyer (1982) recommended investigating the links between reading and writing to improve attainment for students in both.

Other researchers were also identifying a range of text types and appropriate stages for their introduction. Collerson (1988) categorised early genres, including labels, observational comment, recount, and narratives leading to factual genres to develop at a later stage, such as reports, procedures, explanations and arguments or exposition. Wing Jan (1991) had two main categories of genres: factual, which included reports, explanations, procedures, persuasive writing, interviews, surveys, descriptions, biographies, recounts and narrative information; and fictional, which included traditional fiction and contemporary modern fiction. The Sydney linguists (Martin & Rothery, 1986, 1980) settled on six important text types – recount, report, procedure, explanation, argument and discussion. Their research showed that, of the six, recount was overwhelmingly the most commonly experienced by students in school.

In order to extend children's experience of texts, the NLS contains a wide range of narrative and poetic genres together with the six non-fiction text types identified by the Sydney linguists. The NLS (DfEE, 1998) published detailed guidance on when and how the forms should be taught. Recount texts are recognised as an early genre to be taught in the school curriculum, as they have the closest resemblance to narrative structures. These are written in the past tense and generally follow a chronological path. Personal recounts are recommended as a suitable starting point for young writers, linking to first-hand experience and a sense of narrative. The advice for teaching includes diagrams for planning; in the case of recount, a timeline is recommended.

Early writing instruction in primary schools also includes instructional or procedural texts, which were present in Lunzer's (1984), Collerson's (1988) and Wing Jan's (1991) categorisations and could be seen as Meyer's antecedent/consequent planning strategy (1982). These texts are familiar to young children in the form of recipes or instructions to play games. Precise ordering is important, but also supportive of the organisation of the text. One instruction leads logically to the next, which makes the structure of the genre clear. Practical activities, rather than a diagrammatic planning structure, are recommended to support the development of understanding in the case of these texts.

Explanation texts are more sophisticated, describing and clarifying procedures or giving information about the way things work, identified as mechanism and principles by Lunzer & Gardner (1984). These texts are taught later in the primary curriculum and need a more sophisticated use of language, being generally written in the present tense and containing both temporal and causal connectives. In this case there is also a coherent organisation to the text – from a general statement to the process to be described to a concluding statement. The process described in most cases will have a strong element of chronology, which could be represented as a flow diagram or timeline.

Children have more difficulties when it comes to organising the remaining genres of non-fiction. Non-chronological reports appear early in the curriculum and children are familiar with reading non-fiction and writing factual accounts linked to a wide range of curriculum areas such as history, geography and science. Difficulties can arise as reports move away from organisation by chronology to organisation by theme, which can be a particular challenge for a novice writer. They are written in the present tense, use the passive voice and are concerned with the generic rather than the individual. This category is very wide and incorporates many of the text types identified in Lunzer & Gardner's taxonomy (1984), such as historical situation, theme and structure, and by Meyer (1982) as a descriptive form. The use of tree diagrams to understand the structure of this kind of text type was evaluated successfully by Meyer (1982), working with 14 year old students. Planning suggestions in the guidance given by the primary framework include categorisation strategies in Y2, for 6–7 year old children, together with the use of ICT-based mind-mapping software and shared spidergrams for Y3 (DfES, 2006).

The final two text types tend to be seen as more challenging and appear later in the primary school curriculum. Persuasive texts express a particular point of view, stated as a thesis early in the text, and make a case to convince their audience, using a number of examples to support a case. Argument texts show a balanced view, with a thesis being argued from more than one viewpoint and ending with a summary and conclusion. Both text types share with reports a thematic approach. The elements of an argument are at the discretion of the author, as is the ordering of the elements.

The expectation of children to engage with a wide range of genres, as emphasised by the Sidney theorists, has led to a wider variety of texts being explicitly taught in schools, but the particular challenges of text organisation have presented further challenges to novice writers (Mallet, 2003). In England, the genre approach was researched notably by Wray & Lewis (1997, 1996), who recognised the difficulties experienced by primary-aged children working with these genres. Their aim was to give more support to children writing non-fiction texts. The Exel project used the teaching sequence as shown in figure 2.6, adding to this a scaffolded phase as part of the independent work. Children were provided with writing frames which contain relevant organisation and appropriate vocabulary to support the production of a given text genre.

The two theories presented have tended to result in different pedagogical approaches. 'Process' writing, historically, tended to work with the production of narratives, stressing personal voice. The 'genre' approach tends to look at structures and lexical analysis, producing text collaboratively as a stage both in construction of the text and in the subsequent editing and revision phase. Genre is seen as providing a template for written texts, though this can arguably lead to resulting text that is formulaic and depersonalised.

Both approaches give support to the novice writer. The process approach scaffolds (Wood et al., 1976) the learner by breaking down the task into more manageable 'chunks'. The genre approach places the writing into a social context and uses an apprenticeship model with peer collaboration to extend expertise in a given range of forms.

While writing instruction begins early in a child's education to allow mastery of the necessary skills to produce clearly communicated text important as a life skill to participate fully in society, writing as a representation of thought is also recognised as a tool for learning. Written representation at its best involves a process of thought that can consolidate, clarify and create new knowledge for a learner. Bereiter & Scardamalia (1987) recognised two types of writing. In the first, 'knowledge telling', in composition consists of a process of retelling ideas accessed from memory translated directly into text. Writers in this mode concentrate on addressing immediate problems in transcription and often rely on chronological strategies to solve organisational difficulties. This is a particular problem in genres of writing which do not have an underlying chronological organisational structure. By contrast, a 'knowledge transforming' approach shows a more expert strategy. The writer is able to consider wider goals and to plan to engage with problem-solving activities linked to content or organisation while taking the needs of their audience into consideration. Through these high-level, problem-solving activities the writer is likely to have undergone cognitive change, constructing new meaning through text production.

The two aspects of writing – learning to write and writing to learn – are both important as part of the primary curriculum. Children as novice writers need scaffolding to simplify the challenging task of writing, and encouragement to write to clarify and reconstruct knowledge as a valuable part of a learning process. Though planning for an expert author may not be a discrete activity, neatly separated from the transcription phase, an effort to simplify the writing process for the novice could reasonably look towards planning strategies to support the development of writing expertise. Bereiter & Scardamalia's (1987) knowledge-transforming model would appear to be a synthesis of an expert understanding of the writing process and text genres, which enables a transformation in the author's understanding as well as informing the audience.

This is the context that provided the motivation for the study. Could providing a flexible planning strategy alleviate some of the cognitive burden on novice writers, be suited to a range of text types and improve written outcomes? There is also a strong suggestion, evident in curriculum guidance and the research discussed, that diagrammatic representations hold the potential to provide effective planning tools. Sections 2.7.3 and 2.7.4 look in more detail at the role played by planning in the writing process and how this can be supported by the use of diagrams.

2.7.3 Planning

Planning writing before the transcription process begins appears to be a supportive strategy and research shows that expert writers differ from novices in the amount of time spent in planning. Primary-aged children, on the other hand, rarely wish to engage with planning in any meaningful way at all (De la Paz, 1999; Troia et al., 1999; McCutchen, 1988). Writing is in itself often regarded as an onerous task for the reasons outlined in the section 2.7.1; therefore planning in written form is experienced as a doubling of the task rather than providing support for it. Bereiter & Scardamalia (1985) found that children under 9 years of age made list-like plans which were then transferred into a slightly fuller written text with little revision or reorganisation. A young, novice writer tends to present ideas in the order they come to mind, without taking into account the needs of reader.

Hayes states that planning itself can be a vague term when applied to the writing process (see Levy & Ransdell, 1996). Planning can be recorded as a separate document, it can be a continuous process as the writing proceeds or it can be a combination of the two. The kind of plan referred to in this thesis entails making a separate document to inform the structure and content of a written text. In making a separate plan, the aim is to simplify transcription by outlining the main content features for the written task. As Hayes states, topic headings reduce wasted effort by avoiding 'blind alleys and false starts' (see Levy & Ransdell, 1996: p. 35). There is also an opportunity to consider the overall structure and organisation of the writing before the task commences and for the plan to act as an 'external memory' source once transcription is underway (Sharples, 1994). This connects to Scaife & Roger's (1996) theory of 'external cognition', providing a space for elements of the writing task to be identified and manipulated.

In practice, children often achieve a reasonable level of success without separate planning documents when writing a narrative text. This could be a result of having a secure grasp of the genre's requirements, a mental model or schema of the conventions of a basic narrative. Studies of young children telling stories show an early awareness of story structure (Applebee, 1978; Pitcher & Prelinger, 1963). This could be termed planning by analogy –

placing individual ideas or closely adapted ideas into an existing cognitive framework (Hayes, in Levy & Randskill, 1996).

However, the national curriculum (DfEE/QCA, 1999) requires even very young children to write in a variety of genres as explained in section 2.7.2. Many of these are unfamiliar and present problems of organisation specific to the genre type, together with demands of appropriate vocabulary and particular stylistic features. In many of these non-fiction genres, the organisation of content becomes an important factor in achieving a successful text, but children do not generally have a secure schema of expository genres to frame the information. This results in a written task which appears flexible and ill-defined, with a variety of possible approaches. Children writing either narrative or expository texts often begin well, only to find inspiration falters as they proceed and cognitive processing becomes occupied with tasks more experienced writers have automated, such as spelling, grammar and punctuation. Having a written plan to remind them of content and structure would seem to offer support to continue more successfully with the task.

Planning has been successful in improving texts for older writers. Kellogg (1988) found that outline strategies had a beneficial effect on writing quality. University students writing in exams scored higher marks when writing from an outline, especially an organised outline, than those writing without one (Piolat & Roussey, 1996). Work with students experiencing learning difficulties has found benefits for a range of self-regulatory strategies which include planning (Graham & Perrin, 2007; Sturm & Rankin-Erickson, 2002; Graham & Harris, 2000, Troia et al., 1999; Kozma,1991; Ruddell & Boyle, 1989). Torrance et al. (2007) found that training students in cognitive self-regulation with regard to writing, which included planning strategies, had positive results. Grade 6 Spanish students, aged 11–12 years, were able to plan work and produce more cohesive texts as a result. The review by Andrews et al. (2006) strongly recommends planning which is 'extensive, elaborate and hierarchical' (p. 1) to make more effective argumentative essays. Another small-scale study by Riley & Ahlberg (2004) with 10–11 year old children investigated whether computer-based concept mapping could be used as a planning method for narrative writing. Though evidence to show an overall improvement in written work was not found, results showed that better concept maps were related to better written texts.

Berieter & Scardamalia (1987) theorised two writing dispositions – those who write from a knowledge-telling strategy and those who write from a knowledge-transforming one. A knowledge-transforming strategy links with higher cognitive processes and can be seen as promoting thinking skills through writing. The intended outcome of a successful planning tool would be to scaffold children's progress from knowledge-telling strategies to knowledge-transforming strategies. Although it would be unrealistic necessarily to expect to achieve this in a majority of cases, emphasising planning as a strategy is arguably a way to structure and scaffold processes necessary to be a competent writer.

In summary, it would appear there is a case for a structured planning approach before writing for younger children, both as an attempt to lessen cognitive demands during the writing task and as a means of developing metacognitive writing skills and understanding. This then leads to the consideration of the kind of planning tool best suited for the task. The question remains:

3. Can children use a mind map representation as a planning tool for writing?

2.7.4. Planning with a diagram

Bereiter & Scardamalia (1987) had found that children, when asked to plan, made list structures which consisted of a shorter version of the final task. Planning was not an opportunity to consider possibilities for relevant content or organisation. Children need to be encouraged to plan using a range of strategies. As reported in section 2.7.3, there is advice and researched practice available to the practitioner for suitable strategies linked to text type. Mind maps had been recommended by the NLS, tree diagrams used by Meyer (1982) and webs recommended by Harris & Graham (1996); it appeared reasonable to investigate the impact of this kind of planning tool.

There is recognition that plans using a diagrammatic structure can offer benefits to the writer. Sharples (1994) sees a variety of external representations including topic maps as both representations of mental content and new stimuli available for reinterpretation. The resulting plan is an 'intermediate representation' (p. 5), allowing the writer to view the related topics before committing them to text. Meyer (1982) found that students trained to use tree diagrams to aid text comprehension could transfer this improved understanding of macrostructure to their own written texts. Harris & Graham (1996) recommend a web form to collect and organise relevant information, which can then provide a reference point for the written task. Beard (2000) also recommends using graphic aides to thinking such as 'grids, columns, spider diagrams, flow charts and so on' (p. 199).

Conversely, research into the effects of planning diagrams has not consistently reported positive results. Isnard & Piolat (1993) found that structured outlines were more effective planning tools than graphic organisers when looking at the writing of a sample of university students. There was an advantage for organising content but not for the diagram. Even at this level, students who were not encouraged to organise their ideas tended to move from a rough list of ideas to the final text. Mandatory structuring led to new ideas, though there was no conclusive finding linked to the overall quality of the students' writing. Research on students using a collaborative computer environment to write argumentative essays showed no positive effect for those using a diagram planning tool when compared with other available strategies, such as the chat facility or collaboration during the writing process (Munneke et al., 2007; Erkens et al., 2005). This could have been caused by a lack of familiarity with the diagram tool and has implications for providing students with sufficient experience in using a new representation.

Constructing a mind map requires grouping and categorising activities, which could promote a global view of the text to be produced with a variety of possible organisational strategies. The mind map form has the potential to encourage cognitive activity based around content generation and organisation. As Zhang (1997, p. 180) points out, 'external representations are not simply inputs and stimuli to the internal mind, but … cognitive activity is guided, constrained and even determined by them'. The mind map form could scaffold thinking processes to create grouping strategies particularly important for the structure of thematic text types.

A good representation system can be said to capture exactly the features of a problem that are important, rather than representing everything (McKendree et al., 2002). The features highlighted by the mind map concern ideas generation through the concepts represented and overall text organisation through the branch structure, leaving local decisions concerning sentence construction to be made as the writing task progresses. The mind map form is flexible enough to allow collections of specific vocabulary to be made, which can alleviate difficulties around the spelling of certain words. Non-fiction text types make use of specialised vocabulary and cohesive ties in the form of connectives. These elements can be recorded as a section of the mind map to act as a word bank as writing commences.

Scaife & Rogers' (1996) concept of 'external cognition' specifies particular three advantages for the use of diagrams to support learning. One is the 'computational offloading' available through the use of external representations; in this way diagrams can provide additional external memory. This could be seen to assist the generation of content as the mind map is constructed and as an ongoing source of reference as transcription takes place. The second derives from the 're-represented' form. The overall structure is represented in one display with visible connections on a mind map. Each of the content elements for a written text are briefly summarised into concepts on a mind map using keywords. This enables the author to perceive the structure clearly and, if necessary, to change the locations of concepts which is easier on a mind map than in a linear planning document. Finally, 'graphical constraining' means that inferences are limited by the way information is presented; a lever represented on a diagram will have a specific size, shape and location relative to other elements of the diagram. On a node and link diagram this visually determined aspect is less important as text still tends to be the mode of communication and ambiguities can still remain, but decisions about the relationship between nodes have to be made, elements are placed in relation to other elements. This necessity clarifies the grouping of information or highlights choices that can be made about the location of concepts presented on the mind map and in the subsequent written text.

In addition to acting as external memory for the individual learner, the resulting document can also be accessed by a wider community of learners. Collaboration can also involve the use of external representations. Barron (2003) found that successful groups co-ordinated their joint attention through a variety of strategies, including the use of external representations. A number of studies have specifically investigated the role of different external representations when combined with collaboration (Naykki & Jarvela, 2008; van Amelsvoort, 2006; Kinchin & Hay, 2000). Suthers & Hundhausen (2003) explored the use of representations for collaborative problem-solving with older students working across computer networks and identified three possible factors that could be implicated: meanings could be negotiated, there was a representational proxy for gestural deixis and there was a visual foundation for shared awareness.

Negotiation using a shared representation becomes necessary as disagreements are likely to arise between the participating authors. This may impact on the way items are represented. Resulting discussion over elements of a shared representation may also provide cues to associated shared or individual knowledge. In Suthers & Hundhausen's study (2003), three conditions were investigated. Participants constructed either a node and link diagram, a 'graph', a diagram consisting of rows and columns in a spreadsheet-type format, a 'matrix' or wrote notes in the 'text' condition. Results showed that participants in the 'graph' condition had better content in post-test essays when compared to matrix and text-shared representations. Revisiting previously discussed ideas was also more prevalent in the 'graph' condition, which could encourage more consideration of content ready to include in a written text.

The external representation can also offer a visible record for focused intervention. This can be a peer, for support or collaboration, or a teacher who can identify misconceptions or a lack of content in areas related to the writing task. This gives an opportunity for contingent intervention before the child proceeds to transcribing the written task, where it is more difficult to make structural changes.

In conclusion, graphical representations have been shown in some instances to have beneficial effects on learning and can offer a scaffold for particular kinds of cognitive activity. It is not clear from existing research whether young children can be taught to construct mind maps, which is the first question posed by this thesis. Mind maps potentially offer a structure to organise content in categorised and hierarchical form, which could then possibly be a framework for a written task if children can be supported to engage with this representation successfully. Such a planning tool might be particularly valuable when linked to certain genres of writing, which are part of the present literacy curriculum requirements and hold particular challenges for young children. Research evidence shows that children find writing challenging, but that 'process'-based strategies can improve performance and separating planning from the transcription phase could offer benefits to the novice writer.

There are few reported studies that investigate the impact of planning written tasks using mind maps with primary-aged children or that investigate the links between this kind of representation and the resulting written task.Therefore the final two research questions are:

3) Can mind maps be used as a planning tool to improve written tasks?

4) Is there a relationship between the structure or content of a mind map and the subsequent writing task?

Chapter 3: Methodology

3.1 Introduction

As stated in chapters 1 and 2, the aim of these studies was to ascertain whether primary-aged children could construct mind maps and use them as a tool to plan written tasks. Children were introduced to a particular form of graphical representation and their work analysed to gauge whether or not this was suitable intervention in a primary classroom. The representation was seen as a tool for learning, rather than an end in itself, and as such had to be evaluated in a particular task environment, in this case as part of the writing curriculum. There appeared to be very few studies which had investigated mind maps or concept maps in this field (Nesbit & Adesope, 2006; Riley & Ahlberg, 2004).

Studies reported in this thesis developed from an initial exploratory intervention and as a result experiments were designed to investigate the impact of using mind maps to plan written tasks. Further interventions were designed to support the construction of mind maps, including the social environment in which the mind map construction took place. The research conducted throughout these studies uses an experimental paradigm, but is conducted by a practitioner working in a naturalistic setting in a primary school.

3.2 Real-world environments

Robson (2002) makes the distinction between 'real world' and laboratory studies. Research in the real world is distinguished from laboratory study by a lack of control and 'messiness' which is inevitably present in the situation. There is a tradition of conducting educational research in this way. Brown (1992) abandoned research in the laboratory to conduct her design experiments in the 'rich, complex and constantly changing environment of the classroom' (p. 144), with the aim of contributing both to theory and practice, and developing active strategies for learning. She describes her earlier interventions, conducted as laboratory investigations into learning, as taking place over a very short timeframe with little thought to the teaching method employed, usually didactic in nature, and often on a one-to-one basis (p. 147). Working in actual classrooms offers the opportunity of developing authentic tasks over more realistic timeframes to judge the impact of an intervention.

Classroom environments are important because of the social aspects of learning, acknowledged to be an important part of the learning process. In these environments, support from the 'more knowledgeable other' (Vygotsky, 1978) can be provided by teacher, learning support assistant and peer. Results gained in this environment may well differ from conditions in a laboratory where children would be working in an unfamiliar setting and possibly not with familiar peers. The resulting findings may therefore have a greater relevance to other similar classroom environments than work carried out in laboratory settings.

Barab & Squire (2004) put forward the view that research in the learning sciences field investigates cognition in context, making the argument that naturalistic settings have a vital role to play in investigating and improving the processes of learning. The Pittsburgh Science of Learning Center identifies 'in vivo' learning experiments as having 'ecological validity': the experimental setting is in the field with real students pursuing real course goals over realistic durations. This is another aspect of work in real classrooms: the interventions can be designed around real curriculum goals; the setting and the tasks are authentic.

The associated problems with this approach come with the understanding that working in real classrooms brings with it problems of generalisability and replicability. Classroom environments change over time, as a result of changes in curriculum and organisation. The findings reported from one very specific context may only have suggested implications for other contexts and replicating the study may be difficult.

3.3 Practitioner as researcher

The reported studies were all carried out by a practitioner–researcher working as a classroom teacher in the primary school with the children whose work is examined. This has many advantages as the children were all comfortable with the researcher, colleagues were supportive and timetables flexible enough to accommodate the research during a normal school day. As noted by Robson (2002), practitioner insights and role help the design, implementation and analysis of useful and appropriate studies. Studies could be adapted to be relevant to the prevailing curriculum requirements, which were familiar to the practitioner–researcher.

Continuing professional development as a teacher can also include small-scale research in areas of interest to school priorities and development goals. This tends to be in the tradition of action research, looking at personal practice and reflecting on progressive series of intervention in a 'plan, do, review' cycle. The research is directed at improving personal practice in a particular situation, with the emphasis on personal development (McNiff & Lomax, 2003). An increasing emphasis on research-informed practice in teaching (Cochran & Lytle, 1999) is leading teachers to be more informed about existing research and to become personally involved. Desforges (2004) claims that the involvement of teachers in research has the potential to make important contributions to academic achievement and lifelong learning for pupils, while also enhancing the quality of teachers' own professional knowledge. A recent review (Bell et al., 2010) supports this argument. The review reports a number of advantages for teachers and their students in the use of professional research. Teachers who carry out research are engaging with a wider research community and achieving positive outcomes for their students.

Disadvantages of the practitioner–researcher approach come from a possible lack of research skills and confidence in pursuing research goals (Robson, 2002). In this case, research skills have been developed and supported by a doctoral programme and supervision during an extended period of part-time study. The choice was made to look at the effects of a particular intervention rather than concentrate on aspects of personal practice, in an attempt to suggest a strategy for supporting children's learning, which could be recommended to a wider audience than the context in which the research took place.

The difficulties of researching practice in the workplace using an experimental research framework can also be seen as lack of distance between the researcher and the context. A detached researcher role is arguably more difficult to assume. This means that the methods chosen and the checking of data must be particularly transparent and rigorous in order to compensate, as far as possible, for suggestions of researcher bias influencing the reported findings.

3.4 Choice of methods

The philosophical stance taken in these studies is that of a critical realist (Robson, 2002). There is an acknowledgement that 'truth' is a difficult concept and investigations are limited by the political, social and cultural context in which they occur (Cresswell, 2009). However, there is also a belief that a shared reality exists and scientific method can be used to identify some aspects of this reality (Muijs, 2004) which can in turn contribute to ongoing debate and understanding. Reichardt & Rallis (1994, reported in Robson, 2002) bring the beliefs of researchers working in qualitative and quantitative paradigms together by describing the beliefs they share, which are:

- There is a value-laden aspect to enquiry and a theory-laden aspect to facts
- Reality is constructed, complex and multilayered
- Sets of data may be explained by many different theories.

A scientific attitude (Robson, 2002), whether using quantitative or qualitative methods, incorporates three aspects: a systematic mode of working, which has involved serious thought and consideration of all the factors involved; scepticism about the findings which can be held up for scrutiny; and an ethical framework which safeguards the welfare of all involved.

3.4.1 Experimental method

The following research studies into children constructing mind maps have been framed by an experimental design. This was in order to make an evaluation of the impact of introducing the mind map representation across the 7–11 year old population in a particular primary school. The research was related to the stated aims of the school to improve the teaching of writing, and it was felt that innovative planning techniques through the use of this representation may have had a beneficial effect. The collection and analysis of data related to children's writing levels was seen as relevant evidence to gauge the effectiveness of this intervention, which could be reported to colleagues and possibly impact on practice in the school. Teachers are familiar with assessing children's work using grading schemes that are moderated nationally in England and Wales. Again, this is an advantage of working in a real-world situation; the resulting findings appear to connect to practitioners more directly. The finding reported can then have a greater impact on practice. As Anderson (2002) notes, 'It is some-how more compelling to read an account by fellow insiders' (p. 22).

The method consisted of children being allocated to groups on a random basis across class groupings, though there was an attempt to ensure a mix of gender and abilities in most cases. Groups were then treated in different ways according to an independent variable. Examples of this include children in one group being given support for the map-making process compared to a group given less support, or groups completing a writing task with or without a mind map plan. The resulting outcomes were then analysed as dependent variables. These were most often the features of the mind maps produced by each group and the quality of the written work.

Independent variables were limited as much as possible to ascertain impact on the way the children produced mind maps and the quality of the written tasks. However, this was tempered by the fact that children were in classrooms and as far as possible engaged in authentic tasks, which involved conversations with familiar peers and the teacher–researcher. Though the focus was on a limited number of variables, the tasks involved were complex and a number of measures were used to identify the outcomes. The experiments were designed to investigate the impact of using mind maps in a variety of situations and it became clear that, despite attempts to make the context as similar as possible, the tasks themselves had a significant effect on the outcomes. Social interaction was not a feature of the research in the first four studies but became an independent variable for the last two studies.

There was no use of a separate non-intervention control group for any of the experiments carried out. Using a non-intervention control can present ethical problems when working in an educational context, where some children could be seen to be disadvantaged by being excluded from a beneficial intervention (Muijs, 2004). The restricted number of participants was also problematic in using a control group, as the studies were based in one primary school. This was a school with a one form intake, meaning one class of children for each of the four KS2 year groups. Some of the studies compensated for this by using a repeated measures design where children acted as their own control. There is an acknowledgment that this can result in order effects, which are discussed in the relevant studies. There are also problems with participants not always being available for all parts of the study, which has resulted in fewer data sets in some instances and the numbers in groups becoming unbalanced.

Following the exploratory work, each individual study developed organically as a result of findings from the previous work and was related to a predetermined set of hypotheses.

3.4.2 Measures

The two main products investigated in these studies were the mind maps constructed by the children and written work produced with or without an initial mind map plan. This section will be divided into two parts to explain the measures used to score first the mind maps and then the written work.

3.4.2.1 Mind map scoring

The two influential resources used to inform these studies on mind maps do not provide guidance on making any assessment, qualitative or quantitative, of the mind maps produced. Buzan (2000) offers no criteria for scoring mind maps in his work, though suggests that there will be a process of improvement and revision involved in constructing the representation. Caviglioni & Harris (2000) also do not provide a mark scheme to distinguish more accomplished model maps.

As a result, other work has guided the design of a mark scheme. Novak & Gowin (1984) designed and employed concept maps to gauge students' developing understanding of science concepts and developed a scoring system based on the components and structure of the concept map. Novak & Gowin's system assigns points for valid propositions which includes two concepts joined by relevant linking word (1 point each), levels of hierarchy (5 points for each level), number of branchings (1 point for each branch), cross-links (10 points for each valid cross-link) and specific examples (1 point for each example). This complex system gave a detailed assessment of the concept map with a summative score.

The ImpaCT2 study (Harrison et al., 2002) used concept/mind maps to assess children's developing understanding of digital technologies, and again a complex scoring system was devised to compare maps created at the beginning and end of the study. This was based on the number of nodes, the number of links, the type of map and the depth. These maps were created using images, though many were found to include words. There was some teaching on the formation of concept maps but the emphasis was on children using the representation flexibly to convey their knowledge. The study found a great range of map construction but the types of map generally conformed to five identifiable constructions:

- Unconnected – a map which contains content in the form of nodes but without links
- Linear – a map where the nodes are linked in a sequential fashion; each node is linked only to its predecessor and successor
- One-centred – a map with a clearly discernible central node from which links to other nodes radiate outward
- Several-centred – two or more nodes are detected in the map which act as centres of interest
- Spaghetti – this rather graphic term was used for a concept map in which the linkage between nodes was so intense that the map resembled a plate of spaghetti.

The depth of the map was calculated by counting the maximum number of nodes attached to any one section of the map. Hence a map with no links has a depth of 0, and a map which resembles a spider (one body with legs attached to outlying nodes) has a depth of 1 and adding another node to one of the legs increases its depth to 2.

Kinchin & Hay (2000) also categorised concept maps into three categories, based on the form of construction. These were identified as 'spoke', 'chain' and 'network'. Spoke had nodes radiating from a central concept; chain was a series of linked concepts in a more linear form, each node relating to the one above and below in the structure; network was a series of interlinked concepts. The three types of concept map were judged to show the level of understanding in a particular area of knowledge. Networks were judged to show the greatest and most complex understanding of a given domain.

Mind maps in this study were not used as a representation to assess a child's growing understanding of a given topic. The object was to introduce a tool to engage children in a planning process which would encourage the generation of possible content and give a structure to that content. This mind map tool could then inform a subsequent written task. Initially, it was decided to investigate the particular features of the mind map, which could then be judged in relation to the writing task, rather than simply give an overall score. The features investigated were number of organising branches present on the mind map, number of connections present and number of words written. Connections were the concepts recorded on the mind map. Unlike concept maps, mind maps record the concepts on the lines which make up the diagram. There should not be a separate line to a node; line and node are incorporated. In practice, many of the children's mind maps had a line and node structure, but there are no linking words as on a concept map. Numbers of words and connections measure different aspects of the mind map, as one concept could be indicated either by a single keyword or a short phrase. Analysis of the mind maps showed that some children had difficulty in expressing concepts in keywords and an increased word count did not necessarily imply a greater number of concepts.

One result of the exploratory study, reported and discussed as a finding in chapter 4, was the development of a classification of mind map types, which bears some resemblance to the characteristics identified in relation to concept maps by Kinchin & Hay (2000) and the types and depth of maps classified in the ImpaCt study (Harrison et al., 2002). It was felt that the numbers of features alone did not give a picture of the range of mind maps produced. The resulting classification was based on the structural features and levels of hierarchy present on the mind maps. As will be seen, it was possible to apply this classification scheme reliably across the studies.

3.4.2.2 Writing scores

As has been previously stated, a major focus for these studies was to investigate whether planning writing with a mind map would improve the quality of written work produced. Children's written work is routinely assessed in English primary schools using the level descriptors provided in the national curriculum documentation (DfEE/QCA, 1999). This outlines national expectations for children's achievement in broad categories; each level of achievement is expected to take two years to accomplish by the majority of children. The expected levels of achievement in KS2 runs from Level 2 to Level 4. These broad categories are broken down into three sub-levels which means that progress can be more closely monitored and achievable individual targets set for children in each of the four years in KS2.

At the time these studies began, the national primary strategy team had not supplied one detailed criterion scale to inform judgments on writing, so a variety of resources were developed by local authority teams or consultants to assist teachers in making judgments and setting targets for children. The scale used in the first two studies reported in chapter 4 and 5 uses a mark sheet developed by Derbyshire's literacy team incorporating a variety of resources authored by the DfEE (see appenidix 1). This writing assessment grid used seven categories to define writing skill: phonics and spelling; handwriting; language effects; sentence construction; punctuation; purpose and organisation; and process. Each skill set was described in relation to national curriculum levels and sub-levels from a starting point below Level 1 extending to Level 6. The grid gave no advice on the weighting of each area of skill. This could lead to differing judgments made on the relative importance of each skill as judged by individual teachers. In order to ensure greater consistency in assessing levels and sub-levels various moderation activities were carried out nationally and these writing levels were assessed in national tests. Time was given in schools internally for teachers to work together and moderation was also conducted across groups of schools, leading to high levels of agreement. As a practising teacher these moderation activities had been part of my training over a number of years and informed the judgments made about the quality of children's written work. In addition, in order to confirm the judgments made in these studies, the writing scores were assessed by a second marker, also an experienced teacher, who was blind to the condition under which the writing was produced, and a high level of agreement was reached as described in the individual studies.

The later studies reported in chapter 7 used a similar but weighted criterion scale developed by an independent literacy consultant (Wilson, 2003) that was then being used across the school. This looked at a similar set of skills, but included an initial set of criteria to be fulfilled for each level before the detailed indicators of each of the three sub-levels. This was felt to give more guidance in making a decision about the quality of the written work and was therefore employed to assess the writing in the final two studies. A second marker assessed the work using these scales, and the resulting agreement was high.

Writing levels and sub-levels were converted into one numerical score to facilitate statistical analysis. A Level 1 was scored as 1, Level 2c was scored as 2, Level 2b scored as 3, etc. These scores were still judged as an ordinal scale rather than an interval scale so nonparametric statistics were employed to analyse correlations between the writing scores and the mind map characteristics (Field, 2005).

A total word count for each piece of writing was also included. Research by Snow et al. (1991) had found a high correlation between writing length and scores based on holistic ratings and other measures such as the sophistication of vocabulary. A measure of writing length provided further validation for the writing scores awarded, as the correlation between word count and writing score was found to be significant in the studies presented.

3.4.3 Quantitative analysis

The measures used in each study gave data which were then analysed statistically to assess the nature of the mind maps produced and the quality of the written work. In many cases nonparametric statistics were employed as mind map levels and writing scores were typically ordinal in nature. However, where the data meet the assumptions of parametric tests, they were preferred (Field, 2005; King & Minium, 2003). Possible relationships between the mind maps and written tasks were investigated by the use of correlation tests, again using nonparametric statistics. More detailed analysis of items in common with both mind map plan and written task were also investigated, as the writing score encompassed a number of criteria not expected to improve directly as a result of more detailed planning, such as phonic spelling strategies and sentence construction.

Levels of significance are reported, using p values. It is recognised that these values are linked to sample size and that the commonly used values have a somewhat arbitrary nature (Field, 2005; Muijs, 2004), therefore effect sizes are also reported in the results for each study.

3.4.4 Qualitative analysis

The main emphasis of each study is to judge the impact of the intervention through statistical methods in line with the experimental approach taken. In addition, it was felt there was some value to be gained in providing examples of the work produced, in order to illustrate the range of mind maps collected and the relationships between mind maps and written work. Each study reported, therefore, has included examples of the children's work with interpretive commentary.

3.4.5 Trustworthiness

The following sections, 3.4.5.1 to 3.4.5.3 relate to the trustworthiness of the studies conducted and the results presented.

3.4.5.1 Reliability

Studies conducted for this thesis were based on good sample sizes, reducing the effects of individual participants performing in an atypical way when data were gathered. It is acknowledged that the real-school environment does bring its own challenge; sometimes children were called away in the middle of sessions or sessions had to be organised to fit in with the more pressing demands of the school timetable. Statistical results can be altered by the influence of such factors. The six studies reported were carried out over a number of years and included changes in participants as children progressed through the school. Some of the findings were replicated consistently across the studies, which suggests that participant error or bias is not a strong factor.

Observer error was minimised by the use of second markers for written work and aspects of coding and the ensuing interrater reliability assessed. Results reported show interrater reliability to be at 0.8 or above in most instances. Observer bias was reduced by the use of statistical methods to investigate effects. Finding representative individual cases where mind maps had proved a valuable tool would have been easier to differentiate than the more challenging process of judging results taken from the cohorts of children who participated in the studies.

3.4.5.2 Validity

A number of possible threats to internal validity have been identified (Cook & Campbell, 1979; Campbell & Stanley, 1963, cited in Robson, 2002), which will be considered in turn.

History – Cannot be completely ruled out as circumstances in schools change over time and this includes the methods for teaching writing and the use of representations. Children in this school were more familiar with mind maps as a representation by the time of the two final studies and making some kind of plan for written work was common practice across the school. Writing was a focus for school improvement and a number of strategies were routinely used to support children's achievement.

Testing – Children were not subjected to any formal tests as a dependent variable for the studies reported and were expected to write on a regular basis as part of the school's normal curriculum. Any general improvement in writing standards achieved across the school would not have prejudiced the results, which were based on comparing effects of using mind maps or discussion in Study 2 and looking at the impact of collaboration in Studies 5 and 6.

Instrumentation – An alteration in instrumentation did occur, in the case of writing scores, during the course of the studies reported. This is made clear in the measures section dealing with writing scores, 3.4.2.2. However, writing outcomes have not been compared across studies where slightly different mark schemes were used, so this should have no impact on the reported findings.

Regression – Participants were not selected by measures of writing ability, but randomly grouped from the school population. Each study included children with a wide range of writing ability.

Experimental mortality – Each study had a large enough group of participants to be viable even when some children were absent for part of the process. In each individual study, where comparisons were made, incomplete children's scores were excluded from the analysis if they were not present to complete the required tasks for that part of the study.

Maturation – Studies continued to draw on the population of KS2 in the same school which continued to be children between the ages of 7 and 11.

Selection – Groups were subject to change owing to some absence during the studies. Statistical analysis was able to identify if the particular composition of one group was having an influence on the outcomes.

Selection by maturation interaction – This was not a problem as each individual study took place over relatively short timespans, no more than one school year.

Ambiguity over casual direction – The correlational findings reported show possible relationships between aspects of mind maps and written texts, but it is accepted that there could be a precursor to explain these outcomes. There are no claims made that improved mind map construction is a cause of better written texts.

Diffusion of treatments, equalisation of treatments or compensatory rivalry – None of these effects appear as problems in the studies conducted. All groups studied were involved in very similar tasks.

3.4.5.3 Generalisability

It is recognised from the outset that these studies have all been conducted in a particular context at a particular time and claims for generalisability would need to be demonstrated by further study in other contexts. However, the decision to use an experimental method was made with the expectation that the findings could apply to children's learning in similar primary school settings.

The school population was varied in terms of social class and range of ability, in common with many other suburban primary schools. The school was judged to be 'good' by Ofsted reports, which implies that children were making satisfactory to good progress against national expectations, judged by national standard assessment tests. Teaching conformed to the national curriculum (DfEE/QCA, 1999) and used the National Literacy Scheme guidance (DfEE, 1998) from its introduction and later the Primary Strategies guidance (DfES, 2006). This implies the sample presented would have much in common with the wider population of primary school pupils.

The fact that the interventions took place in a real world setting also has an advantage for the claim of external validity (Frankfort-Nachmias & Nachmias, 2008). These were not laboratory studies, which meant the results were gained in a natural setting. In addition, the researcher was a familiar member of staff and children accepted the study tasks as a normal part of their school day. This minimised the possible impact from having an unfamiliar researcher, and a situation in which the children could have reacted in an untypical way.

3.5 Ethics

Research was carried out with reference to the British Educational Research Association guidelines for educational research (BERA, 2004).

Permission for the research to take place was originally sought from the head teacher, who gave his consent. Consent was also sought from other members of staff to ensure that children could attend sessions and that the teacher-researcher's own class could be covered at times.

All participants were informed about the research and parental permission was sought and received for their children's involvement in the project. Children were expected to attend sessions as normal, as each was part of a timetabled school day and writing sessions in particular were a normal feature of a week's work in school. However, in the single case where parental permission was not obtained for a child's work to be used, these sets of results were not included in the study.

Permission was also sought and received for presenting findings from the studies at conferences and in written papers. No information that could identify individual children was given during conference presentations and all names have been anonomised in this thesis.

Every effort was made to cause the minimum amount of disruption to normal school routines, and data collection procedures involved no additional workload on children taking part. Children were familiar with the teacher–researcher and the reasons for the studies. The written work used as data was produced during the course of normal literacy lessons and completed as part of timetabled sessions. Children were not expected to spend any time during break times or after school to complete the work.

As the researcher was a full-time member of staff at the school, parents with any questions regarding the impact of research sessions on the children's education, or enquiries about the motives behind the research, could easily make contact. School governors were also apprised of the research and some discussions evolved during the period of study, with particular governors showing an interest in the outcomes of the children's developing skill. Information gained from these studies was and will be made available to the school staff and interested parents or children on completion of the research.

All data have been securely kept in line with the Data Protection Act and are only accessible to the lead researcher and research supervisors.

Chapter 4: Study 1

Using mind maps as planning tools for narrative writing tasks

4.1 Introduction

This chapter describes the initial study into mind maps as planning tools for narrative writing tasks. The investigation and data collection were carried out over one academic year as part of a Best Practice Research Scholarship awarded by the DfEE, in collaboration with the National Union of Teachers and Newcastle University, in 2000. A group of teachers from around the country were supported to carry out projects in their own classrooms linked to 'thinking skills' approaches. There was an appreciation by government that these kinds of approaches could raise children's achievement and recognition of their popularity with a growing number of practitioners and researchers. Carol McGuiness was commissioned in 1999 by the Department for Education and Employment to write a report into thinking skills and associated research and found that: 'Several classroom evaluation studies have successfully linked teaching thinking methodologies with learning outcomes both in the short term and the longer term' (1999: p. 1).

The NUT and Newcastle University support entailed personalised mentoring, together with training in framing appropriate research questions, data collection and analysis, and subsequent advice on writing a suitable report to be published on a teachers' research website.

This particular study was carried out in one Nottinghamshire primary school, through the participation of two primary school classes being taught by the teacher–researcher at the time, taking into account the development aims of the school. There was an interest expressed by members of staff in using 'thinking skills' approaches across the curriculum, and in introducing innovative ways of incorporating higher-level thinking strategies into classroom practice. In common with many schools in the UK, the school had experienced a rise in reading standards after the implementation of the National Literacy Strategy (DfEE,1998), as measured by standard assessment tests. However, standards in written work remained a cause for concern. The head teacher of the school was happy to support innovative approaches to address this situation. Mind mapping was identified as a novel way to support planning for writing and this became the focus of the study.

4.2 Graphical representations in learning

As detailed in the literature review, there are a number of related graphical representations which use a node and link structure to represent knowledge in a given domain or to serve as a scaffold or support for a particular task such as collaborative writing (Ralston & Cook, 2007; van Amelsvoort, 2006; Suthers, 2003; Jonassen, 1998).

'Concept map' is the term often loosely applied to a number of related graphical representations. Originally, concept maps were developed in science education by Novak & Gowin (1984), mainly as an assessment tool, and are now investigated in various contexts by a growing research community, including as a planning tool to support writing (Riley & Ahlberg, 2004). Mind maps have a very similar construction, though are arguably simpler, and have been promoted by Buzan (2000); similar constructions called 'model maps' have been advocated by Caviglioni & Harris (2002, 2000).

Mind maps were chosen as a suitable representation for this study, as they appeared to offer a relatively simple structure, which would be within the grasp of a 7–11year old student, especially when compared to the more sophisticated organisation on a fully developed concept map.

It was envisaged that mind maps could be used as planning tools for children's writing tasks as they offered a structure for generating and organising ideas. The potential benefits were considered as follows:

A novel representation: Children in the study had not been introduced to this kind of planning tool previously. It was hoped that they would engage with learning a new representation and appreciate an alternative method of organising ideas.

A tool to generate ideas: Children were encouraged to create a rapid, free-flowing association of ideas that could be quickly recorded. Concepts on a mind map are represented briefly using keywords, supported by images if it is felt appropriate. There is no requirement to write in fully formed sentences. This means that ideas are less likely to be lost owing to difficulties with the recording process. Potentially, this could stimulate the production of a rich fund of content to populate the written task, as a large number of associated ideas can be represented with relatively few words. This economy appeals to young children who often view writing, especially writing in correctly formed sentences, as an onerous task.

Structure to provide organisation: Ideas stored in memory, together with sets of associations, can be recorded and possibly reorganised within the constraints presented by the diagrammatic structure. The relationships between ideas can be explored and made explicit in mind map form. Structuring a map well leads to related groups or clusters of concepts, but there is no expectation that any written task would necessarily engender a particular or correct set of groups. Mind maps offer children a structure to generate and organise their personal set of clustered content before attempting to convert it into formal text. This leaves children free to find their own way to organise first the mind map and subsequently the linear text.

Writing prompts: Specific items can be recorded on mind maps to act as prompts during the writing process. This could consist of particular word lists as a reminder to use a range of description or relevant connectives. In story writing, particular elements, such as setting or main characters, could be identified and developed as part of the mind map. In particular, the important elements of the story can be identified and considered before writing – such as the ending and resolution, which often prove problematic to children. Writing prompts have been successfully used to support children with expository writing tasks

(De la Paz et al., 1999; Wray & Lewis, 1997).

External memory source: The mind map becomes a record of thought processes and a collection of relevant content which can then be referred to during the writing process (Scaife & Rogers, 1996). This could be particularly useful to novice writers who are still struggling with a range of competing demands when engaged in writing.

Thought scaffold: The process of producing the mind map alters the way the child approaches the task, providing a stimulus to consider various aspects of the task and the possibility of a variety of solutions to the particular writing problem.

However, set against these potential advantages, potential difficulties were also envisaged. To make the best use of any representation, a learner needs to be familiar with the form. If the learner is too preoccupied with understanding the conventions of the representation the advantage for learning can be negated. Instead of making the task more manageable, it can become a complication (Ainsworth, 2006). The participants in the study were new to this form of presenting information, so a suitable length of training to become familiar with the representation was necessary. In addition, once the form of representation was mastered, the relationship between making a mind map and using this as a planning tool for a written task also needed to be understood.

One purpose of the study was to investigate whether children found any benefit in producing a mind map as a planning tool, whether gains were outweighed by disadvantages in mastering the mind map form, as well as looking at any links between the planning process and the resulting written work.

As previously stated, young children find writing a particularly difficult challenge. Writing at any stage is concerned with generating content, addressing a particular audience, using appropriate structures and vocabulary, all of which can be intimidating for adult writers. But, at this early novice stage, children also have to contend with processes adults tend to have automated, such as handwriting, grammar and spelling. A suitable method to encourage effective planning appears to offer some alleviation for this cognitive challenge. Flower & Hayes (1981) described planning as a 'hero' of the writing process as it can support goal setting, content generation and organisation and text structuring. Constructing a mind map to work as a plan could facilitate the shaping of ideas into a cohesive form and outline an overall direction for the text in advance. These wider aims considered at a planning stage leave the writer free to concentrate on local issues, such as improved vocabulary selection, better punctuation and sentence construction when engaged in producing text – the transcribing stage. Although Bereiter & Scardamelia (1987) were sceptical about young children's ability to plan, older students have been shown to profit from outlines (Kozma, 1991; Ruddell & Boyle, 1989; Kellogg, 1988), therefore it seemed logical that some kind of planning tool might also offer advantages for younger writers. In addition, planning was advocated as a teaching strategy by the National Literacy Strategy (DfEE, 1998), and national standard assessment tasks (SATs) for writing incorporate a planning section, which children are entitled to make use of on the examination paper.

4.3 The Exploratory Study

This initial exploratory study was designed to explore children's ability to create and use mind maps. All the 8–10 year old children in two separate classes were novice mind mappers. It was expected that children would be able to produce plans for written tasks in mind map form after a suitable period of specific training, though it was not initially clear how long a suitable period of training would be. There was also a question around the level of cognitive maturity necessary to produce this kind of representation. As the year progressed, it was expected that the children's ability to produce structured maps would increase.

To facilitate children's understanding of the representation, work using mind maps in a number of curriculum areas was introduced, with the support of the two class teachers involved. Although the data collected and reported on in the study came from tasks where mind maps had been used to support and plan aspects of narrative writing tasks, a number of other tasks were carried out using mind maps during the course of the year. This was important to consolidate an understanding of the mind map structure for the children, while also extending the use of the mind map as a 'thinking tool' in other areas of the curriculum

4.3.1 Aims

One aim, identified at the beginning of the study, was that, once mastered, this kind of planning would prove more popular with children and be regarded as useful. Generally, teachers' experience in the school had been that children were resistant to making any kind of written plan before starting to write and found little or no value in the process. This was often evidenced in examination papers where the planning box was left empty or with very little content.

A further aim, was that this kind of planning would enable a greater degree of forward thinking. In the main, it was found that although children's written work often began well, it tended to lose momentum and end in an unsatisfactory manner. Planning using a mind map it was hoped would show a beneficial effect by enabling children to have a better overview of the whole structure of their written text, including a satisfactory ending.

4.3.2 Design

This was an exploratory study looking at the mind maps linked to written tasks produced by two groups of children over the course of a year. Simple questionnaires were used to assess children's reactions to learning the new representation. Data, in the form of maps and associated written work, were collected at two points during the year – in the autumn term and in the summer term. The investigation was exploratory practitioner research to begin to assess the impact of innovative classroom practice.

4.3.3 Questions for exploratory Study 1

The first set of questions related to the ability of children to learn how to construct a mind map. It was recognised that to be able to construct mind maps, as described by Buzan (2000) and Caviglioni & Harris (2000), grouping strategies and ability to name the groups would be necessary. It was not clear whether children would be able to generate category headings for use as branch headings. This involves a level of abstraction in language use, which might be inappropriate for the maturity of primary school children.

The second set of questions clustered around the usefulness of the representation as a planning tool. Could children produce mind maps as plans for narrative writing tasks? Would this particular form of planning be more successful and popular than others used in the past? Various other planning strategies had been used, but something that was relatively quick to produce and involved organising as well as generating content in this way had not been tried.

Finally, the study sought to explore the nature of any relationship between children's mind maps and the subsequent written text.

4.3.4 Participants

The participants were 73 children in two junior classes in the same Nottinghamshire primary school. Both groups had a similarly mixed range of abilities and gender. One class consisted of 35 children, 19 girls and 16 boys between the ages of 8 and 9 years; the other class had 38 children, 21 girls and 17 boys, between 9 and 10 years old.

4.3.5 Procedure

Both classes were taught how to construct mind maps, following a procedure outlined in 'Mapwise' (Caviglioni & Harris, 2000). A series of three linked 45-minute sessions introduced the key features of mind maps for each of the two classes. This began with the concept of keywords to express ideas as economically as possible, a kind of note-making, leading on to an exploration of the structure of tree diagrams from a series of worksheets provided in the book. This introduced the concept of hierarchical organisation, a crucial element of mind map construction, as the finished map should consist of a number of tree diagrams surrounding a central concept. All these sessions were introduced by the researcher. During the final part of the third skills session, each child had time to produce an initial mind map either about themselves or on the topic of holidays.

The two participating classes had a class teacher in addition to the teacher–researcher. Both teachers were introduced to the principles of mind mapping by being present at the children's training sessions. Their support meant that children in the two classes gained additional practice by using maps in other areas of the curriculum during the course of the year, including maths and science.

Two writing tasks were then planned using mind maps and data collected from each class: the first in November, following the mind map teaching sessions, from both groups; and another later in the year, in April from the Y5 class and in May from the Y4 class. This is summarised in figure 4.1. Brief anonymous questionnaires were also used to gain feedback from the children.

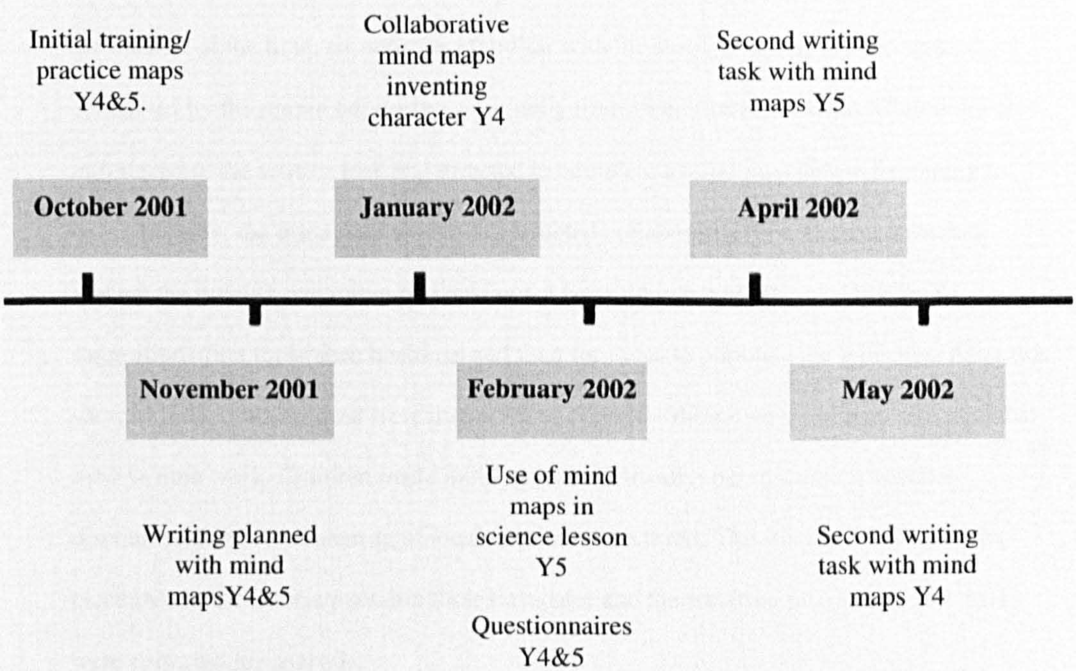

Figure 4.1: Timeline for Study 1

4.3.6 Questionnaires

In order to assess children's opinions on the usefulness of learning a new representation, a short questionnaire was distributed to both classes in February, about halfway through the period of research. In line with ethical considerations, children could refuse to fill in the questionnaires and if choosing to answer could respond anonymously. The three questions were open to elicit as wide a response as possible. Children were asked: Have you enjoyed making mind maps? What did you find useful? Can you think of other ways to use them? The resulting responses were grouped into categories and counted.

4.3.7 Writing tasks

Task 1 and 2: 8–9 year olds

Task 1 for the Y4 children, completed in November, was the retelling of a familiar narrative: the biblical story of Joseph. The children were working on a school production of the musical at the time, so were very familiar with the story. The first session was conducted by the researcher during a normally timetabled literacy session. Children were introduced to the writing task and directed to complete a mind map before beginning to write. Initially, the mind map was co-constructed collaboratively, with the researcher leading the process, recording responses on a large whiteboard. The children made suggestions first for branch headings and then for items to populate the branches. After this short introduction, children were instructed to complete their own mind map as a plan for their written work. Children made mind maps individually, but discussion was not discouraged and some sharing of ideas inevitably occurred. The story-writing task took place in a further literacy session three days later and the resulting mind maps and texts were collected for analysis.

Task 2 for Y4, which took place in May of the same year, was to develop a suitable character to appear in a story. The associated narrative writing task was to incorporate a moral dilemma for this person (DfEE, 1998: Y4 unit 4). As the guidance for the task points out, 'Characterisation is fundamental. The main characters are often well-established from the beginning with additional detail such as background, history or interests included. The reader understands why a character feels the way they do.' It was hoped that identifying aspects of the character using a mind map would lead to more skilful characterisation in the narratives produced. The second task was also introduced as part of a literacy session, following work on stories with dilemmas developed by their own class teacher. The purpose of the task was to create a suitable character using a mind map, to feature in a dilemma story. The mind map construction took place in one session led by the researcher and the writing was conducted in another session two days later, led by the class teacher. Mind maps and writing were then collected and analysed.

Tasks 1 and 2: 9–10 year olds

Task 1 in November for the Y5 children was to describe an ideal day written as a recount, but based on fictional events of their own choosing. The session was conducted as a timetabled literacy session, where the activities for an ideal day were discussed and then children were directed to produce a mind map to record their ideas as a plan for the written task which was part of the same session.

Task 2 in April involved a retelling of a story incident in a published novel from a different character's point of view. This involved a complicated narration, where chronology was particularly important. The children were familiar with the story of Harry Potter, as it was being read as a class book. One episode was identified by the class teacher and discussed. The children were invited to make a mind map of that part of the story – taking into account that this would form a plan to help them with the writing task. For their own narrative, they would be writing in first person, as a character other than Harry Potter, to retell that episode. Unfortunately, time became limited and few of the texts were completed versions of the story. However, the texts and mind maps were collected and analysed.

4.3.8 Measures

4.3.8.1 Scoring questionnaires

Questionnaires had three questions. The first question asked for a positive or negative response to learning about mind maps and a yes/no answer was anticipated. This was the case and responses were simply counted.

Question 2 asked for a description of what the children found useful. Responses were analysed using a grid method under categories resulting from the answers given. This led to ten categories for Y5 and 11 for Y4 – many of these were similar. The categories in common from each class consisted of references to learning, memory, researching a topic, and generating ideas. Unique to Y5 were the categories of fun, speed, reviewing a topic, planning, ease of reading and constructing. Y4 mentioned spelling, recording information, categorising, setting work out, writing stories, making descriptions and finding mind maps interesting.

The third question had a range of responses also placed on a grid system, but the range led to fewer categories and both groups were considered together as reported in the results section 4.4.1.

4.3.8.2 Mind map scoring

A suitable scoring system for the mind maps produced was needed in order to quantify the children's developing skill in producing the representation and to make comparisons between mind map and writing task.

Mind maps have been scored in a number of ways, depending on the task for which they are being constructed, as outlined in chapter 3. Novak's concept maps were originally designed to assess the developing understanding of scientific concepts. In scoring concept maps, Novak & Gowin (1984) recommended analytical scoring of the maps on various criteria, while additionally taking into account the validity of the scientific concepts included and the levels of hierarchy present. This led to a numerical score for each concept map which could then be compared with a map produced later in a course of study with the purpose of judging improvements in understanding.

Pearson & Somekh (2000) used a form of concept map/mind map as a research tool to assess children's understanding of networked technology. In a similar way to Novak & Gowin (1984), part of this scoring system was numerically based on quantities of links and nodes. This scheme also included a judgment of map type and the depth of the map.

Following these examples identified in the literature, similar principles were adopted in order to produce a scoring system for this study. Mind maps produced for these tasks tended to be simpler constructions than either concept maps or the visual maps produced in Pearson & Somekh's work. This led to a scoring system originally based on content. A 'connection' was the main feature examined. This term incorporates link and node as concepts are placed on the linking line, in a Buzan-influenced representation (2000), and should consist of keywords to represent one idea or concept on the mind map. Mind maps varied in their use of keywords; some examples of connections consisted of long phrases or sentences. In order to analyse this tendency, the actual numbers of words on the mind maps were also recorded. As with concept maps, the degree of hierarchy present is important, so this was also considered and initially viewed as the number of branches present.

There was an expectation that the mind maps would be increasingly well structured as the study proceeded through the year and the children became more familiar with the representation.

If mind maps were to be useful as planning tools it was interesting to assess how much of the material presented on the mind map transferred to the written text. In order to quantify this, a count of how many branches were used in the written text was made.

4.3.8.3 Categorisation scheme for mind maps

A wide range of maps was produced from the four tasks. The numerical information was useful and is reported in the results section 4.4.2, but did not completely capture the varieties of mind map collected in the study. Further analysis led to a categorisation scheme, which placed the mind maps into one of four groups depending on the increasing level of organisation and structure present. This scheme went on to inform the statistical analyses carried out in this and subsequent studies.

There follows an explanation of this scheme together with examples of the four categories identified.

Association star Level 1 mind map

Data collected from all four tasks from both classes did not include a Level 1 mind map, however an example is provided from a mathematics task carried out by the Y4 class teacher during the same academic year. The example was made by a Y4 child who also participated in the narrative writing study. Following a unit of work on 2D shape in mathematics, the children were asked to record their understanding using a mind map. Figure 4.2 is an example of a mind map classified as an association star. The mind map consists of the central idea, '2D shapes polygons', surrounded by a number of related ideas: 'octagon', 'isosceles', 'rectangle', etc. There has been no attempt to group the related ideas into branches under any superordinate concepts.

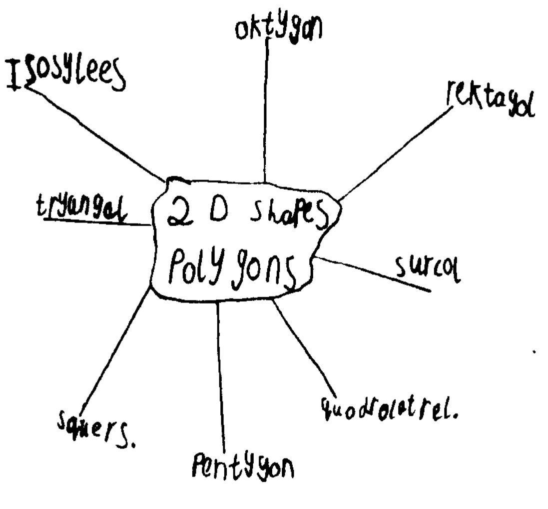

Figure 4.2: Association star, which has a central concept and number of links produced in maths lesson

Association chain: Level 2 mind maps

Level 2 mind maps show the expected visual features of a structured mind map, as they appear to be organised in branch structures. However, closer analysis reveals the items gathered on the branches are chained by association rather than subordinates of a superordinate category. An example is shown in figure 4.3, where the heading begins a chaining process from 'go out' to 'cycling' to 'shopping' to 'KFC' to 'bowling'. When this happens on one or more branches the mind map is categorised as Level 2.

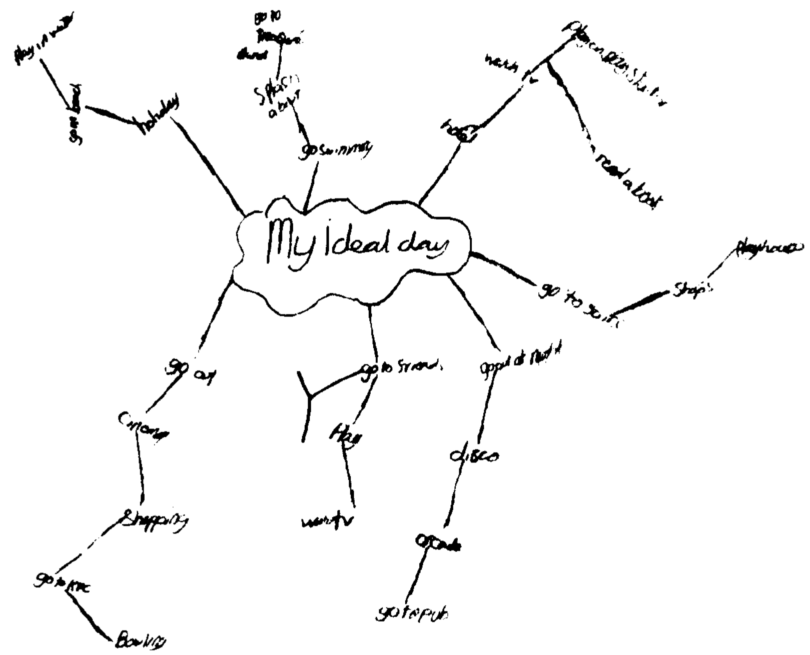

Figure 4.3: Association chain consists of branches with chains of associated ideas

Simple semantic cluster: Level 3 mind maps

The mind map in figure 4.4 shows grouped content under a series of branch headings which describe the items then listed: 'Feelings' is the superordinate for the linked subordinate examples: 'jealous', 'frightened', 'surprised', etc. This kind of mind map was most commonly found in the study as following results will show.

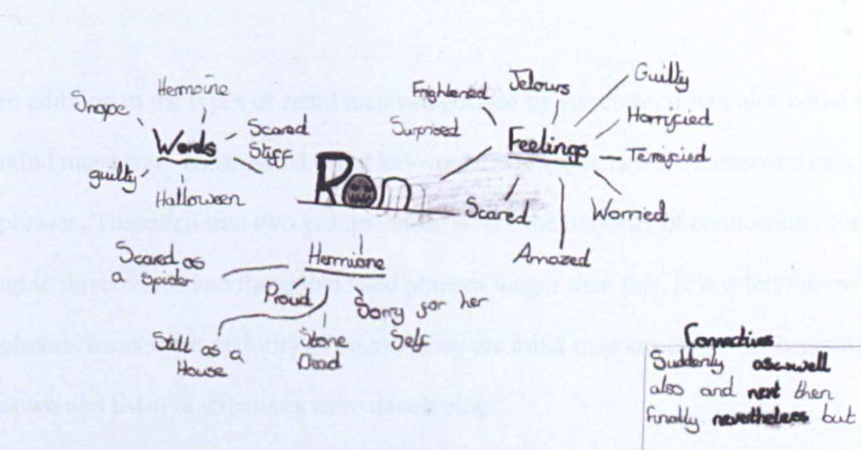

Figure 4.4: Semantic cluster showing branch headings, which are superordinate to subordinate items

Elaborated semantic cluster: Level 4 mind maps

This category of mind map was rare in the study. Basically, a Level 3 mind map with organised content, there was also evidence of further categorisation present on one or more of the branches. This is illustrated in figure 4.5, where the branch heading 'Feelings' is sub-divided into 'sad' and 'happy', followed by examples of times in the story where the character feels either happy or sad.

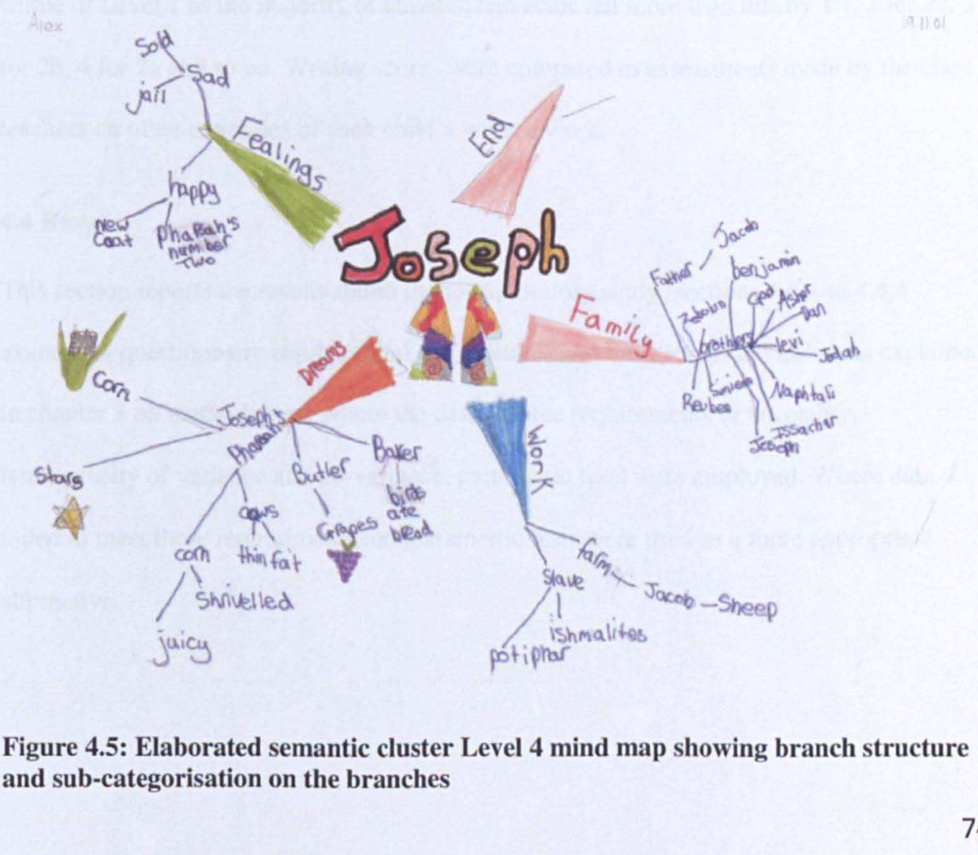

Figure 4.5: Elaborated semantic cluster Level 4 mind map showing branch structure and sub-categorisation on the branches

In addition to the types of mind map categorised by structure, it was also noted that some mind maps were constructed using keywords, while others were composed using longer phrases. These fell into two groups: those where the majority of connections consisted of up to three words and those that used phrases longer than this. It was felt that where longer phrases formed the majority of connections the mind map structure was beginning to break down and list-like structures were developing.

4.3.8.4 Scoring written tasks

Written tasks were scored holistically by using national curriculum writing levels. To support this analysis, a matrix of criteria developed by Derbyshire literacy team was used, as this was in use in the school at the time of the study (see appendix 1). Each child's written work was levelled from Level 1 to 5, and sub-levelled using 'a' for very secure, 'b' for achieved level and 'c' for some aspects that identified the work at that level. These scores were then converted into a numerical scale from 1 to 10, a score of 1 standing for the whole of Level 1 as the majority of children had achieved more than this by Y4, 2 for 2c, 3 for 2b, 4 for 2a and so on. Writing scores were compared to assessments made by the class teachers on other examples of each child's written work.

4.4 Results

This section reports the results found in the exploratory study, sections 4.4.1 to 4.4.4 examining questionnaire results, mind map features and links to written tasks. As explained in chapter 3 on methodology, where the data met the requirements of normality, homogeneity of variance and co-variance, parametric tests were employed. Where data failed to meet these requirements, nonparametric tests were used as a more appropriate alternative.

4.4.1 Questionnaires

There were 58 completed questionnaires in all; most were anonymous but all had indicated gender and year group. Question 1 asked 'Have you enjoyed learning how to make mind maps?' The response was scored as positive or negative. The results were 95% positive; some responses were extended with comments such as 'Yes because they can help you with your stories', 'Yes, because it helps me remember things', 'because they're good fun to draw'. Only three respondents gave negative responses, which centred around finding them difficult to organise: 'no, because I always get in a mess with it', 'it makes my brain hurt', 'boring ... having to try and think of things to put on the branches'.

The second question asked for areas of learning that children felt mind maps could support and this was analysed on a grid created with categories drawn from the data. Four categories were common to both groups and the most populated. Responses stated that mind maps support: memory, 47% ('they help me remember things easier than when I write them in sentences'); learning, 16% ('you learn lots of information about that certain thing'); ideas, 14% ('useful for jotting ideas instead of getting them all mixed up in your head'); and planning/writing stories, 19% ('they are a short way to plan things').

Responses from both groups to the third question, 'Can you think of other ways to use them?, fell into six categories. Planning was cited by 21%; recording information by 29%; 19% referred to particular subjects such as maths or science; 5% cited memory; and 9% said for fun. The remaining 16% of responses were from children who could not think of a use for mind maps beyond those mentioned in the second question.

4.4.2 Mind map features

Mind maps were produced by all children taking part. There were wide differences in the amount of content – as measured by numbers of branches, words and connections. This is demonstrated in table 4.1, showing the means and range for these measures from both tasks. The widest variation comes in the numbers of connections and words used.

Table 4.1: Means (and standard deviation) and range of mind map branches, connections and words over the four tasks

Y4 8–9 year olds n=30			**Y5 9–10 year olds n=28**		
	Mean (sd)	Range		Mean (sd)	Range
Task 1					
Y4 Joseph			**Y5 Ideal Day**		
Branches	4.47 (1.25)	2–7		3.54 (1.14)	2–7
Connections	34.1 (9.74)	7–57		25.12 (8.98)	12–40
Words	45.43 (14.85)	8–80		37.46 (13.08)	16–56
Task 2					
Y4 Character			**Y5 H Potter**		
Branches	5.23 (1.19)	2–6		3.81 (1.17)	2–7
Connections	35.3 (10.9)	10–60		26.3 (10.6)	8–45
Words	56.37 (16.06)	27–85		55.35 (24.0)	11–102

As the tasks were different in the different year groups, the data from each group have been analysed separately. In the case of Y4, there was a significant difference in the number of branches present on Task 2 mind maps ($F(1,29)=10.79$, $MSE=8.82$, $p<0.05$, partial $\eta^2=0.27$), with Task 2 mind maps having more branches than was the case in Task 1. Numbers of connections were not significantly more in Task 2 ($F(1,29)=0.52$, $MSE=22.82$, $p=0.48$). However, there were significantly more words on the mind maps for Task 2 ($F(1,29)=18.45$, $MSE=1793.07$, $p>0.05$, partial $\eta^2=0.39$).

The results for Y5 showed there was no significant difference in the number of mind map branches for Task 2 compared to Task 1, ($F(1,25)=0.56$, $MSE=0.42$, $p=0.46$) or mind map connections ($F(1,25)=0.34$, $MSE=18.48$, $p=0.57$). There was a significantly greater number of mind map words present for Task 2 ($F(1,25)=14.03$, $MSE=4158.17$, $p<0.05$ partial $\eta^2=0.36$).

Each map was also given a level from 1 to 4 depending on its categorisation, referring to the degree of structure present, as explained in the section 4.3.8.3. A second coder assessed 20% of the mind maps using this system, which resulted in a satisfactory agreement (kappa = 0.79, p<0.001). All children were able to construct mind maps using branch headings to give clustered content, though a number of these mind maps were judged as Level 2.

Table 4.2 shows the mind map levels produced by Y4 for each of the tasks.

Table 4.2: Medians and interquartile ranges of mind map levels produced in tasks for Y4

Y4 8–9 year olds	Mind map level median	Interquartile range
n= 30 Task 1 Joseph	3	1
n=30 Task 2 Character	3	0

Table 4.3 shows the mind map levels produced by Y5 for each of the tasks. Both groups of children had successfully constructed mind maps.

Table 4.3: Mind map levels related to Y5 writing tasks

Y5 9–10 year olds	Mind map level median	Interquartile range
Task 1 Ideal Day n=26	3	1
Task 2 Harry Potter n=26	2	1

As table 4.2 shows, Y4 produced more structured mind maps for their second task: median 3, interquartile range 0. A Wilcoxon signed-rank test showed a significant increase in the numbers of more structured mind maps produced (T=7.5, p=<0.05, r=–0.29).

Y5 children had a different outcome. The median score for their mind maps dropped from 3 to 2, table 4.3, and a Wilcoxon signed-rank test showed a significant decrease in the levels of mind map structure, (T=9.25, p=<0.05, r= –0.44).

A Mann–Whitney test shows the significant differences in the mind maps levels for each group. Reporting only on the children who completed both tasks, in Y4 30 children and in Y5 26 children, the results show that Y5 produced significantly more structured mind maps for their first task (median=3) than Y4 (median 3) (U=239.00, p<0.01, r=–0.35). This was not the case for the second tasks, where Y4 produced significantly more structured mind maps: Y4 (median=3), Y5 (median=2) (U=141.00, p<0.001, r=–0.65).

4.4.3. Correlations between mind map features and text quality

Spearman's correlations between mind map features including mind map level and writing quality were investigated. Tables 4.4 and 4.5 show the correlations between mind map features and the quality of the written texts for Y4.

Table 4.4: Task 1: Joseph correlations between aspects of the mind maps and writing quality

	1.	2.	3.	4.	5.	6.	7.
1. Mind map level		0.20	–0.03	–0.13	0.25	0.12	0.31
2. Mind map branches			0.43*	0.43*	0.21	–0.10	0.46**
3. Mind Map connections				0.76**	0.20	0.18	0.20
4. Mind map words					0.26	0.48**	0.41*
5. Branches used in writing						0.11	0.53**
6. Writing score							0.53**
7. Writing words							

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

The quality of the writing was significantly correlated with the quantity of words written in the task (r=0.53, p<0.01). This has been noted in other studies looking at primary-aged children's work (Snow et al., 1991) and is a useful corroboration for the holistic judgment of writing quality used in the study.

There was no significant correlation between the structure present on the mind map and any of the features investigated. Mind map branches were correlated significantly with the number of connections and words present (r=0.43, p<0.05, r=0.43, p<0.05), which is a measure of the quantity of material represented on the mind map. Branches used in the writing were correlated significantly with the number of words written (r=0.53, p<0.01), though this did not necessarily result in a higher writing score. The quantity of words on the mind map correlated positively and significantly with the written score and number of words in the written task (r=0.48, p<0.01, r=0.41, p<0.05).

Table 4.5: Y4 Task 2: Character correlations between aspects of the mind maps and writing quality

	1.	2.	3.	4.	5.	6.	7.
1.Mind map level		0.00	0.19	-0.08	0.30	0.31	0.20
2. Mind map branches			0.58**	0.62**	0.26	0.24	-0.09
3.Mind map connections				0.62**	0.53**	0.57	0.19
4. Mind map words					0.24	0.31	0.01
5.Branches used in writing						0.60**	0.31
6. Writing score							0.52**
7. Writing words							

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

For Y4's second writing task the majority of children produced a Level 3 mind map. There were no significant correlations between mind map level and any other feature on the mind map or in the written task. The number of branches on the mind map again significantly correlated with mind map connections and words (r=0.58, p<0.01, r=0.62, p<0.01). There was also a significant positive correlation between the number of connections and the branches used in the written task (r=0.53, p<0.01). The number of branches used in the writing also had a significant positive correlation with the quality of the written work (r=0.60, p<0.01). Writing quality and number of words written in the task were positively significantly correlated (r=0.52, p<0.01).

The results for the Y5 writing tasks, given in tables 4.6 and 4.7, show that there was no correlation between the level of mind map and most of the features identified either on the mind map or in the writing. In the Ideal Day task there was a significant negative correlation between the number branches used in the writing and the level of mind map structure (r=-0.41, p<0.05). The number of connections correlates significantly with the quality of the written work (r=0.52, p<0.01) and the number of words in the written text (r=0.44, p<0.01). The number of mind map words also correlates significantly with the quality of the written work (r=0.51, p<0.01) and the number of words in the written text (r=0.46, p<0.01).

Table 4.6: Y5 Task 1: Ideal Day correlations between aspects of the mind maps and writing quality

	1.	2.	3.	4.	5.	6.	7.
1. Mind map level		-0.23	0.31	0.08	-0.41*	0.29	0.20
2. Mind map branches			0.43*	0.22	0.38*	-0.06	0.08
3. Mind map connections				0.68**	0.15	0.52**	0.44**
4. Mind map words					0.23	0.51**	0.46**
5. Branches used in writing						-0.06	0.17
6. Writing score							0.66**
7. Writing words							

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

The second writing task for Y5 shows no significant correlation between mind map level and any other feature (see table 4.7). There are positive significant correlations between the numbers of branches and connections on the mind map (r=0.41, p<0.05) and with the number of branches used in the written task (r=0.50, p<0.01). Higher numbers of mind map words are also correlated with the number of branches used in the written task (r=0.39, p<0.05). The number of connections present correlate positively and significantly with both the writing quality (r=0.63, p<0.01) and numbers of words (r=0.41, p<0.05) in the written task.

Table 4.7: Y5 Task 2: Harry Potter correlations between mind map features and writing quality

	1.	2.	3.	4.	5.	6.	7.
1. Mind map level		0.06	-0.22	-0.15	-0.06	-0.24	-0.19
2. Mind map branches			0.41*	0.28	0.50**	0.10	0.27
3. Mind map connections				0.59**	0.35	0.63**	0.41*
4. Mind map words					0.39*	0.43**	0.60**
5. Branches used in text						0.08	0.36
6. Writing score							0.41*
7. Writing words							

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed).

4.4.4 Writing quality

The scores for the written tasks are shown in table 4.8. The Y5 children have a higher writing score in both of the two tasks. However, writing scores between the two classes are only significantly different in the first task, U=324, p=<0.004.

Table 4.8: Writing scores for each task Y4 and Y5

	Task 1 – writing scores		Task 2 – writing scores	
	Median	Interquartile range	Median	Interquartile range
Y4 8–9 year olds	3	3	4	2
Y5 9–10 year olds	4.5	2	5.5	4

4.5 Discussion

This was largely an explorative study, to investigate children's ability to learn a novel representation and apply that new knowledge to planning a written task.

4.5.1 Children's mind maps

Following the training sessions, children were able to produce mind maps. All participants had understood the visual features of a mind map, beginning with a central concept surrounded by a series of branches. The categorisation scheme described in the measures section resulted from an analysis of the degree of organisation present on the mind maps produced over all four tasks. The majority of the mind maps produced for all four tasks were Level 3, semantic clusters. In this case, children were able to invent suitable branch headings and populate them with appropriate content. In some cases, Level 2 association chains were produced; in these cases the branch heading did not provide a superordinate category to describe the content used to populate the branch. In less frequent cases still, children were able to show a greater level of organisation by sub-dividing branch headings into subordinate categories and populating these sub-headings. These were judged as Level 4 mind maps, elaborated semantic clusters. These findings can be compared to a similar categorisation scheme devised by Kinchin et al. (2000) for assessing concept maps, where three levels of structure, namely spoke, chain and net, were identified.

In addition to the levels of organisation present on mind maps, individual features of mind maps also varied. Numbers of branches varied, though within a comparatively narrow range of two to seven. This was expected as the optimum number of branches for a mind map is recommended to be between five and seven (Buzan, 2000). The reasoning expressed for this tends to be linked to the perceived limits of short-term memory (Baddeley, 1974). A practical consideration also applies, as larger numbers of branches than this tend to be difficult to locate on a page legibly. Larger numbers of mind map branches can also be seen to imply less organised content, which could explain why writing quality is not positively correlated with larger numbers of branches in any of the four reported tasks.

Y4 children included significantly more branches on their second mind map, but for this task many of the branch headings had been suggested during the lesson as possible aspects of a character to be considered. Y5 had less specific guidance and showed a similar number of branch headings for each task.

Numbers of connections varied most widely, showing how some children found it relatively difficult to generate content even when the expectation was for keywords rather than fully formed sentences. Children in both groups tended to have similar mean numbers of connections present on mind maps produced for both tasks.

There were also differences in the way connections were constructed. Connections as described by Buzan (2000) should consist of keywords which are, in effect, single words or very short phrases. This is in order to capture important concepts in as few words as possible, acting as an economical way to outline the key ideas and relationships in a given domain. Some mind maps produced by children were constructed using longer phrases, which looked more like the lists of planning observed in studies by Bereiter & Scardamalia (1987). This tendency appears to have increased for both groups, as Task 2 mind maps had significantly more words than those produced for Task 1, but with no corresponding increase in the numbers of connections present. This tendency to populate mind maps with longer phrases tended to be linked to a loss of structure and organisation of concepts. Children were moving away from the structure of a diagram, which could present an overview of their ideas, to a list structure, where one idea linked to another but with no organised structure.

4.5.2 Perceived usefulness as a planning tool

Another concern of the investigation was to assess how popular the representation would be with the children. Results from the first question of the short questionnaire had elicited a positive response in the majority of cases. This was evident in planning sessions where mind maps were used enthusiastically by most children, which was noticeably different from the way planning tasks were often approached. The representation was novel to all the children, which may have been part of the initial appeal, together with the opportunity to use coloured pens, mentioned on a high proportion of questionnaires as a reason for the positive reaction.

In reply to the second question, 'What aspects of mind maps were most useful?', a range of reasons were given such as: 'they are a short way to plan things', 'you remember things that are important', 'it's useful for jotting ideas instead of getting them all mixed up in your head'. The most commonly cited reasons for finding mind maps useful was for memorising work, though 17%, almost a fifth, mentioned planning in particular: a mind map 'helps me write more interesting stories'.

When Y5 were offered the chance to choose their own method of planning in Task 2, only six children chose not to use a mind map. Four of these children still used headings in a grid formation and grouped their ideas in a form that corresponded with branch headings used by many of the children choosing to construct mind maps. The remaining two children made chronological lists of the main events that occurred in the narrative.

From a teacher's perspective, children were engaged in planning the written task in a motivated fashion. In the majority of cases, relevant content was generated and recorded in a relatively short amount of time. The visible representation of some thought processes before the written task began could give the opportunity to intervene at an early stage in the writing process, mind maps being easier to adapt and change than linear sections of text.

It was also noticeable that children tended to abandon the mind maps as soon as they became engaged in the written task. It did not appear that the plan was used as an external memory aid once the written task was underway. Having made the mind map and generated content, the document did not often appear to be used as a prompt sheet.

4.5.3 Impact on writing quality

The overall aim for introducing mind maps as planning tools was to have a beneficial impact on writing quality. This was hard to quantify during this study. Writing scores over the four tasks showed no dramatic improvement, as most scores were generally in line with the writing scores expected by the class teacher. In the case of Y5 and the Harry Potter Task 2 time constraints meant that the writing task was not completed. As a result, it was difficult to judge the level of content present on both mind map plan and finished text. However, each task showed some differences in the way mind maps had been constructed, together with various relationships between mind map content and writing scores.

4.5.4 Task effects

In order to explore possible relationships between the writing tasks and the mind map plans, a series of correlation tests were carried out. One area for analysis was the correlation between the amount of structure present on the mind map and the writing quality. There was no significant correlation between these, as the task itself appeared to have an impact on the type of mind map produced. The children's use of the mind map structure varied with the writing task set. Y4 children moved from the Joseph task, where a variety of mind map levels were produced, to their second task, Character, where the majority of the children constructed a Level 3 mind map. This showed a significant improvement in the number of well-structured mind maps from those constructed for Task 1. This could have been interpreted as the children becoming more accustomed to the representation and more skilful in the construction process or that the task set was more appropriate for the mind map form.

The results from the Y5 group support the second assumption. Children in this class produced less structured mind maps for their second task, Harry Potter, than their first about an Ideal Day. The nature of the task had influenced the kinds of mind map being produced. Closer analysis of the mind maps showed that the Y5 children had included chained content on one or more map branches for the Harry Potter task. This often appeared in the form of a timeline of story events. The task connected to Harry Potter required them to understand and reproduce part of a story with events happening in different locations concurrently. In order to plan this, they had often adapted the form of the mind map to accommodate the task requirements. This led to their mind map being judged as a Level 2, as chaining rather than categorisation was the best solution to this particular writing problem, with one of the branches tending to be adapted as a timeline rather than a cluster of grouped content. The two children who chose not to make mind maps prepared their own rudimentary timelines, which they considered a more appropriate planning strategy for this task.

For the Joseph task in Y4 the structure of the mind map did not correlate to the writing quality, however the quantity of content generated, seen as words on the mind map, correlated with the quality of the written text. In the second task, Character, most of the children were able to produce a structured mind map and there was an expected range of writing scores, so no relationship between the two was evident. There was no correlation between the amount of content on the mind map and the quality of the writing, for in this case the plan was to develop one aspect of the written task, namely the main character. It was interesting to see that the children who included more of their mind-mapped content, measured by the number of branches incorporated into the written task, were also able to achieve a higher writing score. This was particularly important in this written task where a dilemma faced by one leading character was pivotal to the narrative. Some children used very little content from their mind map in the final story, and in one case the class teacher had to support a pupil to plan her writing orally, as the mind-mapped character did not enable her to construct her story. For this child, the mind map and the writing tasks were separate; one did not support the other.

The correlations for Y5's first task, Ideal Day, show that a greater quantity of content relates to the writing level achieved, both in terms of connections and mind map words. More ideas appear to lead to better writing. However, there is no correlation between the number of branches used from the mind map and the quality of the writing. This may be because better organised mind maps would have fewer branches owing to the content being grouped under fewer branch headings. In the second task, Harry Potter, the quantity of content was again related to the quality of the writing, though the number of branches used was not. Many of the texts in this data collection were unfinished which may have influenced these results. Children who had not completed their written task had not had time to include items from sections of their mind maps.

It was interesting to see how the content on these mind maps was organised in response to a task dealing with complicated chronology. This task involved planning a whole episode rather than one character, which was more difficult to accomplish in mind map form. One child accomplished this by having an events branch heading and numbering the events identified to use in the writing. The writing showed she was following the chronology identified on the mind map but she did not have time to finish the written work. Some children scarcely used any of the mind-mapped content in their writing. One boy concentrates entirely on the main incident, a battle with the troll, in his written task, though this is not represented on his mind map as either a branch or grouped connections.

4.5.5 Aspects for further investigation

Looking at the results from this exploratory study across the four tasks, some areas for further investigation were developing. In general, better texts were associated with richer content on the mind map. Poorer writers found generating content difficult whether this was for a mind map or for the written linear text. Support to generate a wider fund of content was an issue at the planning stage as well as at the writing stage. Better writers were able to populate both mind map structure and essay. This finding was similar to that reported by Riley & Ahlberg (2004), where more populated concept maps were also associated with better written texts.

The relationship between more structured mind maps and better quality texts was less clear. There was no correlation between better quality texts and grouped content on the mind maps. This may have been a result of the varied tasks carried out by the different groups of children. The second task for Y4, Character, was particularly easy to mind map, using headings such as appearance, friends, personality rather than attempting to plan for chronology. The Y5 task, Ideal Day, also proved appropriate, with headings such as activities, food and friends. The second task involving a story incident where chronology was important had led to different structures. Y5 children had made adaptations to the mind map structure in order to make a more appropriate tool to plan a difficult chronology, constructing branches to serve as timelines for their writing.

To summarise, many of the questions posed by this exploratory study had been answered. Children were able to work with this kind of representation after a relatively short period of training. The representation was engaging for the majority of children taking part in the study. This may have been influenced by the opportunities offered to use a variety of coloured pens and the perceived freedom from the usual constraints of grammatical sentence construction. Making a diagram using keywords and relevant icons was appealing for most children. This was evidenced in the reports from the questionnaires and observation in the classroom. The quality of mind maps varied, both in the quantity of information present and the way this was structured.

It became evident that the nature of the task was crucially important and would have a strong impact on the character of mind maps produced. This study led to the categorisation system employed throughout the rest of the thesis. Children were not only generating varying amounts of content for their mind map constructions but the form of the mind map was also subject to change in response to the written task with which it was associated.

It was not clear from the study how useful the planning process with a mind map was for children of this age. Some children continued finding the process of planning very challenging. In one extreme case, it appeared that the two tasks, producing a mind map and writing a linear text, were regarded as completely unrelated. There was also the question of how ideas explored in one representation would transfer to another – from non-linear to linear, from keywords to sentences. However, there were indications that children who could produce mind maps rich in content as measured by mind map connections were also able to produce better written texts. The question of how the structure of the mind map could be associated with better texts was not clear from this study. The mind map form had been adapted by children to fulfil a perceived need in the case of Y5's second task. There was little evidence to suggest that better structured mind maps were related to better written texts.

Further studies offered the opportunity to attempt to measure the effects of this representation when combined with a more suitable task. It was felt that a thematic task would be more appropriate to planning on a mind map, where themes could be identified and developed rather than planning a narrative where a timeline form might be a more appropriate representation on which to explore ideas.

The larger question about whether written planning made a difference to the quality of primary-aged children's writing was also unanswered. All pieces of written work in Study 1 had been produced with the aid of a mind map. This study had not attempted to measure the difference in writing with or without a mind map plan. This could be explored in an experimental design comparing the effects of planning with discussion or with a written mind map plan. This became the aim of Study 2 reported in chapter 6.

Chapter 5: Study 2

Using mind maps for expository tasks

5.1 Introduction

As has been seen in both the literature review and Study 1, various claims have been made for the use of mind mapping techniques (Buzan, 2000; Caviglioni & Harris, 2000, Jonassen et al., 1998) but it has proved difficult to find research evidence to support these claims. Buzan (2000) recommends mind mapping as a creative and 'natural' way of representing and supporting cognition, especially with regard to memory and the generation of ideas. He particularly emphasises the difference between linear representations of knowledge, such as note-making, and the concept of 'radiant thinking', which employs processes of association and creating connections. Caviglioni & Harris (2000) support this view and recommend model mapping, an almost indistinguishable representation from mind mapping, as a way of demonstrating and eliciting intelligent and categorised modes of thought, to be modelled and demonstrated in a variety of contexts. They claim that 'it is impossible to construct a model map without being intellectually active and involved with core concepts and details of the subject under study' (p. 159). Jonasson (1998) sees a similar representation, computer-aided concept mapping, as a 'mind tool', the benefit of which lies in encouraging critical thinking approaches – a tool designed to support the learner in a process of knowledge construction.

Mind maps as planning tools for written work are also specifically recommended. Buzan (2000) asserts that a well-constructed mind map 'should provide you with all the main sub-divisions of your essay' (p. 212). Caviglioni & Harris (2000) also state that students can use mapping as a planning tool – though they acknowledge that some may need support in organising the main branches.

The earlier exploratory study, reported in chapter 4, found that children from 8 to 10 years had some success in producing mind maps and using them as a planning tool for narrative writing. Consequently, Study 2 aimed to investigate further the advantages that such a tool could offer children of 7–11 years to support planning a written task, in this case an expository text.

As previously stated in chapter 4, encouraging children to plan before starting written work is problematic. Bereiter & Scardamalia (1987) found planning a problem for children, who tended to write abbreviated lists of their resulting texts. Yet studies with older students have shown that planning is a beneficial strategy (Sturm & Rankin-Erickson, 2002; Graham et al., 2000; Piolat & Roussey, 1996; Kellogg, 1988), even if the main effect appears to lie in the amount of time taken to consider the task rather than any specific benefit accrued from a particular planning format. Yet the writing curriculum for England and Wales, as detailed in the New Primary Framework (DfEE, 2006) still places a great deal of emphasis on planning before writing commences, specifically recommending the use of mind maps and expecting this even of very young children (6–7 year olds).

For teachers in classrooms expected to support children in the planning process, diagrammatic structures promise a great deal. Mind maps have the undoubted benefit of being a stable, visible record of cognitive activity prior to the writing task. They are constructed using short phrases and offer the opportunity to group and organise ideas before transcribing the written text. Sharples (1994) recognises how mind maps can show the relationships between ideas and act as a visual reference point when writing is underway.

However, beneficial outcomes rely to some extent on individuals using the tool creatively, with understanding, and engaging in particular process of thought leading both to the generation and organisation of ideas to be included in the written text. In most cases, for primary-aged children, the challenge of an expository written task requires them to construct text which includes both new content knowledge and the use of a relatively unfamiliar text type, certainly when compared to narrative texts (Wray & Lewis, 1997; Martin, 1985). There is a possible benefit of creating a mind map to work out the form this will take. The construction process includes accessing items from memory, recording these in brief note form and restructuring the information as a diagram. This potentially becomes a cognitive rehearsal for the demands of the written task.

Once the written task commences, multiple demands will be made on the child's attention and the cognitive pressure may be lessened by having rehearsed the content and organisation of the expository text prior to the task. Conversely, mind maps as a potential thinking tool may not be understood or be developmentally inappropriate for young children and these purported benefits prove elusive or illusory.

Study 1 had established that children of 8–10 years were able to construct mind maps in connection with narrative texts, after a period of training. However, certain aspects of the map construction process had proved challenging. While the visual aspects of the representation had been imitated successfully in all cases, generating a hierarchical, categorised structure had proved difficult for some children.

As a planning tool, the mind map can function with varying levels of sophistication. It can represent an initial memory search, producing a related collection of items recovered from memory that will provide useful content for the written task. This mode of planning content was described by Burtis et al. (1983). Young children below 12 years tend to generate lists of content for transfer into a written assignment. This was evident in Study 1, where all children were able to generate items to place on a map. Children who could generate larger numbers of items also tended to be able to produce better written texts. However, this function alone could be adequately served by generating a list of items, without the inconvenience of learning a novel representation, which in itself has been recognised as problematic (Ainsworth, 2006; Scaife & Rogers, 1996). The mind map form in addition requires further organisation of material into categorised hierarchies. When used as a writing plan this has the potential to encourage children to order and group material, scaffolding children's planning abilities from content generation towards consideration of organisational strategies. This conceptual level of planning was rarely seen in Burtis et al.'s (1983) findings.

Study 1 did not show a clear relationship between better writing and better structured mind maps. One reason for this appeared to be the nature of the task. To be effective, representations need to be closely related to task demands (Ainsworth, 2006; Cox, 1999; Scaife & Rogers, 1996). Narrative writing implies a chronological structure and mind maps are not best suited to this form of organisation. Children adapted the form and many of the mind maps became association chains.

Study 2 was particularly designed around the belief that a thematic text type would be more related to planning using the mind map form. In consequence, the writing tasks carried out were non-narrative.

Mind maps were seen as an alternative way to scaffold the thinking processes necessary to write expository text, providing a less prescriptive solution to writing frames (Wray & Lewis, 1997) in supporting the organisation of content and paragraph structure.

Study 1 was exploratory and had looked at the possibilities of children constructing mind maps in relation to writing. The experimental design of Study 2 was constructed to compare writing outcomes between groups; one group using a mind map to plan compared to another where no written form of planning was made.

5.2 Aims

The main aims for this study were to investigate planning with mind maps for an expository writing task and to compare this to writing planned through peer discussion. It was hoped that planning using mind mapping would scaffold an independent organisation strategy through giving children a planning structure which could support them in making their own decisions on paragraph content. Map branches could become the focus for generating grouped content which could then possibly transfer into more organised text. Children would have more freedom to construct their own text structure, rather than using the paragraph headings typically supplied on a writing frame (Wray & Lewis, 1997).

Can children create mind maps as planning tools for writing?

As described in the literature review in chapter 2, expository writing has been categorised in the NLS (DfEE,1998) into six text types: recount, report, instruction, explanation, persuasion and argument. In deciding which would be most appropriate, recounts were rejected, as these tend to follow a chronological structure very closely related to narratives. Similarly, instructions and explanations have a chronological or ordered procedural element, which would not be well represented on a mind map. The remaining three text types – report, persuasion and argument – appeared to be suitable. Argument texts tend to be taught later in the primary curriculum, so report and persuasion were chosen for the study as all KS2 classes from Y3 to Y6 (7–11 year olds) were to be involved.

To investigate the possible benefits, the study was constructed to compare pieces of writing produced using a mind-mapped plan with writing produced after a more typical classroom technique of peer discussion. Planning expository text requires thematic organisation. To construct a plan using a mind map form there are various options but two strategies can be identified as starting points for the process: either various themes need to be identified and content grouped around them, or content needs to be created, listed and then grouped into suitable themes. The end result should be branches containing related content in mind map form. Transcribing grouped content into a linear text is a matter of choice for the author in an expository text, as the structuring of content need not be defined by a temporal thread as in narrative accounts. There is a variety of solutions for constructing the shape of an expository text. A visual representation of grouped content on a mind map could structure the concepts to be presented, show relationships between them and lead to a more coherent and well-structured piece of text. In summary, it was expected that expository writing which involves the identification of broad themes would benefit more explicitly from this form of non-linear planning.

The hypotheses tested in Study 2 were:

1. Children between the ages of 7 and 11 would be able to produce well-structured mind maps for expository writing tasks.

2. Planning writing on a mind map would be more effective than peer discussion, as the mind map is a concrete document which can act as an external memory during the written task. The form of the mind map encourages children to group related concepts more formally than would be expected in speech.

3. Children's mind maps would vary in quality, both in structure and content.

Consequently, it was hypothesised that:

a) Mind maps with better structure, as seen in the use of branch headings, would be associated with better quality texts.

b) Mind maps with more content, shown as connections, would be linked to better quality texts.

c) Mind maps with better structure would be associated with greater transfer of content from map to writing.

5.3 Method

5.3.1 Design

Study 2 used a partial crossover design. Each child wrote two pieces of writing: one planned using a mind map and one discussed with a peer for a similar length of time as preparation for each writing task. Thus, the study design was a 2 by 2 mixed design with a within-groups factor of type of support (mind map/no mind map) and a between-groups factor of condition (map Amenities/map Brochure). There were three categories of dependent variable. One variable was the quality of mind map produced, measured in terms of structure (mind map level) and mind map features – branches, connections and words. The second was the quality of written task linked to national curriculum levels. The third was the similarity in content between the mind map and the written task

5.3.2 Participants and writing tasks

For this study the teacher–researcher had the opportunity to involve 126 children, aged 7–11 years, attending one primary school in Nottinghamshire. The children were in four single-year group classes. One of the classes had been involved in the exploratory study described in chapter 4. It was decided to focus on tasks using a persuasive genre with familiar subjects based on the children's experience of events in school rather than content from any specific curriculum area, as each class was following a different programme of study. The writing tasks chosen were felt to be equivalent in terms of background knowledge and genre. Each involved organising information for the reader but left the means of organisation open to the writer's discretion. The two tasks were:

Amenities: Writing Task 1 – write a letter explaining with reasons/justifications ideas for the amenities to be included in new school grounds, including different play areas and general environmental considerations.

Brochure: Writing Task 2 – write, in role as the head teacher, a brochure entry telling parents about how technology is used in school.

Table 5.1 shows the original composition of each group – the first number in each cell shows the total number of children whose data were analysed, the number in brackets those who were actually involved in the study. Only children who completed both tasks were included in the data analysis.

Table 5.1: Condition, number, gender and age of participants, tasks and scaffold

	Condition 1 Amenities mind map/ Brochure discussion n=43		Condition 2 Brochure mind map/ Amenities discussion n=57	
	Girls	Boys	Girls	Boys
Y3 (7–8yrs)	5(9)	5(7)	6(7)	7(7)
Y4 (8–9yrs)	7(8)	7(10)	8(8)	9(10)
Y5 (9–10)	7(8)	6(8)	9(10)	5(5)
Y6 (10–11)	3(8)	3(6)	6(7)	7(8)

There was a balance of participants in each condition, considering gender and writing ability as assessed in the previous year's writing tests supported by the judgment of their class teacher. Table 5.2 shows the median of each group's writing ability assessed at the end of the previous year by standard assessment tests. The test score has been converted to a number on a scale used to judge writing performance throughout these studies. NC level 1=1 point, 2c=2, 2b=3, 2a=4, etc.

Table 5.2: Median writing scores of participants in Conditions 1 and 2

	Writing score median	Interquartile range
Condition 1 n=43 Amenities mind map/ Brochure peer discussion	7	5
Condition 2 n=57 Brochure mind map/ Amenities peer discussion	6	5

There was no significant difference in the writing scores of the two groups as shown by a Mann-Whitney test (U=1097.5). During the sessions reported below two classes worked together – Y3 and Y4, aged from 7 to 9 years, and Y5 and Y6, aged from 9 to 11 years. Y3 and Y4, n=54, split into the two conditions shown in table 5.1. Y5 and Y6, n=46, also split into two conditions. This arrangement was necessary to cause the least disruption as possible to the normal school day.

5.3.3 Procedure

There were three sessions for all participants in the study.

Session 1 – mind map construction revision

Shortly before the writing task that would be planned using a mind map, children were given a revision session to remind them about mind map construction. Children taking part in the study were all familiar with mind maps, but some children had used the technique more often, or more recently, than others. In order to compensate for these differences, a short revision session of about 45 minutes with the researcher, independent of any writing task, was provided to consolidate understanding of the representation.

During the session, children were taught two complementary ways to construct a map – by listing items and then placing them together in groups on the map, an *inductive* method, or by starting with branch headings and adding relevant concepts to the main ideas, a *deductive* technique. The researcher worked with the groups to revise mind map construction by modelling these two possible strategies based on the familiar topic of school life. Shared maps were constructed on a large whiteboard, with contributions from the whole group of children. Following this introduction, which included instruction and co-construction, children were given time to produce an individual practice mind map. This was produced independently on paper, referring to one of two possible subjects – 'Me' or 'Holidays'.

The period of time between revision session and writing task varied, as sessions were constrained by the school timetable. Group 1a, Amenities Y3/4, had a gap of four days between revision and the writing session, which involved planning with a mind map, Group 1b, Amenities Y5/6. had 15 days, Group 2a, Brochure Y3/4, had 19 days, and Group 2b, Brochure Y5/6, had five days.

Session 2 and 3 – writing tasks

Each experimental group had two writing sessions, one for each task, introduced by the same researcher. The work took place during a normal lesson time of approximately one and a half hours in a familiar classroom setting. Children worked seated at tables in friendship groups of 6–8 pupils. There was also a period of time between the two writing sessions. Writing about amenities was the first task for all groups. Timings were not ideal, but had to be organised around staff commitments and standardised test pressures for the older age group. This is summarised in table 5.3 below.

Table 5.3: Schedule for mind map revision and writing task

	Revision mind map session	Amenities writing	Revision mind map session	Brochure writing
Condition 1 Y3/4 Amenities mind map/ Brochure peer discussion	March 4th	March 8th		May 25th
Condition 1 Y5/6 Amenities mind map/Brochure peer discussion	April 13th	April 28th		May 26th
Condition 2 Y3/4 Brochure mind map/Amenities peer discussion		March 10th	April 29th	May 18th
Condition 2 Y5/6 Brochure mind map/ Amenities peer discussion		May 3rd	May 19th	May 24th

In each writing session children were given an introduction consisting of an explanation of the task together with a visual writing stimulus. The visual stimulus consisted of a series of photographs on A4 sheets presented in a random order and displayed throughout the task on the wall of the room. In the case of the Amenities task there were 26 photographs on seven sheets of paper showing a variety of elements possible to include in a design for the environment around school. All examples shown were actual examples from various schools taken from school websites and play equipment manufacturers' advertisements. There was a group discussion as the photographs were introduced. The pictures included ideas for hard and grassed surfaces, recreational equipment suitable for older or younger children, along with decorative or wildlife garden schemes. This formed an authentic task, as at the time the existing school was being rebuilt and pupils were being consulted on what kind of outdoor equipment they wished to have in the new school.

For the Brochure task 12 photographs on five sheets of paper showed various members of staff and children using computers in the school environment, along with screenshots of programs frequently used by children, such as Microsoft Word and the Google search page. A brief introduction to the task was given lasting 10–15 minutes. This included a whole-group discussion about the photographs with the researcher. Following this, children were given time to discuss in small groups or mind map ideas for their writing for a further 10–15 minutes. Children making mind maps were also able to discuss ideas as they worked, but it was noticeably quiet as the mind-mapping task was carried out. Children were then instructed to start writing. This was an independent writing activity and children were encouraged to work quietly without further discussion for the remaining 45–50 minutes. Children were accustomed to similar requirements being made during writing sessions as part of the regular timetable during the week. It was stressed that the writing should be completed in the session, as there would not be a further opportunity to finish the task. Children responded well to this and texts were finished during the allotted timeframe.

5.3.4 Measures

5.3.4.1 Mind maps

As in the previous study, a range of mind map features were counted or assessed. This included map branches, connections and words. Mind maps were also given a level using the categorisation scheme developed in Study 1 into mind maps and narrative writing. The levels were as follows:

- Level 1 – association star
- Level 2 – association chain
- Level 3 – semantic cluster
- Level 4 – elaborated semantic cluster

Some mind maps were felt to show elements of more than one map type, so a best-fit approach was used. Level 4 maps achieved this status if there were any sub-divisions on any map branch. Level 2 was designated such when one or more of the mind map branches had become increasingly distant from the category heading.

5.3.4.2 Writing

Writing was looked at holistically, using national curriculum levels, divided into three sub-levels per level and given a numerical score to aid analysis: all Level 1 writing scored 1 point, Level 2c scored 2, 2b scored 3, and so on, based on the mark scheme shown in Appendix 1.

In addition to this, the relationship between the map and the writing was explored in a number of ways. Written texts were examined one sentence at a time, as demarcated by the child. Concepts listed on the map were traced through to the writing. In most cases the same words occurred on the mind map and in the written text. These were counted as items in common. In addition, if a very close paraphrase of the mind map item was present in the text, this was also counted as an item in common. Items in common were only counted once, even if they occurred in the text on more than one occasion. Items do vary in character. Some map concepts are specific examples such as 'climbing frame', while other items are broader or more abstract, such as 'learning', but in practice there were direct semantic transfers between mind map items and text items. Items present on the mind map but absent from the text were also counted, again taking into consideration close paraphrases. Finally, items that were in the text but not on the mind map were counted. This is a less secure measure, as items could vary between the more general and the particular. However, as is shown in the results section 5.5.5, a high level of interrater reliability was achieved. Sentences containing elaborations of items were not counted as novel text items, and similarly formal phrases present in the writing, such as introductions or concluding statements, were considered but not included in the analysis.

5.4 Examples of mind maps produced

There follows a series of examples from the mind maps produced as a part of this study, with commentary to explain the classification system used to place mind maps into one of four levels taking account of their structure.

Level 1 mind maps

Mind maps in this category show the least amount of structure, basically consisting of a list around a central node. Below are three examples that show the typical structure for these kinds of maps. Figure 5.1 shows a map that at first sight may appear to be a branching structure, but closer examination shows there are no groupings – each item is an individual requirement with a qualifying statement, 'a fountain so we could sit down and talk', 'a race track so we can play races'. The central node is essentially 'Things I would like' in the 'school grounds'. The map has supported ideas generation and justifications for the choices made are given, eg 'so we can get out of the rain',' 'so we can play races'. The reasons can then be used to frame persuasive elements in the associated text. However, there is no thematic organisation of the ideas presented.

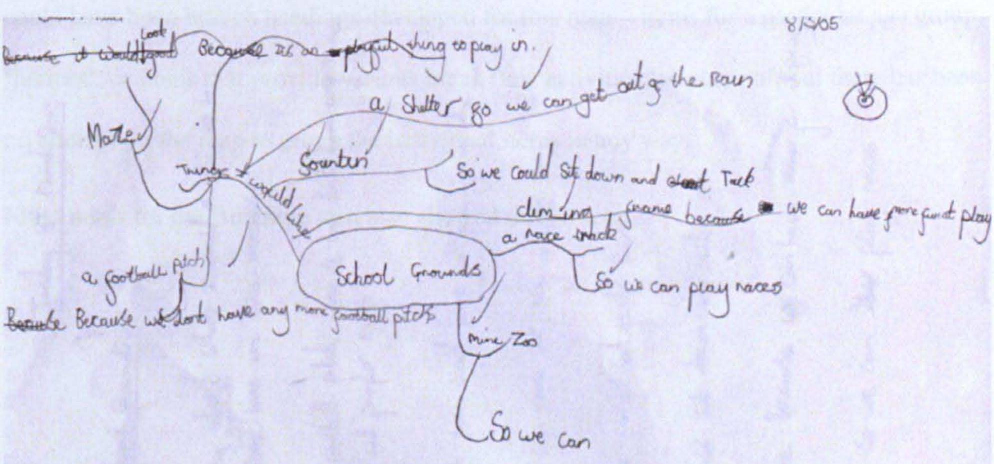

Figure 5.1: Y4 boy's Amenities Level 1 mind map, no groupings

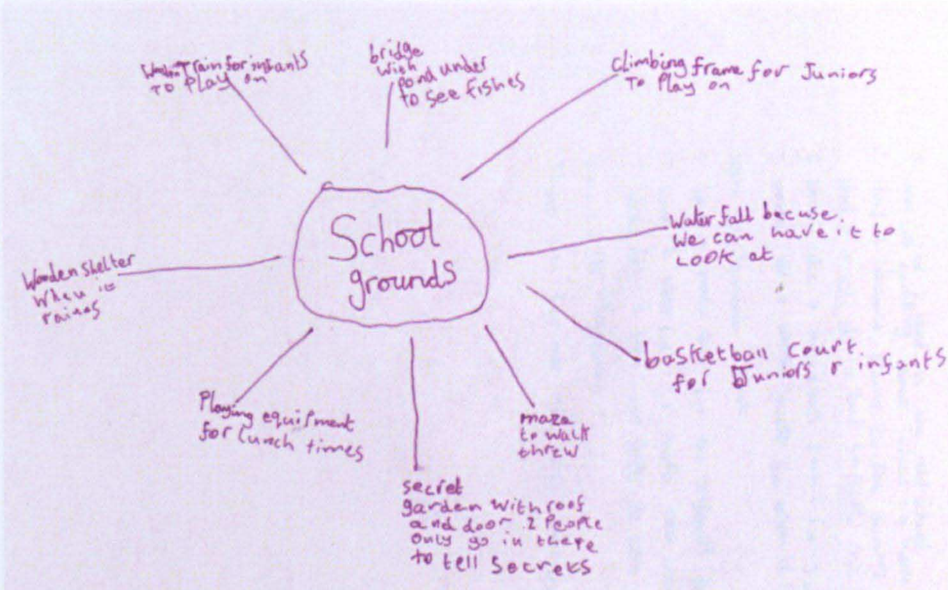

Figure 5.2: Y3 girl's Level 1 mind map, no groupings

The second mind map, figure 5.2, is also a Level 1 mind map. The branches are items on a list with some additional information: the basketball court is for infants and juniors; the climbing frame is for juniors to play on. There are a series of necessary justifications outlined to support items generated. However, again, there is no grouping of content. There could have been branch headings developed for this map – items for a particular age group, 'juniors', or items that provide various break time activities 'to play on', but there has been no attempt on the map to group the individual items in any way.

Mind maps for the Brochure task also showed this structure.

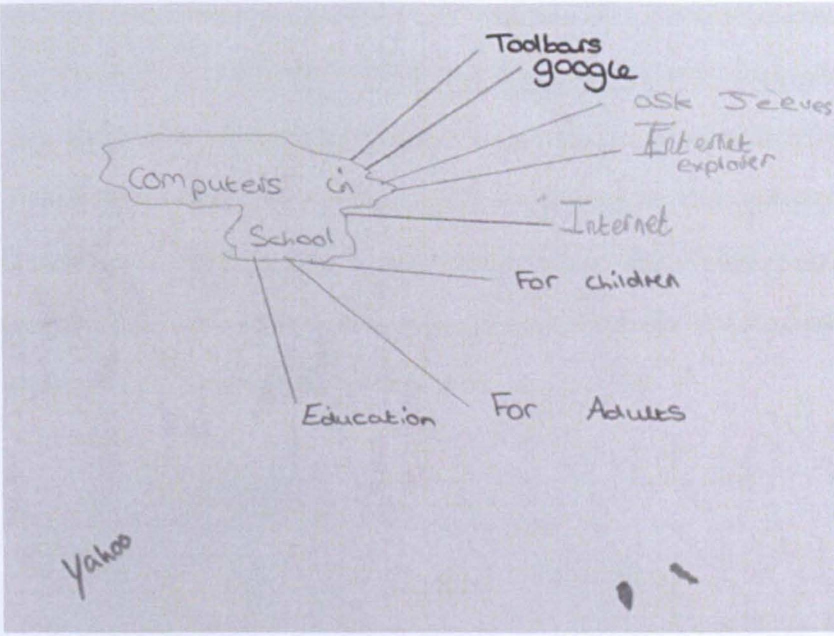

Figure 5.3: Y5 girl's Level 1 Brochure map, no groupings

The Y5 girl's map, figure 5.3, again shows no attempt to group the items on the map. She appears to have given internet use a large amount of consideration but has not grouped the resulting items in any way, and has then moved on to considerations about users, 'adults' and 'children', together with the purpose of using computers, 'education', but has not organised categorised groupings for these.

Level 2 mind maps

Mind maps in this category often appear to be grouped in branches, but the items linked to the branch headings become association chains. This Y3 girl's map, figure 5.4, has a heading of stepping stones, which leads on to a variety of items, ending the branch with a toy train for the infants. 'Stepping stones' cannot be said to act as a superordinate category heading. On another branch, a bridge is linked to a shelter and a number caterpillar. Though the mind map has the visual appearance expected, the branches have not been used to organise items in a thematic way. A branch heading is a starting point for a series of associations rather than a superordinate category with related subordinate items. The map content could have been organised by using the heading of 'playground equipment' to list the items in that location, or consideration could have been given to different age-related requirements around the school, eg infant play equipment. Instead, it appears that the branch follows particular thoughts related to a context, one particular location in the school grounds that could contain a variety of games and equipment. That particular location has been imagined in some considerable detail, and the other branch shows a similar train of thought about a different area containing a bridge and a shelter. The concepts are often expressed in sentences rather than keywords.

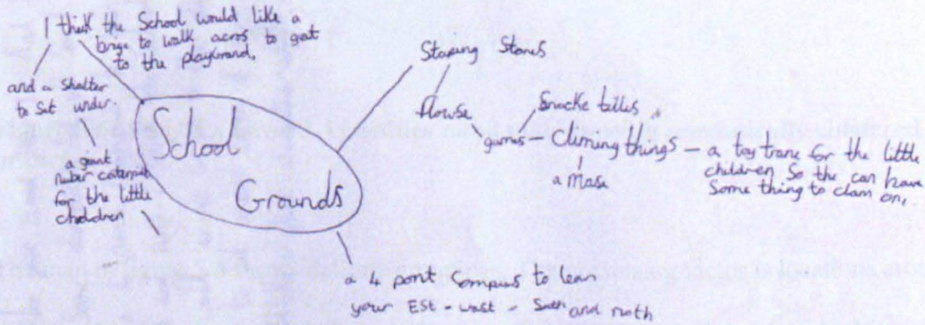

Figure 5.4: Y3 girl's Level 2 Amenities mind map showing string of associations on branch

This Y4 girl's map, figure 5.5, also uses association rather than categorised groupings on her technology map. Her list of subjects to be covered in the ICT suite works well, but her 'education' branch then links to photocopying, cameras and computer. The internet branch needs a heading such as 'software' to make it a coherent branch.

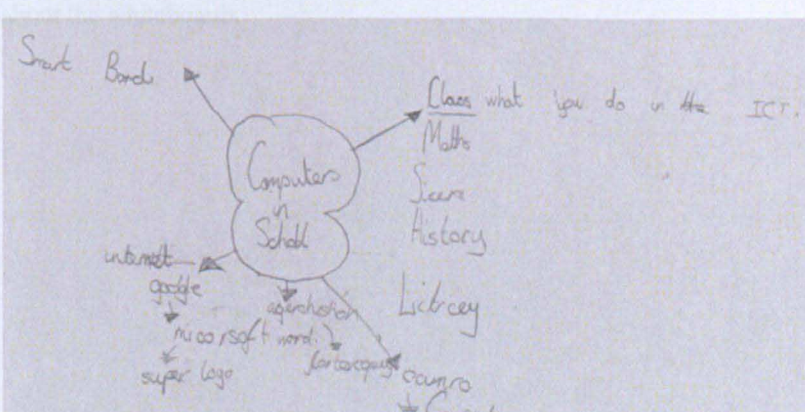

Figure 5.5: Y4 Level 2 Brochure mind map with branches formed from strings of associations

Level 3 mind maps

Figure 5.6: Y5 girl's Level 3 Amenities mind map showing semantically clustered branches

The map in figure 5.6 shows definite groupings. The organising factor is locations around the school and the items that belong in these locations, such as 'painted areas' which include snakes and ladders, netball court, hop scotch, target, all to be painted onto the surface of the playing area. Each heading defines an area and lists the requirements for each one.

Again this Brochure map figure 5.7, shows clear information grouping on the branch headings, people who use the computers, programs that are used, location and information about the whiteboards.

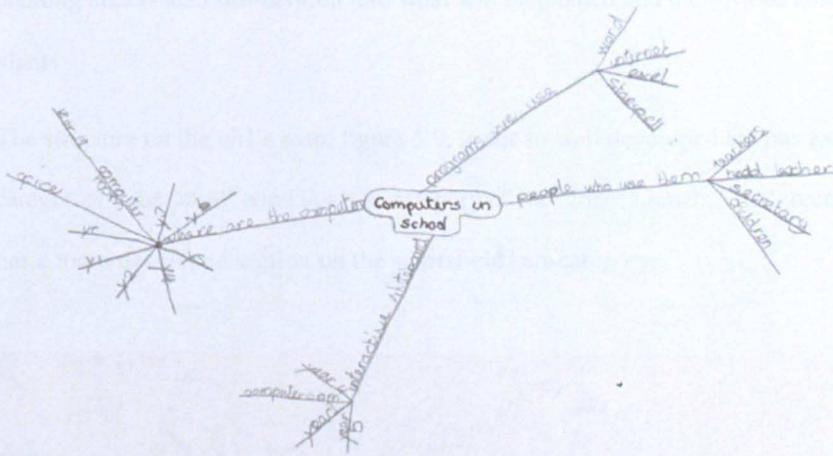

Figure 5.7: Y6 boy's Level 3 Brochure mind map showing semantically clustered branches

Level 4 mind maps

These maps occur infrequently, and sub-categorisation is often only present on one branch.

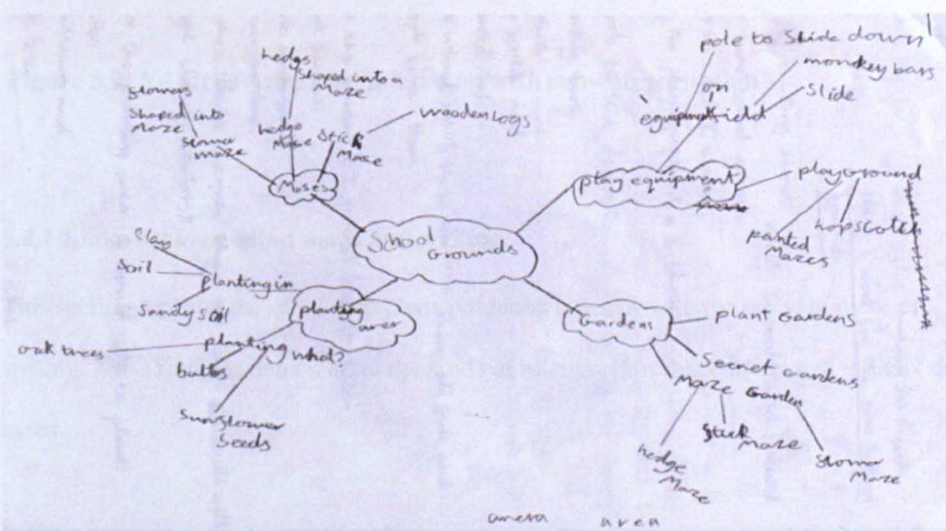

Figure 5.8: Y4 boy's Level 4 Amenities mind map with sub-categorisation

This mind map, figure 5.8, has grouped content on the branches, but this is also sub-categorised: play equipment is divided into items that can be used on the field and those more suitable for the playground. The garden branch has three items one of which – maze garden – then becomes a sub-category of the different kinds of maze garden possible. The planting area is also sub-divided into what will be planted and the various containers for the plants.

The structure on the girl's map, figure 5.9, is not so well developed but has example of sub-categories – the 'chill' zone is a sub-category of the 'zone' branch. The 'green area' branch has a more developed section on the sportsfield sub-category.

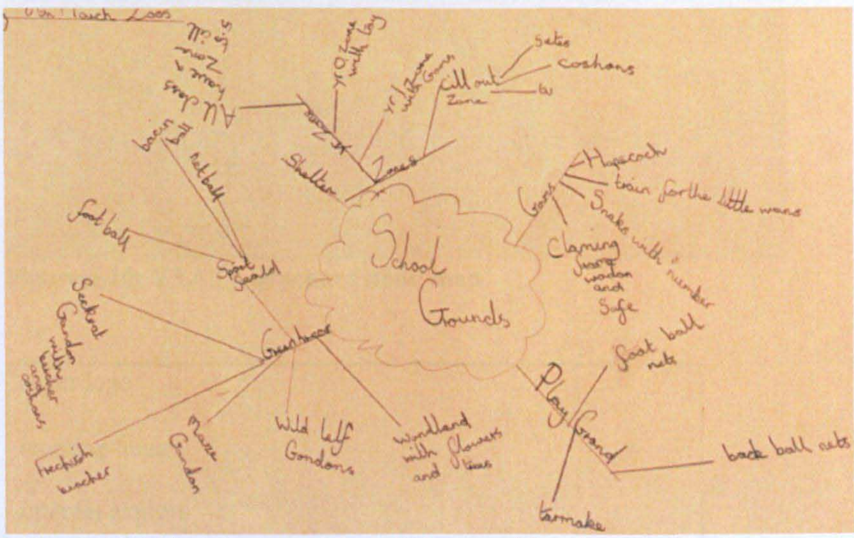

Figure 5.9: Y4 girl's Amenities mind map with sub-categorisation

5.4.1 Links between mind maps and writing

This section looks at the mind map plans produced together with the relevant piece of writing. The examples demonstrate the kinds of relationships that can be seen in individual cases.

Level 1 mind map plan and writing

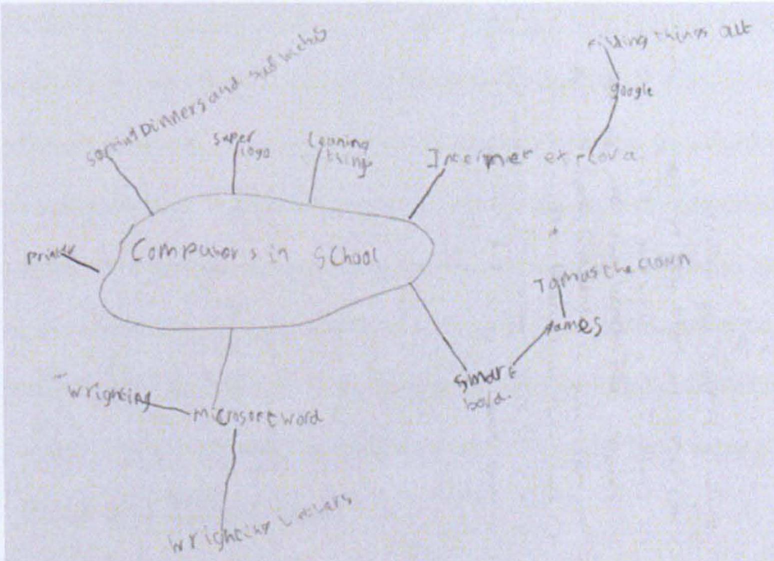

Figure 5.10: Y3 AJ's Brochure mind map

super logo		
learning things		
internet explora		
smart board	Games	Thomas the Clown
microsoft word	wrighting	
	wrighting letters	
sorting dinners and sandwiches		
printer		

Figure 5.11: Typed version of AJ's mind map

At school we use the computers for helping children find things out and to learn. Sometimes we use them for games for the children to have some fun. Mrs Windsor sorts out the dinners and sandwiches so we know what we are having for lunch. The children use them for writing things on and print them off so they can do there work on the computer instead of writing it. The adults use it for printing photos off. Instead of drawing them. And it really helps our school.

Figure 5.12: Y3 AJ's written Brochure task

AJ has a list of possibilities for his written task on his mind map, figure 5.10, but he has not attempted to group the items under branch headings. His map lists a variety of ICT applications, from specific pieces of software (Thomas the Clown) to more general office administrative tasks (sorting dinners and sandwiches which are recorded on the office computer system). The text, figure 5.12, follows this level of organisation. AJ begins by talking about children using computers to learn or for playing games but gives no examples in the written text. He next moves on to the usefulness of computers for office administration and finishes by considering printing in different contexts. Some items are omitted, others condensed, eg 'Microsoft word', 'writing' and 'writing letters' become 'writing' and 'children's work'.

Level 4 mind maps and writing

Below is a sample of work from. EB, who has constructed a Level 3 map and transferred groupings given by the branch headings into her written task. The branch headings are converted into topic sentences and the content grouped in a similar way in her written text, figures 5.13 and 5.14.

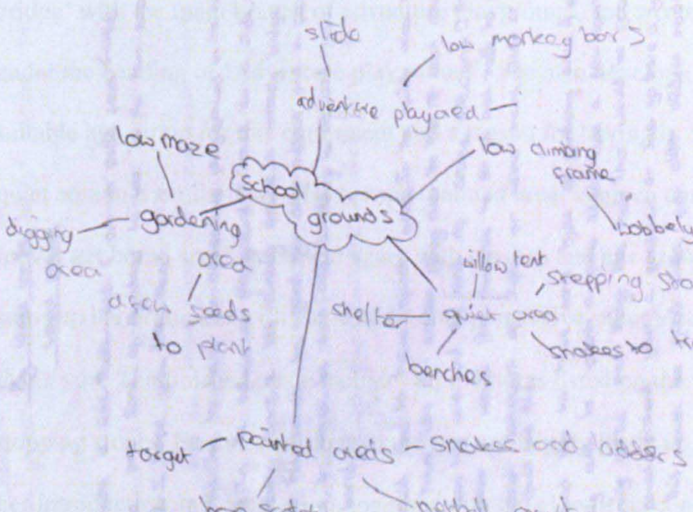

Figure 5.13: Y6 EB's mind map linked to Amenities writing

My name is EB and I am a pupil from **** School. These are some of my ideas to use in the new school play ground, I hope you like them.

I would like to have an adventure playground in the new school grounds. In the adventure playground I would like a slide, some low monkey bars, a low climbing frame, a wobbly bridge and a rope. This would be good for older children and a few younger children, it would be fun and something to do and you wouldn't get bored.

I would like to have a quiet area. In the quiet area I would like to have lots of snakes going over the top of each other so you can try and find the end of the snake A, B, C and D. Around the snakes I would like benches to sit on and talk to your friends and some sort of shelter or willow tent. Older or younger children could use this.

I would like to have some type of gardening area. A place to dig and to plant a few seeds. Have a few spades, gardening forks and things like that. This would be good because you could pretend you're a gardener or just go there if you're bored this would be a good idea for older children mostly but maybe a few younger children.

I would like a never get bored area. Here you could have painted things on the ground like targets, snakes and ladders, netball court and hopscotch. You could have a low maze and a place to get to in the middle so you can't cheat then. I think this will be a good idea because you won't get bored. It will be fun and challenging and suitable for all ages.

I hope you enjoyed looking at my ideas and I hope you use them in the new school grounds. I think other people will like them as well. If you use mine and other peoples ideas not many people will get bored again. Even if people don't use them and play something else when they get bored of playing there game they can play on the activities we thought of. Thank you for reading this and I hope you use some of my ideas. I think by using other Peoples ideas it will make the school a better place and more fun a playtime. Thank you!

Figure 5.14: EB's writing on Amenities

In her written text, EB has combined the stray branch of 'low climbing frame' and 'wobbly bridge' with the main branch of adventure playground, and written about all these features under the heading of 'Adventure playground'. She also develops this idea by suggesting a suitable age group for this equipment and a reason for having it. She goes on to describe the quiet area in a similar way. Her branch 'painted area' is given a new heading in the text, a 'never get bored area', complete again with reasons and age group suggestions. Finally, she sums up her argument with some additional persuasive statements and signs off with a thank you. The finished piece includes all the items listed on the map with the exception of stepping stones. Further additions in the text are largely made up of formal features, such as her introduction and conclusion, together with developments concerned mainly with the purpose or potential user of each item.

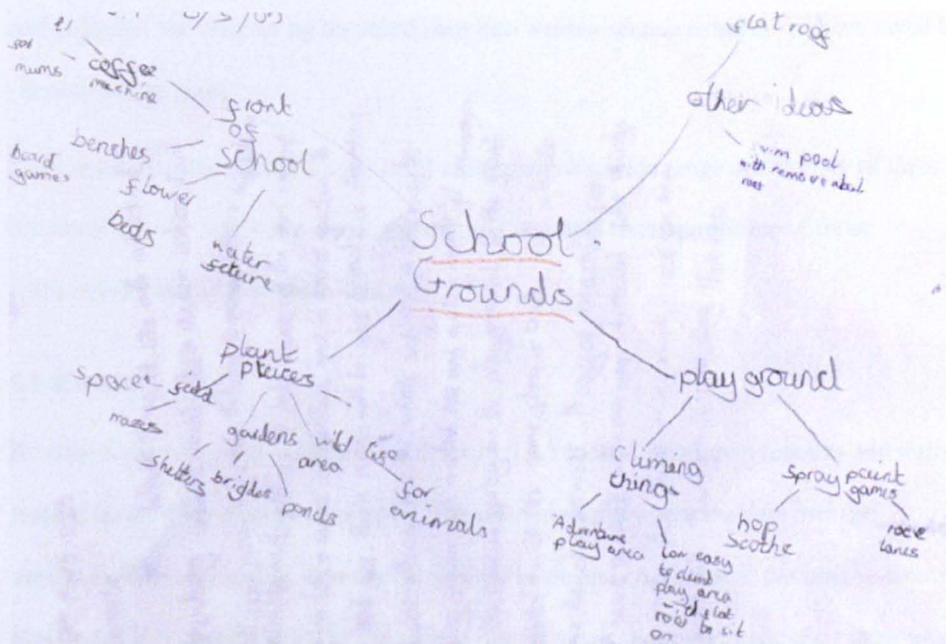

Figure 5.15: Y3 JF's mind map on Amenities

What I would like in the new school
I've been thinking what I would like in the new school. I am going to tell you now. I the new school I would like a big place for animals and plants to take care of the environment. I would also like a series of gardens and a secret garden to make it look nice. Some ponds and bridges to make it interesting. I would like something for the whole school a low easy to climb climbing frame with a flat roof and a little door to get inside. I would also like games spray on the playground. In the front of the school I would like some flower beds, and a water feture some benches as well. A coffee machine for the mums to have a drink in the morning. I would like things sprayed on the walls. These are my ideas I hope you find my ideas yousefull. Thankyou for reading this note bye bye.

Figure 5.16: JF's writing on Amenities

JF's mind map, figure 5.15, has been well structured, with items placed under superordinates, which could then have been used to structure the written task in a similar way to EB's work. He has identified locations around the school that need to be planned for different users and functions. The linked text, figure 5.16, is not developed in quite the same way. He talks about a plant and animal area but does not use all his ideas. The area at the front of the school is discussed in some detail and includes most of his ideas opening with a topic sentence, but other items are taken more randomly from the map and much of what he listed for the playground area is lost. Ideas on the map were easy for JF to generate and organise, but converting the mind map into written sentences seems to have taxed his stamina for the task.

Each mind map and piece of associated writing show a wide range and variety of links and relationships, the following statistical analysis attempts to capture some of those relationships across the whole study.

5.5 Results

Results in the following section from 5.5.1 to 5.5.5 look at mind map features and links to written tasks. As explained in chapter 3 on methodology, where the data met the requirements of normality, homogeneity of variance and co-variance, parametric tests were employed. Where data failed to meet these requirements, nonparametric tests were used as a more appropriate alternative.

5.5.1 Mind map levels

The first hypothesis was that the planning task linked to expository writing would be more suitable using a mind map and, as a result, well-structured mind maps would be produced. Contrary to this, an analysis of mind map levels showed significant task effects. Mind maps from both the Amenities and Brochure tasks were given a level as illustrated in the measures section, 5.3.4, which designated the degree of structure present. A second coder (blind to condition) coded 20% of the mind maps and agreement was judged satisfactory (kappa=0.87, $p<0.01$).

Table 5.4: Median mind maps levels for Amenities and Brochure tasks

	Median score	Interquartile range
Amenities n=43	1	2
Brochure n=57	3	2

A comparison of the map level scores using Mann–Whitney tests shows that mind maps used to plan the brochure writing (median=3) were significantly better structured than those produced to plan the Amenities writing task (median=1), U=856, $p<0.006$.

5.5.2 Mind map features

Other mind map features were analysed to capture the relative richness of content present between the two tasks. Mind map features were quantified and compared in three independent t-tests. Tables 5.5, 5.6, 5.7 show the number of branches, connections and map words produced in response to the two tasks.

Table 5.5: Mean numbers of mind map branches in both Amenities and Brochure tasks

Amenities mind maps n=43	5.77 (2.43)
Brochure mind maps n=57	4.25 (2.96)

Table 5.5 shows the mean number of branches produced by children in each condition. Analysis by independent t-test revealed a significant difference on the number of branches present on the mind maps in either condition ($t=2.75, df=98, p=0.007, r=0.07$). Children in Condition 1, the Amenities group, produced significantly more branches on their mind maps than those in Condition 2, the Brochure group. This difference was significant.

Table 5.6: Mean number of connections on Amenities and Brochure mind maps

Amenities mind maps n=43	12.88 (7.01)
Brochure mind maps n=57	12.68 (5.39)

Table 5.6, shows the mean number of connections produced by children in each condition. Analysis by independent t-test revealed no significant difference on the number of connections present on the mind maps in either condition ($t=0.16$, $df=98$, ns).

Table 5.7: Mean number of mind map words on Amenities and Brochure mind maps

Amenities mind maps n=43	44.02 (26.96)
Brochure mind maps n=57	26.11 (14.94)

Table 5.7 shows the mean number of mind map words produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of words present on the mind maps in either condition ($t=4.23$, $df=98$, $p<0.001$, $r=0.15$).

Children in Condition 1, the Amenities group, produced significantly more words on their mind maps than those in Condition 2, the Brochure group. This difference was significant.

5.5.3 Writing levels

It was hypothesised that written texts planned using a mind map would be more successful than those planned by using peer discussion. Writing levels were analysed to measure the impact of each type of planning strategy. A second coder marked one-third of the written texts. Agreement reached was r=0.98.

Table 5.8: Median writing levels achieved in each condition

	Amenities writing score		Brochure writing score	
	Median	Interquartile	Median	Interquartile
Condition 1 n=43 Amenities mapped/ Brochure discussed	5	3	5	2
Condition 2 n=57 Amenities discussed/Brochure mapped	4	3	5	2

A Wilcoxon signed-rank test showed there was no overall effect on writing score where a mind map rather than discussion was used as a planning tool ($z=-0.22$, ns). Looking at the two groups individually, a Wilcoxon signed-rank test showed that there was a significant difference in writing quality for children in Condition 2 who planned using a mind map for the Brochure task and discussed the Amenities task ($T=20$, $p=0.05$, $r=0.19$). This was not the case for the children in Condition 1 where there was no significant difference in the writing scores whether the writing was planned with a mind map or through peer discussion ($z=-1.21$, ns).

5.5.4 Mind maps and writing levels

The final hypothesis looked at three possible relationships between writing quality and mind map features. It was expected that better structured mind maps would lead to better written texts; more connections would also be correlated to better texts, and there would be more apparent transfer from mind map to written text in better texts. More numerous branch headings implies a lack of structure and more words do not necessarily imply a greater wealth of ideas, so greater numbers of these features were not expected to correlate to better texts.

Using a Spearman's test as some of the data are rank, mind map levels and features were correlated with writing level and writing words to investigate possible relationships for each writing task.

Table 5.9: Mind map features correlated with writing quality for Amenities task

	1.	2.	3.	4.	5.	6.
1. Map level		–0.56**	0.62**	0.28	0.49**	0.53**
2. Branches			-0.04	0.05	–0.23	–0.06
3. Connections				0.45**	0.56**	0.52**
4. Map words					0.22	0.25
5. Writing level						0.78**
6. Writing words						

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 5.9 shows correlations between mind map features and quality of the written texts for the Amenities task. High mind map levels were negatively related to the number of branches ($r=-0.56$, $p<0.01$). Large numbers of branches usually indicate that there has been little organisation or grouping of concepts on the mind map; often this is a Level 1 mind map.

Mind maps with higher levels, indicating structure, also tended to have larger numbers of concepts represented by the number of connections present on the mind map ($r=0.62$, $p<0.01$).

The number of mind map words did not correlate significantly with mind map level. This is because concepts or connections should be represented by keywords rather than sentences. Higher numbers of words therefore do not necessarily indicate higher numbers of concepts.

Over half the Amenities mind maps had used longer phrases (over three words) to describe concepts represented as connections.

In this study, writing scores and writing words were positively and significantly correlated with mind map structure (r=0.49, p<0.01/, r=0.53, p<0.01). Children writing better texts also had more structured mind maps.

Table 5.10: Mind map features correlated with writing quality for Brochure task

	1.	2.	3.	4.	5.	6.
1. Map level		–0.64**	0.21	0.10	0.27*	0.05
2. Branches			0.32*	0.30*	0.07	0.25
3. Connections				0.76**	0.55**	0.64**
4. Map words					0.57**	0.60**
5.Writing level						0.74**
6. Writing words						

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 5.10 shows correlations between mind map features and quality of the written texts for the Brochure task. Mind map levels were again negatively and significantly correlated with the number of branches (r=–0.64, p<0.01).

Mind maps levels, indicating structure, did not correlate significantly with higher numbers of connections for this task. As in the Amenities task, a greater number of mind map words did not correlate significantly with better structured mind maps. Writing scores were positively correlated with mind map levels (r=0.27, p<0.05) and numbers of connections (r=0.55, p<0.01).

5.5.5 Similarities between mind map items and written text items

The final aspect of hypothesis 3 referred to the level of similarity between items on the mind map and present in the written text. It was expected that there would be more similarity in items between mind maps with high levels of structure and the written task.

Items present on both mind map and writing were counted, as were items missing from the written text and items only appearing in the written text, as explained in the measures section 5.3.4.

Similarities in mind map items and items appearing in written texts were quantified and compared in three independent t- tests, shown in tables 5.11, 5.12 and 5.13.

Table 5.11, shows the mean number of items in common between mind map and written task produced by children in each condition. A second coder reached an agreement of $r=0.90$, $p<0.01$ on items occurring on mind map and in text. Analysis by independent t-test revealed no significant difference on the number of items in common present in either condition, $t=0.78$.

Table 5.11: Means of items in common between mind map and written text

	Items in common
Condition 1 n=43 Amenities mapped/Brochure discussion	8.98 (5.15)
Condition 2 n=57 Brochure mapped/Amenities discussed	8.16 (5.19)

Table 5.12 shows the mean number of items missing from the writing but present on the mind map produced by children in each condition. Analysis by independent t-test revealed no significant difference in the number of items present on the mind maps but missing from the written texts between the two conditions ($t=1.42$, $df=98$, ns)

Table 5.12: Means of items present on mind map but omitted from written texts

	Items missing from written text
Condition 1 n=43 Amenities mapped/Brochure discussion	3.44 (3.93)
Condition 2 n=57 Brochure mapped/Amenities discussion	4.51 (3.55)

Table 5.13 shows the mean number of items not present on the mind map but occurring in the written task produced by children in each condition. A second coder reached an

agreement of r=0.92 when looking at the number of novel items occurring in the written texts. Analysis by independent t-test revealed a significant difference in the number of novel items present in the written texts between the two conditions. Children working in Condition 2, Brochure task, introduced significantly more novel items into their written task than those in Condition 1. This difference was significant ($t=-2.88$, $df=98$, $p<0.005$, $r=0.26$).

Table 5.13: Means of novel items introduced into writing text not present on mind map

	Novel items in written texts
Condition 1 n=43 Amenities mapped/Brochure discussion	1.86 (2.57)
Condition 2 n=57 Brochure mapped/Amenities discussed	3.37 (2.61)

Is there a relationship between the map levels and the similarity of items from the mind map and in the text?

In the Amenities task, there was a significant positive correlation between the mind map level and the number of ideas in common with the written task ($r=0.62$, $p<0.01$), as shown in table 5.14. Both mind map level and items in common correlated positively and significantly with writing quality ($r=0.49$, $p<0.01$ and $r=0.54$, $p<0.01$).

Table 5.14: Correlation between items in common, missing from the text or novel text items with writing quality for Amenities task

n=43	1.	2.	3.	4.	5.
1. Mind map level		0.62**	0.19	0.16	0.49**
2. Items in common			0.09	-0.03	0.54**
3. Items missing from text				0.35*	0.26
4. Novel text items					0.27
5. Writing quality: Amenities					

**Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 5.15 shows similar correlations for the Brochure task. In this task, the correlation between mind map structure and the number of items included in the writing was not significant (r=0.16, ns); however, there was a positive significant correlation between items in common with the mind map and the quality of writing task (r=0.56, p<0.01).

Table 5.15: Correlation between items in common, missing from the text or novel text items and writing quality for Brochure task

n=57	1.	2.	3.	4.	5.
1. Mind map level		0.16	-0.06	0.03	0.27*
2. Items in common			-0.22	-0.48**	0.56**
3. Items missing from text				0.14	0.12
4. Novel text items					-0.08
5. Writing quality: Brochure					

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

5.6 Discussion

Results from this study show no unequivocal advantage for using mind maps as planning tools for thematic written tasks over peer discussion, but a number of interesting relationships between mind map structure, task requirements and writing quality emerged.

Hypothesis 1: Children of the ages of 7–11 would be able to produce well-structured mind maps for expository writing tasks

Children across the age range of 7–11 years successfully produced mind maps in the study. However, these showed a range of structure from simple association stars, which had not been seen in the exploratory study reported in chapter 4, to elaborated semantic clusters. Such high numbers of association stars were not expected, as the tasks needed thematic organisation which was felt to be more appropriate for this kind of planning. Children who had produced structured mind maps rated Level 3 in the practice sessions were producing Level 1 mind maps in response to planning these writing tasks and this was particularly prevalent in the Amenities task.

The difference between the two tasks was unexpected. Efforts had been made to design writing tasks that would be as equivalent as possible. Both tasks called for an expository style of writing, based on children's experiences in school and requiring a persuasive register. The results show that mind maps produced for the Amenities task had considerably less structure. This was the case across the different age groups included in the study. Similarly, better structured mind maps were also evident in all age groups participating in the study. The unstructured mind maps did not appear to be a result of an inability to group items under branch headings. The association stars appeared to be a response to the particular writing task.

Hypothesis 2: Planning writing on a mind map would be more effective than peer discussion, as the mind map is a concrete document which can act as an external memory during the written task. The form of the mind map encourages children to group related concepts more formally than would be expected in speech

As stated earlier, planning using a mind map when compared to using peer discussion did not have a main effect on the written work produced. However, once again, task effects were evident. Children planning the amenities task on a mind map, compared to those planning through peer discussion, showed no benefit for using this planning strategy in the quality of texts produced. Closer inspection of the type of mind map produced revealed that a very high proportion were association stars. This was in contrast to children planning the Brochure task using a mind map, where a small but significant improvement in writing score between the two groups could be observed. In this case, a higher proportion of mind maps were well-structured and, it could be argued, had therefore provided a prewriting strategy that had directly benefited the quality of written work produced. This is in line with other research which has shown that a variety of structured prewriting strategies have produced better written outcomes (Torrance et al., 2007; Sturm & Rankin-Erickson, 2002; Piolet & Roussey, 1996; Meyer, 1982).

Conversely, it must be acknowledged that the planning strategy may not have been the only factor in this improvement. The brochure-writing task was completed slightly later in the academic year in May. The younger children in both conditions completed their Amenities writing in March. This may have had an impact on the brochure-writing task through a general improvement in writing skill. However, this explanation is unlikely as children planning the Amenities task with a mind map and discussing the Brochure task did not show a similar improvement in the Brochure task. Their writing scores remained consistent for both tasks.

There were a number of relationships between the content and structure of mind maps and the written texts associated with them.

Hypothesis 3a: Mind maps with better structure, as seen in the use of branch headings, would be linked to better quality texts

Mind maps with larger numbers of branches were not associated with better texts. This was true for both the Amenities and Brochure tasks. A larger number of branches tend to be a characteristic of association stars where concepts have not been organised into super- and subordinate categories. Brochure task mind maps were generally more structured and branches tended to contain more than one concept. Where children had generated relevant categories, represented by the branch headings, they had also populated the branches with a number of related ideas, leading to a greater number of both connections and words. Additional content means that children have considered more associated ideas that can be used in the written task.

Hypothesis 3b: Mind maps with more content, shown as connections, would be linked to better quality texts

It was found that mind maps which had richer content, measured in terms of connections, were correlated with better texts, as assessed by the holistic measures used. This was similar across both writing tasks. Children with a greater fund of ideas managed to write better texts.

Hypothesis 3c: Mind maps with better structure would be associated with greater transfer of content from map to writing

Mind maps that were better structured were also associated with greater similarity of content on both mind map and present in written text. In the Amenities task, the mind map level, items in common between the mind map and writing and the quality of the writing were all positively correlated. The Brochure task showed similar relationships. Better quality writing was correlated with better structured mind maps and with the number of items in common between mind map and written text. The number of novel items was higher for the Brochure task but this was not correlated with better texts in either task.

There are a number of possible explanations for this. The first explanation, based on arguments for the benefits of mind maps, is that the more organised structures achieved on mind maps led to easier transfer into better written texts. The visual representation supported the writing task and remained available for reference during the writing task. Peer discussion may enable children to clarify their ideas but there is no visible representation to refer to once the writing task commences. However, it must be acknowledged that this relationship is correlational. Therefore it might also be argued that those children who are able to structure their mind maps are also children who tend to produce better written texts.

These correlation findings provide some evidence to support the assertion that encouraging children to consider the content of a written task before transcription is beneficial and can impact on the quality of the written work produced. Riley's study (2004) also found that a well-constructed concept map was linked to well-written text. Overall, this could suggest that children able to create well-structured mind maps are capable of successfully outlining their written task. The example of EB's work gives some support to this assertion. Once writing goals are formulated in advance, a writer will have the advantage of greater cognitive capacity to deal with local issues of sentence construction, vocabulary choice and so on (Sharples, 1994) when engaged in transcribing text. The similarity between the mind map items and the resulting texts also suggested decisions about items to be included can be made in advance of writing. This suggests that a teacher can make sensible predictions, based on the evidence present on a mind map, for the subsequent quality of the written text..

5.6.1 Additional considerations

The period of time between planning the written tasks and producing the text was relatively short during this study. Children were engaged in a prewriting activity lasting around 15–20 minutes. Successful writers may have found little need to write a visible plan as they could hold the structure and items to include easily in mind, but the correlations between well-written texts and structure and content are suggestive. There are other benefits for visible planning strategies. In a busy classroom, children's discussion is hard for a teacher to access, while the mind map produces a document that can be examined both as planning is in process and in the light of the resulting written text. The relationship between the two documents can be seen and assessments made. The mind map planning strategy does not offer a clearcut advantage over peer discussion – but conversely, neither was it a hindrance to the pupil's planning process and could serve as an indication for suitable teacher intervention at the planning stage.

Children were able to learn the basics of the representation quickly and there appeared to be no detrimental effects on written texts after using this type of planning; writing scores were not poorer when comparisons between planning with a mind map and planning through discussion were evaluated. Cognitive cost, as described by Ainsworth (2006), was not obvious, though children producing higher levels of mind map were rare, which suggests that the representation had not been completely mastered by the majority of children involved in the study.

There appears to be a clear relationship between the mind map plan and written text. This is supported by the way the task impacts on the type of mind map produced. This was shown in the exploratory study and Study 2.There is a high level of similarity between items included on the mind map and occuring in the written text. Children were involved in a planning process. There was only one example of a child who treated the two tasks – constructing a mind map plan and writing an associated text – as completely separate tasks.

It had been expected that there would be little difference in the mind maps produced for each task. The two expository tasks were intended to provide a similar suitable context for planning using mind maps. It was assumed that a thematic written assignment would be supported by the construction of a mind map, giving an opportunity for children to generate and organise content before attempting to compose text. Both tasks were deemed to be equivalent and it was not expected that there would be any significant differences in the types of mind maps produced for each of the tasks. This did not prove to be the case. Children mind mapping the Amenities task produced a large number of Level 1 mind maps. It appears that the task inviting them to generate a number of choices for the school grounds, with reasons for that choice, elicited a dual wheel construction. This consisted of an association star with each of many branches having a further supplementary branch attached, giving a reason for each choice expressed. There were few instances of children considering how their choices could be grouped. The task was close to personal experience and 'knowledge telling' became the strategy most evident, with mind maps becoming lists simply structured by association rather than attempts to group content. In addition, Amenities mind maps had larger numbers of words present though this was not combined with a larger number of ideas represented by connections on the mind maps. This indicates more use of phrases or short sentences rather than keyword generation. This also implies that children had reverted to a list-generating strategy of the kind reported by other studies, (Bereiter & Scardamalia,1987; Burtis et al., 1983) and were not choosing keywords to express their concepts.

The Brochure task differed in a number of ways. Writing in role as head teacher was an additional task demand, which needed mediation between knowledge of technology in school and an appropriate way to represent this, possibly resulting in greater consideration. Knowledge had to be transformed if only to consider it in the light of writing in a different role, which called for appropriate language forms. In addition, use of computers in school appeared to be closely associated to the people, children or staff, using the technology, or the contexts in which the technology would be used, for administration or for learning, and often these gave structure to the items included on the mind maps.

Results were surprising and again showed that the mind map form had been adapted by individuals to suit the task as they perceived the demands. Both Buzan (2000) and Cavilglioni & Harris (2000) suggest that practice will be needed to master the representation, but not that the form will alter in respect to the task. Kinchin & Hay (2000) in their study suggest that the structure of concept maps may be an indication of conceptual development rather than task dependent, and went as far as to suggest classroom grouping strategies based on the kinds of concept map children produced. Results reported here suggest that children adapt the form flexibly in response to the task.

There was still a concern that a large proportion of mind maps created were not well structured and therefore children were not gaining the possible advantages of using this kind of representation. High numbers of children were still making unstructured lists – association stars were the most common mind map form in the Amenities task and the Brochure task also had many association stars and association chains. Unstructured lists of ideas then tend to become list-like texts, where short phrases and part sentences are converted into longer sentences, as reported by Burtis et al. (1983). From the outset of the study, there was an ambition for this method of planning to provide a scaffold to encourage structured thinking about the task, and to achieve this, items on a map had at least to be ordered into basic groups or categories. The type of thinking emphasised by Jonassen (1998) or Caviglioni & Harris (2000) appeared not to be occurring when mind maps were produced as unstructured lists.

Children had been taught two ways to make mind maps: deductively, starting with branch headings and finding items to populate the branches; or inductively, starting with as many items as they could generate, which could then be ordered into groups. Children had tended to reject the inductive approach; only two older girls adopted this technique while making maps for this study. Scaffolding the mind map construction process more clearly, breaking down the stages into smaller steps, seemed to offer a process to enable children to engage with the thinking required to construct a well structured mind map. Studies 3 and 4 address the research question of how children can be supported to create better mind maps. Encouraging children to adopt the inductive approach and the use of visual prompts was considered. This was important as mind maps in this study showing better structure were positively linked to better written outcomes. Scaffolding the mind map construction process appeared to be worthy of investigation.

Chapter 6: Studies 3 and 4

Scaffolding the process of constructing mind maps - boxes and templates

6.1 Introduction

Studies 1 and 2 have shown that children are capable of constructing maps, but the kinds of maps produced varied a great deal in each study depending on the written task. The second study produced a large number of association stars, the least structured form of mind map. This was an unexpected development as most of the children in Study 2 had some experience of constructing mind maps. There had been no mind maps of this type in the exploratory study reported in chapter 4. Both written tasks in Study 2 were thematic and this was seen as appropriate for planning on a mind map structure. Possible items for both the Amenities and Brochure tasks could be represented as organised lists. As a consequence of this, it was hypothesised that mind maps produced would show greater structure overall. However this did not prove to be the case. The Amenities task in particular elicited a large quantity of Level 1 mind maps, which represent collections of ungrouped items. Mind mapping as a 'mindtool' (Jonassen, 1998) was advocated as a means of structuring thought and organising content, in this case before the writing process. The high number of association stars showed that the children were using the mind map to jot down lists of relevant ideas but were not then structuring or grouping these ideas for use in their written task. This strategy in itself may be a useful one for generating content quickly in note form and rehearsing some of the content to be deployed in the written task, but the aim of using this particular representation was to scaffold the planning process by encouraging some consideration of organisation before text was transcribed.

These two studies were designed to investigate ways to support the mind map construction process, independent of any subsequent written task.

6.2 Scaffolding

Scaffolding, a metaphor suggested by Wood et al. (1976), provides support by a more expert tutor to a novice learner in order to achieve a learning goal or to successfully solve a problem. This support breaks down the task into manageable stages and offers contingent assistance as required to understand a concept or solve a problem. The process of scaffolding learning has been incorporated into teaching sequences suggested by the National Literacy Strategy (DfEE, 1998), where initial demonstration by the teacher is followed by a co-construction phase in a whole-class setting, followed by scaffolded independent work leading to fully independent work and mastery of the concept. Scaffolding in these terms can be seen as a person providing contingent support, as described by Wood et al. (1976). However, it is possible to extend the metaphor of scaffoding to include artefacts that can provide additional support for a novice learning a particular task (Sherin et al., 2004; Wray & Lewis, 1997). The mind map teaching sequence employed in these studies had provided modelling and co-construction, but a scaffolded stage before independent work had not been fully considered.

During the teaching process children had seen the teacher-researcher demonstrate how to construct a mind map and been involved in co-construction of a collaborative mind map. As part of this instruction process, two possible strategies for constructing mind maps were introduced:

- A ***deductive*** process which identified the organising branches and populated them with relevant content
- An ***inductive*** process where relevant content was generated in a list form to be placed on a mind map when suitable categories had been identified as indicated by items generated and recorded as a list.

Following this, children were asked to construct mind maps independently, with no further structured support for the task.

Overwhelmingly, when ask to create mind maps for both previous studies, children chose to work using the deductive method (only two cases were noted where children chose to work inductively and first create a list). In order to support the organisation process, in the hope of producing a greater number of structured mind maps and, more crucially, scaffolding the process of thought necessary to categorise information, it was decided to direct the children to work in an inductive way.

In addition to the lack of structure present in some mind maps, some children were writing in phrases and sentences to populate their mind maps. This led to mind maps with a relatively large word count but representative of fewer concepts. The mind-mapped planning was becoming a list of items expressed in short phrases which represented a shorter rehearsal of the finished piece. This kind of planning had been reported in studies by Bereiter & Scardamalia (1987). Children were not planning in a way that involved a series of decisions or alternatives, but producing an abbreviated rehearsal that was largely reproduced for the final written task. This kind of planning justifies the view of many children that the planning process is a waste of time. The writing task is merely repeated in a more elaborated form, rather than planning providing support for the primary task. There is no consideration of overall goals and direction which could alleviate some demands encountered in the transcription phase of writing.

Two types of scaffolding interventions were planned to support mind map construction. The process of making a mind map was broken down into distinct stages and the children worked through these in Study 3 using an inductive approach. The second type of scaffolding involved visual prompts: in Study 3, these took the form of text boxes to scaffold the generation of keywords and in Study 4 templates to guide mind map construction.

The studies took place over two school terms, from the end of January to July 2006.

6.3 Study 3

In order to scaffold the mind map-making process, a number of stages were recognised and supported.

6.3.1 Aims

Mind map content needs to be generated in the form of keywords. This study first looked at how to scaffold this initial concept generation by using a scaffolding device which consisted of a sheet marked with text boxes to encourage the use of very short phrases and implicitly suggest that a large number of concepts were required. Comparisons were made between lists generated with or without the text boxes and between familiar and unfamiliar topics to assess the impact of the scaffold.

Following this, concepts need to be organised under branch headings. The aim of these studies was to encourage children to define organising categories following the generation of relevant content. It was felt that children would be able to produce categories and sub-categories more easily for the familiar topic than a recently taught curriculum subject. This was an intermediate stage where items were grouped under content categories or sub-categories using a cut and paste technique. Once headings and groupings had been decided these could be transferred onto a mind map.

The hypotheses tested in Study 3 were:

1. Children are able to generate lists of keywords related to topic areas

2. Generating keywords would be easier for a familiar topic rather than a recently taught aspect of the primary curriculum

3. Text boxes would scaffold process

4. Children would be able to generate category headings for their lists, but this would be easier for the familiar topic. This would in turn lead to more structured mind maps for the Food topic.

5. Well-structured mind maps would be linked to greater content.

6.3.2 Method

6.3.2.1 Design

The study used a partial crossover design. Each child generated two lists of words, one list generated on a blank piece of paper, the other on a sheet containing text boxes. Children in Condition 1 had paper with text boxes for a topic about food and blank paper for a topic about Egyptians. Children in Condition 2 had blank paper for the Food topic and paper containing text boxes for Egyptians. Thus, the study design was a 2 by 2 mixed design with a within-groups factor of type of support (text boxes/blank paper) and a between-groups factor of condition (text boxes Food/text boxes Egyptians).

6.3.2.2 Participants

The participants in these two studies were 54 members of two primary school classes. The two classes were a Y3 class consisting of 26 7–8 year olds and a Y4 class of 28 8–9 year olds. Children in Y3 had not been involved in either of the previous studies reported in chapters 4 and 5. Children in Y4 had taken part in the study reported in chapter 5, so had more experience in constructing mind maps. Participants were allocated to one of two conditions. Condition 1 consisted of 27 children from both classes, 13 children from Y3 and 14 children from Y4. Condition 2 was composed in the same way, with 27 children, 13 from Y3 and 14 from Y4. Efforts were made to make the two groups as similar as possible. There was a balance of genders: Condition 1 had 14 girls and 13 boys, as did Condition 2. Writing ability was also considered, with a balance of abilities in each group as judged by their class teachers.

Both classes of children had followed a history unit on the Egyptians during the previous term which was jointly planned by the class teachers using the same learning objectives. Experiences during the term included a museum visit and visiting speaker attended by both classes. This history unit is only specifically covered once in the primary curriculum. Food as a curriculum topic had been part of the design technology strand taught in the previous term, but was also part of continuing health and science education and a healthy schools initiative taking place in the school at the time of the study, which meant a high level of exposure to related issues. Obviously food is also a topic children are aware of from media coverage and their own personal experience on a daily basis.

6.3.2.3 Procedure

Session 1: The session took place in the middle of the spring term. It was timed to take place in a lesson period lasting just over one hour, between morning break and lunchtime, which meant both groups of children could complete the keyword-generating task consecutively. Session 1 consisted of a classroom session introduced by the teacher–researcher lasting approximately 30 minutes. Children attended the session in their study group in a classroom familiar to them and were seated in self-selected groups of 4–6 around tables. The task was introduced as a challenge or game. It was explained that they would have to create two lists of keywords. The first challenge was to create a list of words connected to food. After ten minutes, the first sets of lists were collected and a second sheet of paper was distributed for the second list. The second challenge was to create a list of words connected to the topic of Egyptians. Resulting lists were collected after ten minutes.

The support for the two tasks varied as previously reported. Those in Condition 1 had a blank piece of paper for the Food topic and text boxes for the list connected to the Egyptians topic. Children in Condition 2 had text boxes to compose their 'food' words followed by a blank piece of paper for the Egyptians topic words.

While the children were writing their lists independently, the researcher monitored the work and asked for clarification if unconventional spelling made words difficult to understand, but no assistance was given to generate items. Children were asked to work as independently as possible and encouraged not to share ideas. The way the task was framed as a game meant that most children worked quietly and were keen to complete their own lists independently.

In the intervening period between Sessions 1 and 2 the researcher typed all word lists. This was to clarify spelling, making the words listed clear for both the child and researcher for use in Session 2. Children were asked to explain items that were not clear after an initial reading of the word lists.

Session 2: This session took place early in the summer term of the same academic year. This was a longer session and was timetabled for an afternoon. Each group was able to attend on the same day. The session lasted approximately 75 minutes. Children were seated around tables in groups of 4–6 and again chose places for themselves.

The original lists together with a typed copy were distributed to their authors. A short introduction by the researcher explained the task to the children. Instructions were given to cut and paste the typed list onto a new piece of paper, organising the items into appropriate groupings using a category heading. The children were given an example of this related to words connected to films and there was a short group discussion about possible categories for an item: for example *The Lion King* could be placed in a number of categories – a cartoon, a film made by Disney, a film for children, a film about animals.

It was made clear that category headings could come from the original list of items or be generated as the groupings developed. New handwritten items could also be incorporated into the emerging categorised lists. The final grouped list could consist of words from the original list, cut and pasted on to the new sheet, or handwritten words that had been generated as the groupings developed. The cut and paste technique was to give maximum flexibility when deciding on the groupings, and children were encouraged to make the groups before deciding to stick items down. The children were also instructed that they could make use of a 'catch all' category, 'Other', if they were unsure of how to categorise items generated. Children were encouraged to work independently to decide on their own grouping strategies with minimal assistance from the researcher, beyond monitoring and encouragement, to complete the tasks.

Session 3: This session took place during the week following Session 2. Each group attended on the same day. The session lasted approximately 75 minutes. Children were seated around tables in groups of 4–6 and chose places for themselves.

The researcher distributed children's work from the previous sessions in named packs containing original word lists and the paper with the items for 'Food' and 'Egyptians' grouped under category headings. Children were then asked to create two separate mind maps, one on food and one on Egyptians, using this information. They were able to choose for themselves in which order to complete each mind map. Some children also had the opportunity to complete their groupings if they had not already done so in Session 2. Children were encouraged to add items to the mind map that were not present on either their original lists or the categorised lists made in Session 2. At the end of the session all work was collected to be analysed.

Children were familiar with the mind map form and were able to complete the task with little additional explanation from the researcher.

6.3.2.4 Measures

Children's keyword lists were transferred to a spreadsheet in order to count numbers of items and words in each list from Session 1. Numbers of categories were counted, together with any increase in items from the original lists. Mind maps were analysed looking at the level of structure present and given a categorisation from 1 to 4, according to the scheme reported in chapter 4. Mind map features were also counted: number of branches, connections and words.

6.4 Exemplars of children's work

This section shows representative examples of work produced during the three sessions.

The first examples are taken from a Y3 girl working as a member of the group in Condition 2. She was able to generate lists of keywords for both topics, but a longer list of items was produced for the more familiar Food topic (see table 6.1). She was able to put both lists of words into categories, making use of the catch all 'other' category for both topics (see table 6.2), and successfully produced Level 3 mind maps using the categories defined. Her mind map about Egyptians, which included all her items under group headings, is shown in figure 6.1. There has been no increase in items between the original word list for Egyptians and the categorised list. Once JN constructs her mind map, she makes some alterations to how items are categorised and adds to the number of items by including 'gold' and 'patterns' under the branch heading of 'pyramid'.

Table 6.1: Keyword lists by Y3 girl on Food and Eygptians topics

Food (paper) 23		**Egyptians (boxes) 10**
cooking	ham	mummies
dinner	jam	pyramid
lunch	fish	cases
breakfast	tuna	River Nile
celery	beefburgers	jewellery
turkey	chips	beetles
chicken	waffles	ankh of life
rice	fajitas	wrapping
peas		paintings
beans		tombs
oven		
broccoli		
carrots		
beef		
sandwiches		

Table 6.2: Keyword lists as categorised groups by Y3 girl

	Food		**Egyptians**	
Healthy foods	**Dinner**	**Lunch**	**Mummies**	**Others**
celery	beans	sandwiches	cases	ankh of life
turkey	waffles		wrapping	River Nile
beef		**Unhealthy**	beetles	
ham	**Breakfast**	chips	jewellery	**Pyramid**
fish	jam		tombs	paintings
tuna				
broccoli	**Cook with**			
carrots	oven			
peas				
fajitas				
rice				
beef burgers				
chicken				

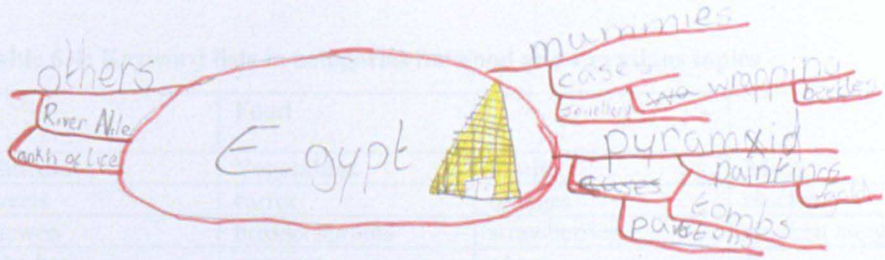

Figure 6.1: Level 3 mind map on Egyptians topic by Y3 girl

The next example shows work by a Y4 girl. She has also produced her lists of words, working in Condition 2, shown in table 6.3. She has created a longer word list for the Food topic using all 30 text boxes supplied, compared to the 11 items on her Egyptians list. She is then able to group her word lists into categories, again using the catch all category of 'other' for both sets of words (see table 6.4).

Table 6.3: Y4 keyword list for Food and Egyptians topics

Food (boxes) 30		Egyptians 11
brussel sprouts	bread	mummies
chocolate	cake bar	tombs
yoghurts	biscuits	Tutankhamun
crisps	chips	Egypt
cereal	chicken dippers	Egyptians
sweets	chicken nuggets	shabtis
fish	yorkshire pudding	deathmask
chicken	stuffing	amulets
bacon	apples	coffin
chewee	strawberries	hieroglyphics
Sunday dinner	cherries	pyramid
	plums	
	grapes	
	fruit	
	vegetables	
	Meat	
	potatoes	
	carrot	
	oranges	

Table 6.4: Keyword lists in categories for Food and Egyptians topics

	Food		
Chocolate	**Vegetables**	**Fruit**	**Meat**
sweets	carrot	oranges	chicken
chewee	brussel sprouts	strawberries	chicken nuggets
cake bar	potatoes	plums	fish
		grapes	chicken dippers
Others	**Potatoes**	cherries	bacon
stuffing	crisps	apples	
yorkshire pudding	chips		
yoghurts			
Sunday dinner			
bread			
cereal			
biscuits			
	Egyptians		
Tombs	**Egyptians**	**Others**	
death mask	Tutankhamun	Egypt	
coffin		pyramid	
hieroglyphics			
mummies			
shabtis			
amulets			

The categories used have transferred over to the mind map on the topic of food, and the mind map is clearly structured as a Level 3 semantic cluster. Sections on the mind map have been extended from the original list of words and the categorised list: a number of examples of chocolate bar are now included and there has been an increase in the kinds of fruit and vegetables mentioned (see figure 6.2).

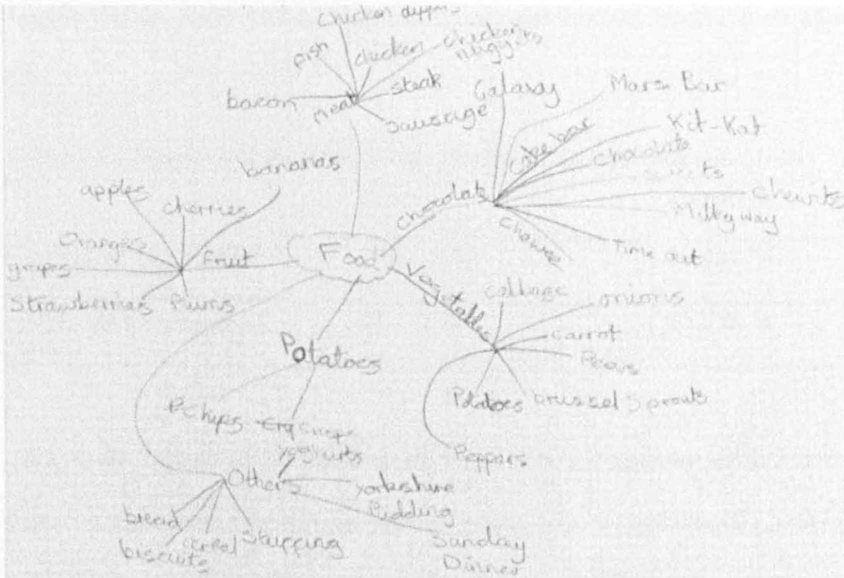

Figure 6.2: Y4 girl's Level 3 mind map showing categorisation

6.5. Results of Study 3

Results in the following sections, from 6.5.1 to 6.5.4, look at keyword generation, category generation and mind map features. Section 6.5.1 looks at the impact of using text boxes on the number of keywords generated and the differences between a familiar and less familiar topic. Category generation was also compared between a familiar and unfamiliar topic and the results reported in section 6.5.2. Children's mind maps were analysed comparing levels achieved and the numbers of individual features in section 6.5.3. The final set of results, 6.5.4, reports on correlations between the numbers of items generated as connection and categories with the level of structure present on the mind maps. As explained in chapter 3 on methodology, where the data met the requirements of normality, homogeneity of variance and co-variance, parametric tests were employed. Where data failed to meet these requirements, nonparametric tests were used as a more appropriate alternative.

6.5.1 Keyword generation

It was hypothesised that children would be able to generate lists of keywords related to topic areas and that this would be easier for a familiar topic. It was also hypothesised that text boxes would support the generation of a higher number of keywords. This section reports the findings from the first session where children generated their keyword lists.

Numbers of keywords were counted from the word lists produced and are shown in table 6.5.

Table 6.5: Mean number of keywords produced by condition and task

	Food	Egyptians
Condition 1 (paper/box) (n=27)	18.2 (10.2)	16.48 (7.3)
Condition 2 (box/paper) (n=27)	24.1 (9.6)	15.9 (8.1)

Analysis by 2 (paper/boxes, boxes/paper) by 2 (Food, Egyptians) on the number of keywords by mixed ANOVA revealed no main effect of condition (F1,52)=1.39) (table 6.5). There was a main effect of topic (F(1,52)=32.46, MSE=660, p<0.001, partialη^2=0.38), with a greater of items generated for the Food topic (M = 21.15) than for the Egyptians topic (M=16.25). There was also a significant interaction between topic and condition (F(1,52)=13.46, MSE=277, p<0.001, partialη^2=0.21), revealing a scaffold effect. As there was no main effect of condition, the data can be analysed by paired sample t-test which showed that more items were generated with boxes (M=20.28, SE=1.26) than with paper (M=17.07, SE=1.25) (t=2.94, df=53, p<0.03, r=0.37).

6.5.2 Category generation

The fourth hypothesis predicted that children would be able to generate category headings for their keyword lists, but that this would be easier for the more familiar topic of Food. Numbers of categories produced in Session 2 were calculated as shown in table 6.6..

Table 6.6: Mean number of categories produced by condition and task

	Food	Egyptians
Condition 1 (paper/box)) (n=26)	3.08 (1.62)	3.00 (1.90)
Condition 2 (box/paper) (n=26)	4.35 (1.79)	3.65 (2.12)

NB Two children absent on day.

Analysis by 2 (paper/boxes, boxes/paper) by 2 (Food, Egyptians) on the number of categories by mixed ANOVA revealed a main effect of condition (F1,50)=4.79, MSE=24.04, p=0.03, partial η^2=0.09) (see table 6.6). Children in Condition 1 produced significantly fewer numbers of categories (M=3.04) than children in Condition 2 (M=4.00). There was no main effect of topic (F(1,50)=1.99). No significant interaction between condition and topic on the number of different categories pupils created was found (F(1,50)=1.27), which suggests there was no effect of scaffold.

6.5.3 Mind map levels and features

There was an expectation that mind maps with the more familiar topic of Food would be more structured. Mind maps produced in Session 3 were assessed. Mind map levels were scored according to the coding scheme developed in the exploratory study and reapplied throughout the thesis. A second coder (blind to condition) coded 10% of the maps and agreement was clear (kappa=1, p=<0.001). As these data are rank, analysis is nonparametric.

Table 6.7: Median map levels for Food and Egyptians topics

	Food		Egyptians	
	Median	Interquartile range	Median	Interquartile range
Condition 1 (paper/box) (n=26)	3	1	3	1
Condition 2 (box/paper) (n=25)	3	0	2	2

NB Three children absent or had not completed part a of task.

Two Wilcoxon signed-rank tests explored if there were differences between the mind map levels for each group. For Condition 2, the Food mind map (created using the text boxes) was more structured than the Egyptians mind map (created using blank paper) (T=0, p=0.005, r=0.44). However, for Condition 1, there was no difference between the maps (T=4). Mann-Whitney tests showed there were no significant differences between the two conditions on either the Food task (U=286) or the Egyptians task (U=286).

Difference in mind map features were quantified and compared in three (2 by 2) mixed ANOVA tests; see tables 6.8, 6.9, 6.10.

Table 6.8: Mean number of branches produced by condition and task

	Food	Egyptians
Condition 1 (paper/box) (n=26)	4.96 (2.88)	4.85 (3.28)
Condition 2 (box/paper) (n=25)	4.88 (1.67)	4.72 (2.56)

NB Three children absent for part of task.

Table 6.8 shows the mean number of branches produced by children in each condition for each topic. Analysis by 2 (paper/boxes, boxes/paper) by 2 (Food, Egyptians) mixed ANOVA revealed no main effect of condition ($F(1,49)=0.04$) on the number of branches present on the mind maps. There was also no significant effect of topic ($F(1,49)=0.73$) or interaction between topic and condition ($F(1,49)=0.00$).

Table 6.9: Mean number of connections produced by condition and task

	Food	Egyptians
Condition 1 (paper/box) (n=26)	25.5 (13.13)	16.7 (7.68)
Condition 2 (box/paper) (n=25)	27.24 (10.8)	14.88 (7.24)

NB Three children absent for part of task.

Table 6.9 shows the number of mind map connections produced by children in each condition for each topic. Analysis by 2 (paper/boxes, boxes/paper) by 2 (Food, Egyptians) mixed ANOVA revealed no main effect of condition ($F(1,49)=0.00$) on the number of connections present on the mind maps. There was a significant effect of topic ($F(1,49)=74.31$, MSE 2865.74, $p<0.001$, partial $\dot{\eta}^2=0.6$), the number of 'food' connections was higher ($M=26.37$) than 'Egyptians' connections ($M=15.79$), but there was no interaction between topic and condition ($F(1,49)=2.04$).

Table 6.10: Mean number of mind map words produced by condition and task

	Food	Egyptians
Condition 1 (paper/box) (n=26)	29.12 (14.34)	18.96 (8.38)
Condition 2 (box/paper) (n=25)	31.4 (11.72)	18.28 (8.07)

NB Three children absent for this session.

Table 6.10 shows the number of mind map words produced in each condition for each topic. Analysis by 2 (paper/boxes, boxes/paper) by 2 (Food, Egyptians) mixed ANOVA revealed no main effect of condition ($F(1,49)=0.86$) on the number of words present on the mind maps. There was a significant effect of topic ($F(1,49)=70.18$, MSE 3451.83, $p<0.001$, partial $\eta^2=0.59$) – children produced more words for the Food topic (M=30.26) than for the Egyptians topic (M=18.62) – but there was no interaction between topic and condition ($F(1,49)=0.86$).

6.5.4 Mind map levels correlated with numbers of categories and items

The final hypothesis for this study was that more structured mind maps would be linked to greater content. A Spearman's test was used to investigate correlations between mind map levels and the numbers of categories devised and items on keyword lists. This nonparametric test was employed as mind map levels are rank. This is shown in table 6.11.

Table 6.11: Correlation between map levels, categories created and items listed for Food and Egyptians topics

	1.	2.	3.	4.	5.	6.
1. Egyptians mind map level		0.37**	0.53**	0.34*	0.51**	0.41**
2. Food mind map level			0.35**	0.43**	0.39**	0.37**
3. Egyptians categories				0.46**	0.60**	0.47**
4. Food categories					0.38**	0.58**
5. Egyptians items						0.67*
6. Food items						

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

There is a significant correlation between the levels of mind map produced for both topics. ($r=0.37$, $p<0.01$). For both topics (Food/Egyptians) the more items listed ($r=.37$, $p<0.01$/$r=.51$, $p<0.01$) and categories devised ($r=.43$, $p=<0.01$/$r=.53$, $p=<0.01$) by pupils, the more structured the map.

6.6 Discussion of Study 3

In the earlier studies, children always chose to make mind maps using a deductive method, starting with branch headings. The outcomes from this approach varied, but in Study 2 a large number of Level 1 mind maps had been produced. These representations are basically list structures, with no grouping or categorisation of information. This study investigated whether children could be supported to produce better structured mind maps by using an inductive approach and by breaking down the process into a series of discrete stages through procedural scaffolding (Azevedo, Cromley, & Seibert, 2003).

Hypothesis 1: Children are able to generate lists of keywords related to topic areas

Children were encouraged to produce a greater wealth of possible content by generating lists related to a familiar topic, Food and a less familiar curriculum topic, Egyptians. This was achieved by all children and only two instances were found where children started to write in phrases of over three words. Examples of children using phrases of over three words to represent one item had been present in mind maps collected from the two previous studies, reported in chapters 4 and 5. This suggests that there was a task effect influencing the way children generated concepts for mind maps. When asked to create keyword lists related to topics with no expectation of a subsequent writing task, all but two children accomplished this effectively. There was a wide range in the number of keywords listed, which was expected. Transferring keywords from the preordered lists led to the use of keywords rather than longer phrases on the mind maps produced.

Hypothesis 2: Generating keywords would be easier for a familiar topic rather than a recently taught aspect of the primary curriculum

As expected, children were able to produce longer lists of words related to the more familiar topic of Food, and this was independent of condition. The provision of text boxes did not make an overall improvement to the number of items generated, as children had a greater wealth of knowledge for the more familiar topic.

Hypothesis 3: Text boxes would scaffold process

This was found to be the case. Lists of relevant keywords were produced in both conditions, but this was enhanced when text boxes were provided. The visual prompt appeared to elicit longer lists.

Children responded well to both task topics when working with text boxes rather than blank pieces of paper. The effect appeared to be stronger for the familiar topic, possibly because children had a greater fund of knowledge on which to draw and thus the challenge provided by the text boxes was more achievable.

Hypothesis 4: Children would be able to generate category headings for their lists, but this would be easier for the familiar topic. This would in turn lead to more structured mind maps for the Food topic

Dividing the resulting keyword lists into appropriate categories was completed with similar levels of efficiency. Items were categorised into similar numbers of groups for both tasks. Children appeared equally able to invent category headings for the familiar topic of Food and the less familiar topic of Egyptians. In both tasks children made use of the 'Other' category for items they were not sure how to categorise. If these mind maps were designed to be used for a writing task, the keywords grouped under a less specific category might still provide useful content that could be integrated into the writing task during the transcription phase.

This ability to create category headings for both topics led to very similar levels of structure on the mind maps produced for both topics. This was surprising, as it had been expected that a greater degree of subject familiarity for the Food topic may have led to more confidence in producing categories, which in turn could have resulted in more structured mind maps. Overall there appeared to be few differences in the levels of structure present on the mind maps produced, either as a result of the topic or the degree of scaffolding provided earlier in the study. However, in Condition 2, there was a significant difference in the level of mind map produced for the less familiar topic of Egyptians and in this case there had been no additional support for the generation of the keyword list.

Hypothesis 5: Well-structured mind maps would be linked to greater content

When a greater quantity of items had been generated, this correlated with more organised mind maps. There appeared to be an effect of general ability at work, as children able to generate long lists of items in one subject area could also do this for the other topic. This appeared to be the case for levels of structure on the mind map, as more structured mind maps produced for one topic were correlated strongly with more structured mind maps for the other task. However, there was a suggestion that enabling children to generate more content could also lead to more structured mind maps. More content represented by numbers of items also correlated with more structured mind maps. This finding would suggest that supporting children to generate content using scaffolds such as text boxes could also result in better organised mind maps. Though there was no overall effect of scaffold on mind map levels, the group in Condition 2 managed to produce more structured mind maps when they had generated more content working with a familiar topic and a scaffold.

6.7 Study 4: Constructing mind maps with a template

The scaffolding procedures had appeared to have a beneficial outcome on the quantity of content generated. Following this, it was decided to assess whether having a simple template would act as a visual reminder to enhance the structure present on a mind map.

6.7.1 Aims

It was hoped that a mind map template would have a positive effect in supporting children to construct more categorised mind maps. Participating children were familiar with similar devices – from using line guides to aid handwriting to templates for written work in the form of writing frames (Wray & Lewis, 1997).

The hypotheses were that:

1. Using a mind map template would improve the structure present on a mind map

2. Better structured mind maps would also have greater content as represented by mind map connections.

6.7.2 Method

6.7.2.1 Design

The study used a partial crossover design, where each child generated two mind maps, one created with a template and one with a blank piece of paper. Children allocated to Condition 1 had a blank piece of paper for a topic about an Indian village and a template for a topic about an animal. Children allocated to Condition 2 had a template for the Indian Village topic and blank paper for the mind map about an animal. Thus, the study design was a 2 by 2 mixed design with a within-groups factor of type of support (template/blank paper) and a between-groups factor of condition (template Indian Village/template Animals).

6.7.2.2 Participants

The participants in these two studies were the same 54 members of two primary school classes taking part in Study 3 reported earlier in this chapter. The children remained in the same groups as devised for Study 3, therefore Condition 1 consisted of 27 children from both classes, 13 from Y3 and 14 from Y4, and Condition 2 was composed in the same way, with 27 children, 13 from Y3 and 14 from Y4.

Both classes of children had followed a geography unit on an Indian village during the summer term which was jointly planned by the two class teachers using the same learning objectives. Many of the resources used by the two classes were the same and some teaching sessions were shared. Both classes produced booklets about the village as part of their work that term. As part of the science curriculum in the same term both classes of children were also investigating animals and their habitats. The teaching approach to this differed between the two classes. Y4 children were encouraged to research a particular animal for themselves and present their findings as a talk to the class. Y3 children were guided through information about hedgehogs which was then used as a model for research into their own animal. Y3 were expected to present information in written form.

Though there were differences in some of the teaching strategies the children spent very similar amounts of time on each curriculum area.

6.7.2.3 Procedure

Study 4 took place in the summer term following Study 3.

The session for each group took place in an afternoon teaching period during two consecutive weeks lasting 75 minutes for each group of children. Children worked as before in the teacher–researcher's classroom seated in self-selected groups of 4–6 around tables. The researcher led both sessions. Children were instructed to produce mind maps to show their knowledge about the Indian village and then the animal of their choice. After a short introduction to remind the children of how to construct a mind map, stressing paper orientation, need for branches of grouped content and use of optional illustrations, children had 25 minutes to make first mind map. This was collected before the second mind map was constructed. Depending on the condition, a blank piece of paper was provided for one mind map and a template was given for the other mind map.

There was no requirement to generate lists before constructing the mind map and it was noticeable that children worked deductively, designing branch headings rather than generating lists when constructing their mind maps in both conditions.

Researcher involvement was limited to answering questions about procedure, providing assistance with spelling and supervising the session, encouraging children to keep on task and to finish within the allotted time. There was no specific assistance given in constructing the mind maps.

6.7.3 Measures

Mind maps were analysed looking at the level of structure present and given a categorisation from 1 to 4. Mind map features were also counted: number of branches, connections and words.

6.7.4 Exemplars of mind maps produced with and without template

Figure 6.3 shows a Level 3 Animals mind map completed with a template. The headings for each branch are clear and items placed on the lines as advocated by Buzan (2000). There has been no attempt to sub-divide the items listed on each branch although the template has been designed to encourage sub-categorisation as each larger branch first divides into two, followed by two more sub-divisions. Many of the headings used by this child would be found in text books or websites about animals. These may have been familiar as children were encouraged to do their own research for this topic. The prescribed form has not prevented the use of illustrations to add to the text items on the mind map.

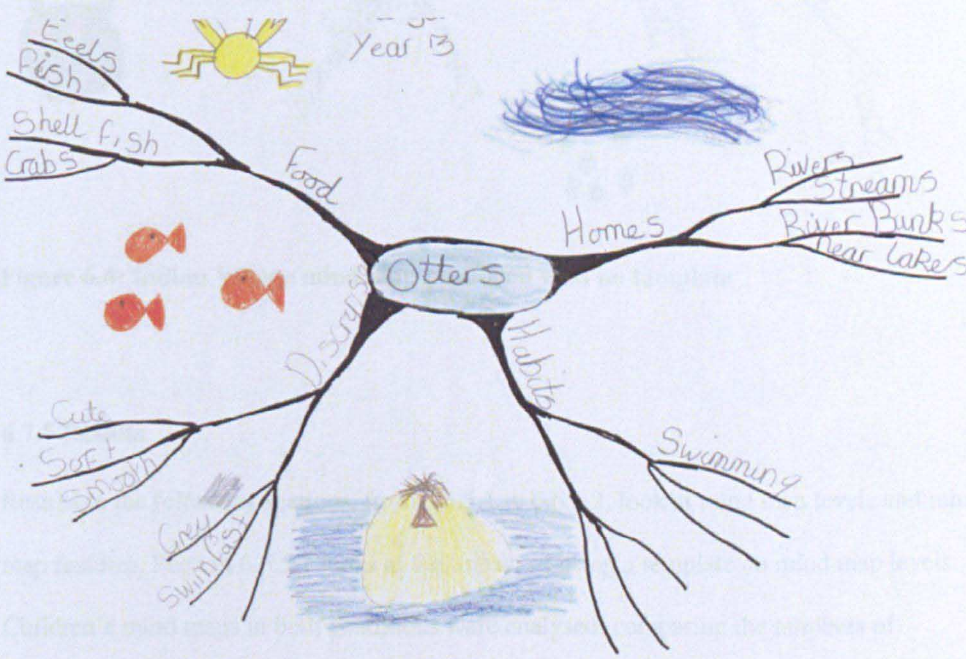

Figure 6.3: Level 3 Animals mind map produced with template

Figure 6.4 shows a Level 3 mind map produced by the same child, ST, this time without the support of the template. The branches are still organised into relevant groupings, though the branch heading is less easily distinguished from the items included. Work on the Indian village had been presented in narrative form through a video, and children's research linked to photographs representing different aspects of life. As a result, children needed to devise their own set of organising themes connected to the material they had seen, heard and read. ST has used 'farms', 'entertainment' and 'food'. Similar numbers of illustrations are used to embellish the mind map.

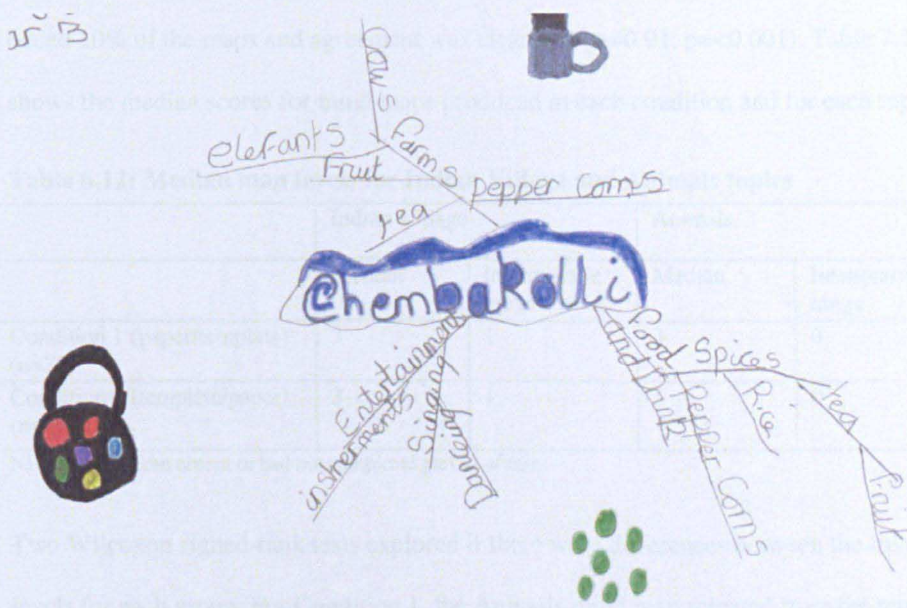

Figure 6.4: Indian Village mind map produced with no template

6.7.5 Results

Results in the following sections, from 6.6.5.1 to 6.6.5.3, look at mind map levels and mind map features. Section 6.6.5.1 looks at the impact of using a template on mind map levels. Children's mind maps in both conditions were analysed, comparing the numbers of individual features in section 6.6.5.2. The final section 6.6.5.3 reports the correlations between mind maps for each topic, the levels achieved and the number of individual features. As explained in chapter 3 on methodology, where the data met the requirements of normality, homogeneity of variance and co-variance, parametric tests were employed.

Where data failed to meet these requirements, nonparametric tests were used as a more appropriate alternative.

6.7.5.1 Mind map levels

The hypothesis for this study was that a mind map template would lead to better structured mind maps and this section reports the levels of mind maps produced in each condition. Mind map levels were again scored according to the coding scheme developed in the exploratory study and reapplied throughout the thesis. A second coder (blind to condition) coded 10% of the maps and agreement was clear (kappa=0.91, p=<0.001). Table 7.11 shows the median scores for mind maps produced in each condition and for each topic.

Table 6.12: Median map levels for Indian Village and Animals topics

	Indian Village		Animals	
	Median	Interquartile range	Median	Interquartile range
Condition 1 (paper/template) (n=25)	3	1	3	0
Condition 2 (template/paper) (n=26)	3	1	3	0

NB Three children absent or had not completed part a) of task.

Two Wilcoxon signed-rank tests explored if there were differences between the mind map levels for each group. For Condition 1, the Animals mind map (created from the template) was more structured than the Indian Village mind map (created from paper) (T=5.5, p=0.005, r=0.40). In the case of Condition 2, the Indian Village mind map (created from the template) was more structured than the Animals mind map (T=0, p=0.02, r=0.31). Mann–Whitney tests showed there were no significant differences between the two conditions on the Animals task (U=321). However, those in Condition 1 produced significantly less structured mind maps than those in Condition 2 for the Indian Village task (U=159, p<0.001, r=0.36).

6.7.5.2 Mind map features

Mind map features were quantified and compared in three (2 by 2) mixed ANOVA tests; see tables 6.13, 6.14, 6.15. This was appropriate as data analysed were scale, not categorical.

Table 6.13 Mean number of branches produced by condition and task

	Indian Village	Animals
Condition 1 (paper/template) (n=25)	4.80 (2.21)	4.00 (1.60)
Condition 2 (template/paper) (n=26)	3.69 (0.88)	4.00 (1.29)

NB Three children absent for part of task.

Analysis by 2 (paper/template, template/paper) by 2 (Indian Village, Animals) mixed ANOVA revealed no main effect of condition ($F(1,49)=2.84$) on the number of branches produced (see table 6.13). There was no significant effect of topic ($F(1,49)=0.71$) or interaction between topic and condition ($F(1,49)=3.59$).

Table 6.14: Mean number of connections produced by condition and task

	Indian Village	Animals
Condition 1 (paper/template) (n=25)	18.40 (10.10)	18.00 (8.46)
Condition 2 (template/paper) (n=26)	20.85 (8.05)	15.15 (6.76)

NB Three children absent for part of task.

Analysis by 2 (paper/template, template/paper) by 2 (Indian Village, Animals) mixed ANOVA revealed no main effect of condition ($F(1,49)=0.01$) on numbers of connections produced (see table 6.14). There was a significant effect of topic ($F(1,49)=9.39$, $MSE=236.53$, $p=0.004$, partial $\eta^2=0.16$). Pupils produced more connections for the Indian Village topic ($M=19.63$) than for the Animals topic ($M=16.75$). In addition, there was a significant interaction between topic and condition ($F(1,49)=7.08$, $MSE=178.49$, $p=0.01$, partial $\eta^2=0.13$), which suggests a scaffold effect. As there was no main effect of condition, the data can be analysed by paired sample t-test which showed that more connections were generated with a template ($M=19.45, SE=1.16$) than with paper ($M=16.75$, $SE=1.21$) ($t(50)=2.52$, $p<0.02$, $r=0.11$).

Table 6.15: Mean number of mind map words produced by condition and task

	Indian Village – mean number of words	Animals – mean number of words
Condition 1 (paper/template) (n=25)	32.64 (19.78)	27.04 (13.16)
Condition 2 (template/paper) (n=26)	33.00 (15.51)	27.76 (12.18)

NB Three children absent.

Analysis by 2 (paper/template, template/paper) by 2 (Indian Village, Animals) mixed ANOVA revealed no main effect of condition (F1,49)= 0.01) on mind map words produced (see table 6.15). There was a significant effect of topic ($F(1,49)=5.66$, $MSE=749.02$, $p<0.02$, partial $\eta^2=0.10$), with more words being produced for the Indian Village topic (M=32.82) than the Animals topic (M=27.4), but no interaction between topic and condition ($F(1,49)=0.06$).

6.7.5.3 Mind map levels correlated with numbers of branches and connections

Spearman's correlation tests show that there were significant and positive correlations between mind map levels for both topics ($r=0.60$, $p<0.01$), shown on table 6.16. The number of connections have significant positive correlations with the levels of mind map for both tasks ($r=0.69$, $p<0.01$/ $r=0.58$, $p<0.01$).

Numbers of mind map branches do not correlate significantly with mind map level on either task, as a greater number of branches suggest an association star, the least structured form of mind map. Mind map branches correlate significantly and positively with connections ($r=0.64$, $p<0.01$/$r=0.44$, $p<0.01$). Mind map words on the Animals mind map significantly and positively correlate with mind map level ($r=0.35$, $p<0.01$), mind map branches ($r=0.59$, $p<0.01$) and connections ($r=69$, $p<0.01$). This is not the case with the Indian Village task where mind map words are positively and significantly correlated with branches ($r=28$, $p<0.05$) and connections ($r=0.42$, $p<0.05$) but not with mind map level. Numbers of connections on mind maps from both topics are significantly correlated ($r=0.61$, $p<0.01$), as are numbers of words ($r=0.47$, $p<0.01$).

Table 6.16: Correlation between map levels, categories created and items listed for Indian Village and Animals mind maps

	1.	2.	3.	4.	5.	6.	7.	8.
1. Animals mind map level		0.95	0.63**	0.35**	0.60**	−0.04	0.45**	0.01
2. Animals branches			0.64**	0.59**	0.21	0.11	0.38**	0.21
3.Animals connections				0.69**	0.47**	0.20	0.61**	0.17
4. Animals words					0.36**	0.19	0.43**	0.47**
5 Indian Village mind map level						−0.20	0.58**	0.08
6. Indian Village branches							0.44**	0.28*
7. Indian Village connections								0.42*
8. Indian Village words								

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

6.8 Discussion of Study 4

Children were asked to produce mind maps about curriculum topics they had been working on that term, namely an Indian village as part of a geography unit and animals as part of a science unit. The study looked at how well children could produce structured mind maps from curriculum-based knowledge.

Hypothesis 1: Using a mind map template would improve the structure present on a mind map

Overall, there appeared to be an advantage for children working with a template, who were able to produce better structured mind maps. Under more fine-grained analysis, the advantage was greater for children working on the Indian Village topic. This may have been the result of the way information had been presented through the two curriculum areas. The work on animals was already structured both in lesson delivery and the type of texts accessed for children's individual studies. These scientific texts tend to group information under subject headings such as 'habitat', 'diet', etc, which are common across a number of resources including internet sites and text books. These labels were commonly used on children's mind maps as branch headings.

The work on the Indian village was presented through the employment of narrative structures, a video showing aspects of a typical day in the village, or discussions about the similarities and differences between life in India and life here. Children had to categorise the information under group headings much more independently. The mind map shown in figure 6.4 categorised 'farms', 'entertainment', 'food and drink' as branch headings, while other children had branch headings such as 'school', 'games', 'landscape', 'jobs', 'animals'. With a less defined domain, it could be argued that children found the scaffold of the template a useful visual reminder of the categorised structure expected on a mind map.

Hypothesis 2: Better structured mind maps would also have greater content as represented by mind map connections

There were again correlations with better structured mind maps and more connections. Having an organised branch structure seems to promote the generation of a greater wealth of mind map content. In this study, the support of a mind map template appeared to have a beneficial effect on the number of connections generated. In these studies, there was no requirement to use the mind map as a planning tool for writing, but enabling children to create more content on a mind map could be beneficial as Studies 1 and 2 seemed to suggest a relationship between richer content generation and better written texts.

Task effects were evident both on the number of connections produced and the number of words written on the mind maps, with the Indian Village topic generating more content in both conditions. There was arguably more to say about the investigation into the lives of a group of people in India, looking at cultural differences and lifestyle, than would be available to the children reporting on one animal researched as part of a wider science topic.

6.9 Discussion of Studies 3 and 4

Studies 3 and 4 were designed to investigate the research question: can children be supported to produce better mind maps? This was investigated by introducing a stepped procedure whereby the children were directed towards an inductive process of working and using visual prompts, such as text boxes and templates.

6.9.1 Directing children to mind map using an inductive staged procedure

In Study 3, children were guided to construct mind maps about two topics by first creating lists and then categorising the lists before constructing a mind map. This procedure meant that most of the children were able to construct mind maps with branch headings. The process was not completely successful as some children still created less structured mind maps, either association stars or association chains. However, these were in the minority, and this tendency was more common for the less familiar topic of Egyptians. This was particularly evident for children working in Condition 2, who also used the blank sheets of paper to produce their keyword list for the Egyptians topic.

This procedure was particularly successful in supporting children to use keywords rather than longer phrases on their mind maps. All of the mind maps collected for Study 3 had used keywords to populate the branches.

Based on this study, a teacher working with children who are unfamiliar with this representation could usefully introduce this inductive procedure early in the instruction process. This procedure enables children to become familiar with using keywords to represent concepts and explicitly guides the construction of suitable category headings. Intervention from the teacher could be focused on children finding difficulties with vocabulary or grouping strategies at an early stage in the mind map construction process. This could result in children having a better grasp of the subject area, through discussion and clarification of content, as well as being able to construct mind maps more skilfully. The initial ambition in introducing these representations was to improve thinking around a subject (Buzan, 2000; Caviglioni & Harris, 2000; Jonassen, 1998).

6.9.2 Use of visual prompts

The use of text boxes in Study 3 had led to an increase in the number of items produced on keyword lists. The impact was clearest for the familiar topic of Food, possibly because children had a greater resource on which to draw and the prompt enabled a more prolonged memory search. The impact on the less familiar topic appeared less, but when mind maps were compared later in the study there appeared to be an advantage for the children who had the support of text boxes for the Egyptians topic. Children working without this support produced mind maps with significantly less structure on this part of the task. It could be argued that children using text boxes to generate content may not have produced significantly more items, but the scaffold had elicited a deeper consideration of the topic which was evidenced in the mind map construction. Encouraging children to generate content by using this simple intervention may lead to better structured mind maps.

In Study 4, children were able to choose their own way of working and without exception went back to a deductive procedure, starting with the main topic and inventing branches. There were no examples of children constructing keyword lists of possible content. In this study the visual prompt consisted of a mind map template. This had a significantly beneficial effect on the structure of mind maps produced. The visual prompt was a successful support, though there were differences between the two topics in how this affected the structure of the mind maps produced. Children had been aware, through their own independent research, and the way lessons were presented, of commonly used categories in texts discussing animals. They were then able to transfer these familiar categories to structure branches on their own mind maps for the Animals topic, which meant the support of the template was less contingent. The template scaffold had a larger effect on the structure of the mind maps produced about the Indian village. This was a generally less structured domain for the children taking part. Lessons had used a variety of modes to introduce work on Indian village life, including video and photographs, which seemed to have a more powerful impact on the children's understanding of the topic than text-based resources. Children had to be more independent in choosing their own categories to classify the information they wished to represent on the mind map. In this case, the template offered a structural support to prompt the division of information into appropriate superordinate and subordinate groupings.

There was also an effect of scaffold on the numbers of connection produced. The mind map template encouraged children to generate more content as well as better structure. This would be important if using the mind maps for a written task as a greater amount of content as represented by mind map connections is also linked to better written texts. It should be acknowledged that the different amount of content produced can be linked to the task as well as the scaffold. Children had more information to present about the Indian village. Research around animals had been limited to such considerations as appearance, diet, lifecycle and habitat. There was a wider range of content on which to draw for the Indian Village topic.

As with Study 3, similar numbers of category headings were produced for both topics. Children were using similar numbers of branch heading for both tasks and this is to be expected on well-constructed mind maps. The number of recommended branches would be between five and seven, (Buzan,2000), in order to make the construction clear and memorable.

The numbers of words written on mind maps also varied between the two tasks. As a consequence of increased numbers of connection there were more words on Indian Village mind maps. Looking at individual cases, there was also an increase in mind maps using phrases rather than keywords when compared to the mind maps produced in Study 3. Children were expressing their concepts in longer phrases in a small number of cases for both topics. This tendency had been avoided in Study 3.

In summary, it was not clear whether an inductive approach necessarily led to better structured or more populated mind maps, though it did appear that the deductive construction process was the preferred mode of operation for the children. The inductive process was not adopted by children in Study 4, which followed from Study 3 and had the same participants. This can be seen as regrettable as the inductive process supports keyword generation together with the consideration of categories and can provide opportunities for focused intervention.

Text boxes were useful in assisting children to generate as much content as possible to populate mind map structures and to use keywords. This can be seen as advantageous as the increase in content was linked to more structure in the mind maps and better written texts in Studies 1 and 2.

The use of mind map templates could provide some children with an appropriate prompt towards better structure, especially in areas where creating superordinate categories may be seen as challenging. The increased content was also a benefit when using templates. Ultimately these measures may lead to improved planning, as in Study 2 greater content and structure was also linked to better written outcomes.

Studies 1 to 4 had looked at children working independently to produce mind maps using paper and pencil methods. In pursuing the question of how children could be supported to produce more structured mind maps, other strategies were considered. The final two studies investigated collaborative mind map production and the role of technology. In Study 5 mind maps were constructed, again using paper and pencil methods, comparing the effects of collaboration. In Study 6, computer software was made available to support the process of collaboration. Collaboration was hoped to bring further opportunities for children to extend their thinking and improve mind map construction. Returning to the main research question, these two studies would also investigate the links between mind map plans and written texts.

Chapter 7: Studies 5 and 6

Scaffolding the mapping process - collaboration

7.1 Introduction

Studies 3 and 4 showed the benefits of introducing scaffolding procedures and visual prompts for supporting the mind-mapping process. The use of text boxes led to an increase in items generated and the mind map templates appeared to increase the number of connections and scaffold the organisation of items included on the mind maps. Collaborative working was seen as a further strategy to scaffold mind map construction.

The studies in this thesis have all looked at children working individually to produce mind maps. The impact of making a mind map in collaboration with peers had not been explored, nor the possible effects on writing planned in this way. Collaboration is reported to have a variety of beneficial effects (Crook, 1994). It was hoped to harness these to improve the structure and richness of content on the mind maps and possibly to give additional support to a writing task planned using a mind map.

There was, in addition, an awareness that groups can disrupt learning unless carefully managed (Barron, 2003). Structures to support collaboration are important

(Mercer, 1993; Palincsar & Brown, 1984). Studies like this show that collaboration has the potential to provide a powerful support for learning, but that the process of collaboration itself needs to be structured.

Collaboration can also involve the use of external representations. Barron (2003) found that successful groups co-ordinated their joint attention through a variety of strategies, including the use of external representations. A number of studies have specifically investigated the role of different external representations when combined with collaboration (Naykki & Jarvela, 2008; van Amelsvoort, 2006; Kinchin & Hay, 2000). Suthers & Hundhausen (2003) explored the use of representations for collaborative problem-solving with older students working across computer networks and identified three possible factors that could be implicated: meanings could be negotiated, there was a representational proxy for gestural deixis and a visual foundation for shared awareness.

Negotiation using a shared representation becomes necessary as disagreements are likely to arise between the participating authors. This may impact on the way items are represented. Resulting discussion over elements of a shared representation may also provide cues to associated shared or individual knowledge (Suthers & Hundhausen, 2003).

With these issues in mind, the two Studies, 5 and 6, were structured to look at the way collaboration influenced the structure and content of mind maps as plans for written tasks. One study examined the results when children produced hand-drawn mind maps in collaboration, together with subsequent written work undertaken individually. The other looked at children collaborating over computer-generated mind maps and individually produced written texts. Children were grouped in pairs and worked face to face in familiar classroom settings.

Choices for the way children were grouped were based on extensive personal knowledge of the children involved and considerations of their writing ability, friendship groups and gender, attempting to avoid the effects reported by Barron (2003) and Mercer et al. (1999).

In Study 5, the mind map-making process was scaffolded for all children by using techniques explored in Study 3, encouraging an inductive approach to the process and providing templates as support. Two conditions were explored, with two-thirds of the children working in pairs to produce their mind maps while one-third worked individually. The second collaborative study, Study 6, looked at the impact of using computer software to produce mind maps individually or with a partner. There was no additional scaffolding provided, and children could decide how to approach the task, using either a deductive or inductive approach. In both studies, the children's collaboration was structured by specific procedures or expectations and monitored throughout the process.

Results presented in sections 7.3.4 and 7.5.4 came from the outcomes of the process, namely mind maps and written texts. The process of collaboration was not the focus of the study.

7.2 Aims for Studies 5 and 6 into the effects of collaboration

Both studies were constructed to investigate the effects of working collaboratively on a mind map-making task. Study 5 encouraged an inductive approach and provided both text boxes and templates. Study 6 looked at the effects of collaboration when using computer software. It was expected that pairs of children would generate more ideas than children working individually, which could potentially provide a wider pool of items to incorporate onto the mind map structure: a productivity effect hypothesis. Greater content potentially necessitates discussion about which items to include and in which category to place them. In order to facilitate collaboration, Dillenbourg (1999) recommends both space for negotiation and space for misunderstanding. In constructing the mind map in pairs, there is opportunity for negotiation, what to include and how it should be organised, and space for some misunderstanding if children see various alternatives to group content or different priorities linked to the writing task. Background knowledge was expected to vary depending on experiences in the home, but there was a fund of common experience in using the technology available in school.

Collaborating pairs were expected to engage in dialogue throughout the mind map-making process and various strategies had been designed to facilitate discussion. It was hoped that this would lead to more consideration of the items to be included and the way they were organised on the joint mind map, which would then be available for the written task. The developing mind map would be a record of content items but, as discussed by Suthers (2001), also a visual reminder of discussions that had taken place in connection with the organisation of each element. The mind map representation demands a particular organisation strategy, categorisation which in turn emphasises particular items and themes. Making decisions about these would also create an arena for possible articulation, conflict resolution and co-construction (Crook, 1994). There could also be a move towards agreement and convergence in which case the items could provide markers for discussions and compromises could be made that could be subsequently included or rejected during the final written task. Potentially, pairs of children working inductively from a greater fund of initial items to place might also lead to a range of category headings and more abstract use of language than children working individually (Schwartz, 1995). All or some of these processes might lead to richer and categorised mind maps, which could in turn lead to better final written texts from collaborating pairs than from individuals.

Negative outcomes were also possible if the collaborating pairs found working together difficult or if one partner was unwilling to listen to the views of the other. Convergence over the mind map construction was no guarantee of convergence or shared knowledge in completing the subsequent written task (Fischer & Mandl, 2005).

To summarise, the hypotheses for both studies were:

1. Children working collaboratively would produce mind maps with more structure than individuals.

2. Children working collaboratively would generate more items for their mind maps than those working individually.

3. It was expected that:

   a) Mind maps with better structure, as seen in the use of categorised branch headings, would be associated with better texts.

   b) Mind maps with more content, shown as connections, would be associated with better texts.

   c) Mind maps with better structure would be associated with greater transfer of content from map to writing.

4. There was a possibility that discussions over the mind map items and structure might lead to pairs also producing better texts overall than those who worked individually on their mind map.

7.3 Study 5

7.3.1 Introduction

As discussed in section 7.2, collaboration was investigated as a strategy to support children's construction of mind maps. Two groups were involved: one group worked individually, one group worked in pairs. In addition, children working in pairs were supported to facilitate productive collaboration during the mind map construction process (see method section 7.3.2). The successful procedures used in Study 3 were employed to scaffold the inductive mind map-making process for all participants.

Both Study 5 and Study 6 investigated the impact of making a mind map as a preplanning document for a written text. This had not been investigated in Study 3, which concentrated on comparing procedures to aid mind map construction. Studies 5 and 6 returned to the consideration of mind maps as planning tools for written texts. The correlation between well-constructed mind maps and better texts had been evident in Study 2. In Study 5 and 6, the effects of collaboration on the quality of mind maps and writing produced could be compared with work completed by children working individually.

Children from all four primary school classes, Y3–6, took part in the study. It was decided to choose an expository writing task based on common experience rather than link the work to a particular curriculum area, which would be difficult to choose across this range of year groups. This was to facilitate comparisons and to keep unexpected task effects to a minimum. A thematic writing task was chosen because it was considered more appropriate to plan on a mind map (see Study 2). Children writing non-fiction texts need more support in considering organisation strategies than children writing narratives, where planning strategies linked to chronology arguably offer more relevant support.

7.3.2 Method

7.3.2.1 Design

The design was a between-groups design, the independent variable being whether the child worked alone or with a partner on the mind map-making task. There were three categories of dependent variables. One was the quality of map produced, measured in terms of structure (map level) and map features: branches, connections and words. Another was the quality of written task measured on a criterion scale linked to national curriculum levels. The third was measures of similarity in content between mind map and written task.

7.3.2.2 Participants

For this study the teacher–researcher again had the opportunity to involve the whole KS2 cohort consisting of 120 children, aged 7–11years, attending one primary school in Nottinghamshire. The children were in four single year group classes following different programmes of study. Participants from year groups 4–6 had been involved in previous studies. Children in Y3 had experience of making mind maps both in their previous class and earlier in the academic year before the study took place.

Children were divided into two conditions. The individual condition contained a third of the total number of participants, who worked as individuals on map-making. The collaborative pairs condition consisted of two-thirds of the children, where participants worked in pairs on the mind map-making task. This ensured that a similar number of mind maps would be produced for comparison from each condition. All four classes of children were involved in the study, so for easier administration the two younger classes worked together, as did the two older classes, but children were assigned to a condition independent of their class groups. The participants in each condition were randomly assigned but efforts were made to ensure a similar range of writing ability in each condition through consultation with class teachers. Each collaborating pair was also determined by the class teachers to ensure a mix of genders (some pairs were same sex pairs, some mixed gender) and abilities (high achievers working with slightly less able children, low achievers supported by slightly more able partners). Social groupings were also taken into account, as the benefits of collaborative work can soon be lost when the groups themselves are dysfunctional (Barron, 2003). Table 7.1 shows the numbers of children in each condition from each year group. Pairs could be from the same year group or a consecutive year group, Y3/4 or Y5/6.

Table 7.1: Table to show numbers of children by year group and gender in each condition

	Individual		Collaborative pairs	
	Girls	Boys	Girls	Boys
Y3	4	5	14	5
Y4	5	4	9	8
Y5	5	2	11	14
Y6	5	9	4	11
Totals	19	20	38	38

7.3.2.3 Procedure

Each of the four groups of children had two sessions to complete tasks for this study.

Session 1: This session took place with the researcher. The younger groups worked in a classroom usually occupied by the Y3 class, so children were familiar with the surroundings. The older age group used the Y6 classroom, which again was familiar to all the children. Children were seated around tables accommodating 4–6 children. The first session was the mind map-making session. This lasted 65 minutes.

Children in both conditions were given the same task – to produce a mind map as a planning document for a written assignment which would be completed independently, irrespective of whether the mind map was made collaboratively or individually. The written task was to write a letter to a friend (real or imaginary) to tell them about the first term in the new school building. This task was chosen as the school had recently acquired a new building and children were experiencing their first year in the new premises. The friend was to be familiar with the previous school building but have no knowledge of the new location.

As a stimulus, a series of eight photographs of the new building were shown on the interactive whiteboard and initially discussed as a class group with the researcher. Children identified the areas shown and commented on aspects they would be likely to include in the letter. The photographs were in no particular order; outside views were mixed with inside views, aspects of classrooms with public spaces, etc, to avoid giving any cues for organising the mind map or the ideas to be assembled in the letter. The task introduction and discussion lasted approximately 15 minutes. The whiteboard display was available throughout the mind map-making task.

There then followed approximately 50 minutes of activity constructing the mind maps.

A carefully structured procedure was followed in all the sessions. This was primarily designed to scaffold the pairs into working collaboratively, while also ensuring that children working individually had a similar amount of time on task. Initially, all the children independently generated as many ideas as they could on a text box sheet provided. The provision of text boxes had seen the production of a larger quantity of ideas in Study 3 and ensured that all the children had an initial bank of ideas to map individually or to share and map with a partner. In the collaborative condition, pairs then shared their lists by colour-coding the items they had in common, while deciding together which would be the key concepts to include on their jointly constructed mind map. This was to ensure the collaborative mind mappers were familiar with all of their partner's listed items.

The individual mind mappers had to reread their list of ideas and colour-code the ones they considered the most important. This ensured individual mind mappers also had opportunity to consider their choices and gave equality of time on task.

Children working in pairs then grouped their ideas ready to transfer onto a map. The cut and paste technique used in Study 3 was time consuming and in some cases items were lost, so in this study children were encouraged to think about which concepts could be grouped together and make written lists before constructing mind maps. Children working individually worked in the same way, grouping items before transferring them to the mind map structure.

Mind maps were then constructed using a mind map template – this time as a line guide placed under a piece of A3 paper (see figure 7.1).

Figure 7.1: Skeleton map used as line guide

Children were told they could add lines, not necessarily using all the lines provided, or choose to group the branches in different ways. These templates, when used as skeleton maps, had shown a beneficial effect on mind map structure in Study 3.

In the paired condition, children were encouraged to work collaboratively through all stages of the mind map construction. There was a clearly stated expectation that both children would participate in recording elements on the finished mind map. To encourage this outcome, children were provided with pens of different colours, enabling the researcher to monitor each child's contribution as the maps were being made, as well as in the subsequent analysis.

During the session the researcher answered questions and generally encouraged the children to remain on task in order to complete all lists and mind maps in the allotted timespan. Some monitoring of the levels of collaboration was carried out with, if necessary, encouragement offered to facilitate the process.

At the end of each session the maps were collected. Collaborative maps were then photocopied to ensure that each child had their own copy for the following writing task.

Session 2: The writing task took place on a different day in the same week as mind map construction for the younger group, and during the following week for the older group. An extended writing session lasting approximately one hour happened on a weekly basis for all four classes and this curriculum time was used for the written task. The original mind maps or photocopies were returned to each child. Each class worked with their own class teacher under normal extended writing conditions. This involves an introduction by the teacher, followed by independent work on the written text carried out in a quiet, purposeful atmosphere. Discussion and collaboration were not encouraged during this part of the session. Each class teacher was provided with a script to use to introduce the task, together with advice on the amount of guidance to give while the task was in progress. The written task lasted for approximately 40 to 45 minutes. All mind maps and scripts were then collected to be analysed by the researcher.

7.3.2.4 Measures

Numbers of words produced by the individual children on the text box sheets were counted.

The mind maps were given a level, using the categorisation scheme developed in Study 1, and branches, connections and words on the maps were also counted. It was also noted whether the mind map contained keywords rather than longer phrases.

Writing was analysed and given a score. The judgment for Study 5 and 6 was based on a holistic system matched to national curriculum guidelines. This had been introduced into the school as an improved way to judge children's writing. It had become available during the time Study 5 was proceeding. It was felt that this criterion-based marking system developed by Wilson (2003) was more accurate and led to greater agreement in writing level judgments. After an initial set of criteria had been satisfied the writing was given a national curriculum-level mark, the sub-level was decided by the presence of given criteria on a set of indicators. These levels and sub-levels were then converted to a numerical score to make statistical analysis possible. All Level 1 work scored 1, Level 2c scored 2, Level 2b scored 3, Level 2a scored 4, etc. The numbers of words in each text were also counted.

In addition to this, the relationship between the map and the writing was explored in a number of ways, as explained in Study 2. Written texts were examined one sentence at a time, as demarcated by the child. Concepts present on the map as connections were traced through to the writing. In many cases, the same words that occurred on the mind map also appeared in the written text. These were counted as items in common. In addition, if a very close paraphrase of the mind map item was present in the text, this was also counted as an item in common. Items in common were only counted once, even if they occurred in the text on more than one occasion. The term 'item' is used in recognition that it is an umbrella term. Items on the mind maps vary in character: some map concepts are specific examples, such as 'stained glass window', while other items are broader or more abstract, such as 'outside areas', but, in practice, the majority of items could be traced from mind map items to items present in the text. Items present could then be subtracted from the total number of items represented as connections on the mind map to give a score for those not used in the written text.

Finally, items that were in the text but not on the mind map were counted. This category was less easy to define as a new idea could be an additional example or a new area of content. The nature of the children's work meant that this could be quantified by taking into account the items that occurred regularly across the whole sample. Sentences containing elaborations and additional information directly based on items mentioned were not counted as novel text items. Similarly, formal phrases present in the writing, such as introductions or concluding statements, were recognised but not included in this part of the analysis as these would not necessarily be expected to be present on the mind map plan.

7.3.3 Exemplars of mind maps and written texts

This section shows examples of hand-drawn mind maps and writing from a number of children.

Example from a child working as an individual to produce mind map and written text

The first example (figure 7.2) shows a mind map produced by a girl in Y5, JT, working without a partner. The highlighted words on the mind map are those items that also appear in her written text.

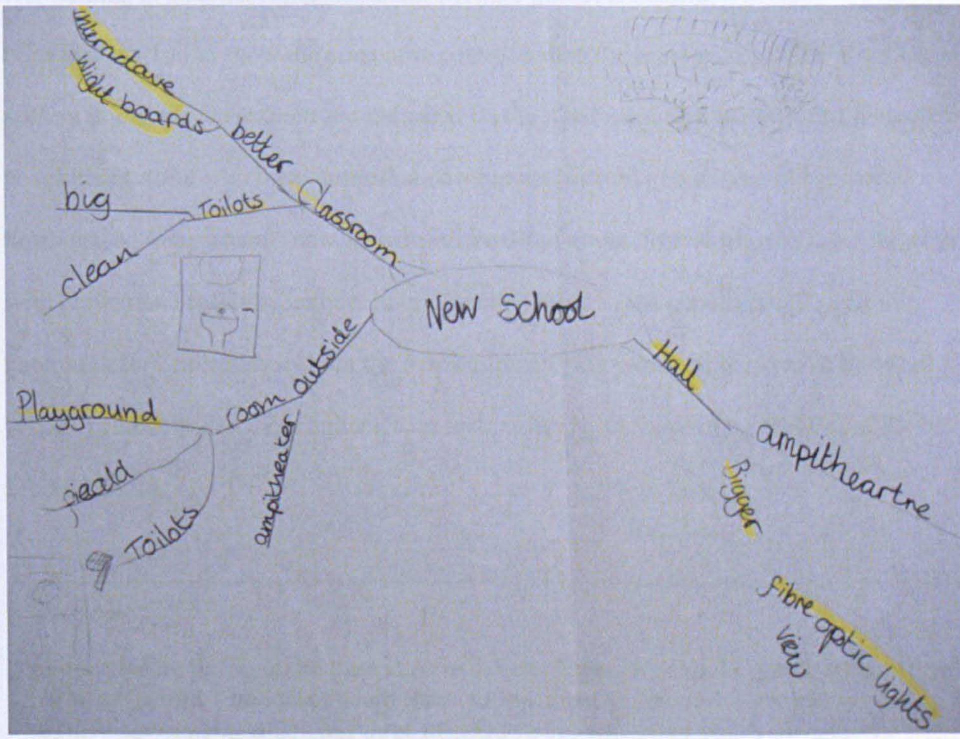

Figure 7.2: Y5 girl's mind map

JT originally made a word list of ten items, four of the words being adjectives to describe the new building: 'fascinating', 'better', 'big' and 'outstanding'. The mind map does not include all her adjectives but has expanded the number of items of note around the building: 'playground', 'field', 'interactive whiteboard'. The remaining six words on her original list were nouns: 'view', 'amphitheatre', 'lights', 'hall', 'classrooms', toilets', and all were included on her Level 3 mind map, though two ('view' and 'amphitheatre') did not occur in her written text. She has used six items that occur on her mind map in the final written text (see figure 7.3). In common with many other children producing mind maps individually or with a partner, JT has repeated items. 'Amphitheatre' occurs twice, once while she considers its location in relation to the hall and once when reviewing the outside space around the school, but does not form part of her text. The item 'toilets' occurs twice, once to report that there are toilets located just off the classroom and once to refer to another set of facilities used during playtime, so linked to the branch headed 'room outside'.

Her writing, at national expectations for her year group, is presented in figure 7.3 and has been text-marked to show the content in common with the mind map and the novel items present in the written text but not indicated on the mind map. She has included a number of novel items, all of which are items that develop more detail about three of her branch headings, eg 'playground' now includes more detail about the two playing areas, together with playground furniture and the long slope that leads to the classrooms. JT has communicated enthusiasm about the new building ('you would have loved to be at this school') and considered her audience, as well as listing the interesting features of the new school building.

Dear Alice,

I hope you are having a fun time at school. I am. Our new school is great. It has a very big **playground** with lots of room for us to run about in. We also have a *lower* and *smaller playground* which has three *benches* in but altogether which includes the *slope* we have six benches.

We have a very **big hall** which has **fibre optic lights**. You would have loved to see the fibre optic lights, in fact you would have loved to be at this school. Also in the hall we have an *electric piano*. We have *stairs* coming up from the hall leading to the *upstairs* classrooms.

Every **classroom** has a **interactive wight board** and **toilets**. We have a *sink* in our classroom. We also have *electric lights*.

See you soon

Yours faithfully

J

Figure 7.3: Y5 girl's writing about the school, showing items in common with her mind map in bold and novel items included in the text but not present on the mind map in italics

Individuals differed widely in the amount of material in common between mind map and written task and also in the numbers of novel items developed during the written task.

Examples of mind maps produced by collaborating pairs

The following examples, together with statistical analysis in the results section, show that many pairs were able to work together to produce a structured mind map.

There were differences between sets of pairs in the amount of similar material present on both the mind map and in the writing.

High numbers of items present on mind map and in writing

Figure 7.4 shows a photocopy of a Level 3 mind map annotated to show the items used in the written task. GR has transcribed the three branches – hall, kitchen and community room. KS has taken responsibility for transcribing two branches – outside and classrooms. The handwriting style indicates the person who transcribed the mind map branches, but this cannot be taken as evidence for the originator of those items as there is no record of the conversation around the activities. Either of the two girls could have been mainly responsible for the items included or the way the branches were organised. The items highlighted in purple show items used in GR's written task; those highlighted in pink show KS's. Both girls had similar writing scores, which were at national expectations for their year. Each piece of writing included items from across the mind map and very few items were not incorporated into the completed texts.

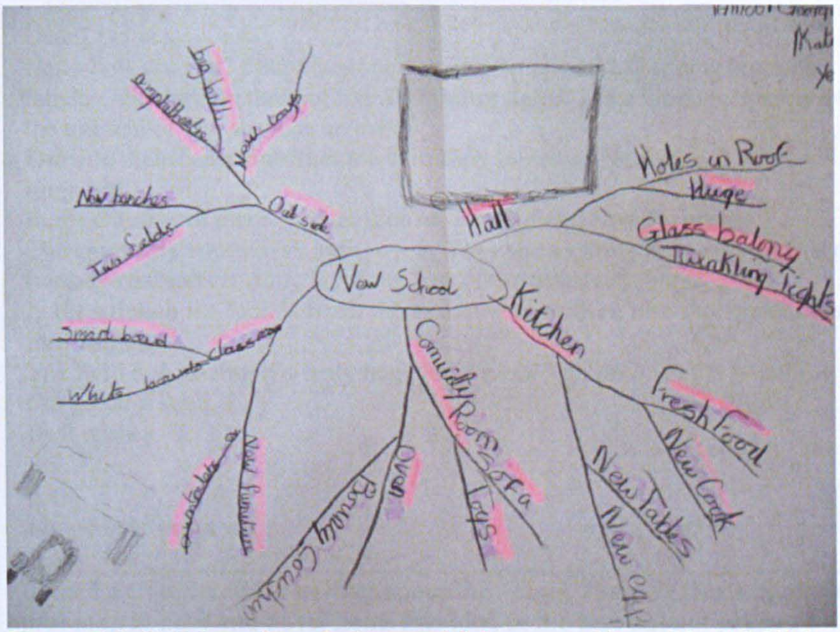

Figure 7.4: Collaborative mind map with items used in writing highlighted

KS had made an initial list containing nine concepts. All of these items were also found on her partner's list, except for community room, which became a branch heading on the mind map, and the resulting items on that branch were not on either girl's original list. Three items – basement, circle windows and stairs – are not included on the mind map. Her item, better dinners, arguably becomes fresh food, as this is included on the categorised list and the final mind map. Her writing includes the greatest number of items from the mind map in her written task (figure 7.5) and begins by referencing an item from one of the map branches transcribed by GR, the hall. KS also includes a description of the hall's shape, which is present on GR's initial list but is not included on the mind map. She then moves to consider the outside area of the school, which was her transcribed contribution to the mind map. The items included on the outside branch also appear to be the results of collaboration as neither girl had included these on their individually compiled lists. KS continues by writing about the classrooms. Most of these items were present on GR's list, but not on KS's. KS includes material from the other two branches and completes the letter by returning to consider the large school field in more detail.

Dear Lucinda,
Hello how are you? I hope your new school is fantastic. Our new school is fabulas. The **hall** on the roof has **Twinkling lights.** It's a lot more **massive** than the old school The shape is an *oval.*
Outside theres an **amphitheatre** with **New benches, New toys, Two fields** and a **huge hill.**
In the **classroom** theres a **smartboard, own toilets, New furniture**.
The **comunity room** has a **sofa, oven, Toys** and a **cumfy sofa** theres loads of **bouncy cushions** It is my favourite part of the massive school.
In the **kitchen** the food is **fresh** theres a **new cook** even **new equipment** and **new tables.**
The field is Amazing It's realy huge but we *can't go on It yet* but hopefully we can go on it soon.
Best wishes
KS
p.s
I hope I see you soon

Figure 7.5: Y4 girl, KS's writing about the school, showing items in common with her mind map in bold and novel items included in the text but not present on the mind map in italics

KS is able to express her enthusiasm for the new building and has interspersed sentences consisting of lists with shorter expressions of opinion – 'It is my favourite part of the massive school' – which makes the letter more personal and adds to the sense she is addressing a particular audience.

Dear Lizzie,
Are you well, How are you getting on at your new school. I will tell you thing's about our new school.
Outside of our new school we have lots of **new toys** to play with at dinner time. Also we have **two big feilds** to play on. Another thing is that we have a large **amphitheatre**. Even we have an **enormous hill** to go up to our classrooms.
In our **classrooms** we have our **own toilets**. We have lots of **new furniture**. We have got big **smartboards**.
We have a **gigantic hall** and it's got a **big glass balcony**. It's got beautiful **twinkling lights** like stars in the sky.
In the **kitchen** Chealsea's mum is our **new cook** she cooks **delicious meals.**
We even have a **Comuity Room** with a **red sofa** in it. It's got some **toys** in it. Even it's got an **oven.**
Best wishes
G

Figure 7.6: Y4 girl, GR's writing about the school, showing items in common with her mind map

GR had generated 20 items on her initial list, most of which find their way onto the mind map. GR's writing begins with one of KS's branches, discussing the outside areas of school. Although this was transcribed by KS, most of the items for this branch were recorded on GR's initial list. GR then writes about the classrooms, again including items from her original word list. GR then reports on the new hall, then to the kitchen and the community room. KS's item 'community room' has been developed on the mind map and GR has included this in her written task, though none of these items were present on her original list.

GR appears to have used a topological strategy for describing the building, following the route most children would take on entering school – from the outside directly into their classroom, to the hall early in the day for school assembly, noting the kitchen located off the hall and returning past the community room to the classroom. This 'virtual tour' approach to ordering this particular written task is evident in a number of the letters produced. In some cases this leads to a very different collection of items from those represented on the mind map. The writing is based on listing the features of the school building. There are no sentences purely expressing an opinion as in KS's text.

Asymmetrical numbers of items used by collaborating pair

DB and JN are an example of a pair who had very different numbers of items from their collaborative mind map in their writing task. JN had made a word list of 30 items and identified ten as particularly important to include on the joint mind map; of these, four were included on the mind map. DB had also made a substantial list of 27 items. He identified four items as particularly important; of these, two appeared on the mind map. DB transcribed the branches headed 'classroom' and 'rooms'; JN transcribed 'outside' and 'hall'. The mind map is a Level 4 map as the hall branch is sub-divided into 'upper part' and 'lower part', as is the branch looking at the outside environment. JN has used the items highlighted in pink in his written task; DB has included the items highlighted in yellow. The photocopy used to analyse the items present in the writing has been taken from JN's copy of the mind map and the visible crosses have been made by JN during the writing task indicating he had checked off the content included as he completed the written task. DB's engagement with the mind map appears less, as he includes fewer items, notably omitting his own branch, 'rooms'. However, from the categories identified by this pair, the rooms branch was a late addition and three items were generated as the mind map was constructed – staff room, stock room and computer room – do not appear on either of their original word lists. Unlike the girls KS and GR, who also generated a branch during the mind map construction phase, this late addition did not become part of either of the boys' written task.

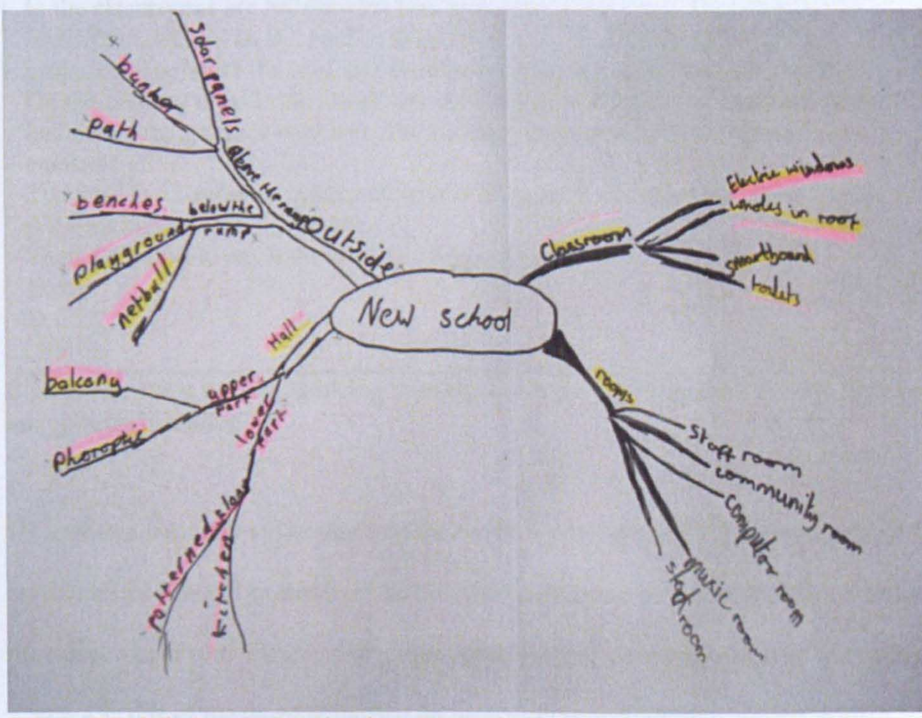

Figure 7.7: Mind map showing items transferred to written task by JN and DB

Both boys' writing was judged a 4c, given a score of 8, an average level for Y5.

DB's writing takes the virtual tour approach and, after explaining about the outside area, moves around the school from the entrance and reception area through to the hall, which is visible from reception as the building is entered, then on to the classrooms. DB introduced slightly more novel items into his writing than he included from the mind map. He also includes one of the items identified as being a priority for inclusion but not included on the mind map – 'stained glass window' – and continues to generate items not included on any of the pre-planning notes, eg 'wooden cabinets', 'basket ball hoop', 'quiet area'.

Dear Uncle Jonathan,
How are you? I'm fine and I've got a new school. It's just behind the old one and it's much bigger.
We have 1 big **playground** with a red *quiet area* and on the big playground is 2 **netball** courses and 2 ***basketball*** hoops. It's about 2x bigger than the old one.
The entrance has ***automatic doors*** then you go through another ***pair of doors***.
Once you go through them doors there's a beautiful *stained glass window* right above you.
In the **hall** is little **fibre optic lights** and there 2 big *metal supports* going along the roof. Theres a *staircase* going along the right side what leads to classrooms and a **balcony** at the back of the hall.
In the **classrooms** are **toilets** what lead to another classroom. There's *new tables and chairs*, **wholes in the roof** to help the ecustics, **smartboards** with the projector hanging of the roof and *wooden cabinets* to put our bags and coats in.
On the balcony outside the classroom are **electric windows** that open and close on how warm and how cold it is. The balcony looks down to the *infant classrooms.*
The *feild* has 2 *secsions* upper and lower the upper is small and the lower is big it's a bit bigger than the old one.
Thats all I have to say hope to have a letter off you
From
D

Figure 7.8: DB's writing showing items in common with his mind map in bold and novel items in italics

JN's written text follows the items on the mind map more closely. He too begins on the outside of the school but mentions all the items listed on this branch with the exception of the ramp, a path which leads to the classrooms. He includes detail about sports equipment, which was one of the items identified on his word list as important but not included on the mind map. He continues by detailing the features of the new hall, the next branch on the mind map, and then goes on to write about the classrooms. The branch listing the specialist rooms is not included. He shows a good sense of audience and describes the effects of items listed, showing his reader the building through his eyes: 'if you walk a bit further there is a glass bridge which you can see from even better'. Additional description also enlivens the tone: 'like stars' and 'cheese dyed white'. The mind map plan has arguably provided a structure but he is able to use a number of 'writerly' strategies to enrich the telling.

Dear Hannah,
I wrote to say How great the new school is. I'll start by saying you know how small the old **playground** was, how it could only fit one **netball** court in well the new one has two it's so big. But there's nowhere to hide unless if you go down to a *quiet part* of the playground which has **benches** around it.
Near the **classrooms** on the roof are **solar panels** so we can have our own energy. We hold our *lunch equipment* in a **bunker** (Better than our old P.E shed) we also hold tennis rackets, tennis balls, footballs and loads of other *P.E equipment*. We have also got a **path** with better grip to stop us falling down.
In the **hall** if you go **up** the *steps* ther's a huge **balcony** on that you can see the whole of the hall and if you walk a bit further there is a *glass bridge* which you can see from even better. And on the roof is one **lights** that turn on and off they look like stars.
At the **bottom of the hall** on the floor there is a **pattern** and the floor is in four separate pieces. Next to it is a door that leads into the **kitchen** where fresh food is cooked!
In the classroom there are **electric windows** which open on their own (if you switch it on auto) and there's **holes** in the roof that look like it's cheese dyed white, and we have clean **toilets** which we share with the year fives it's great here
From
JN
P.S: tell me how your school is. And write back!!

Figure 7.9: JN's writing showing items in common with his mind map in bold and novel items in italics

Low numbers of items in common from mind map to written task

There were also children who transferred very little from their mind map to the written task. This occurred both for children working in the individual and the collaborative conditions. Figure 7.10 shows the collaborative mind map produced by JC and CP and figure 7.11 JC's piece of writing. Her partner, CP, used one-third of the mind map items in his written task, shown highlighted in yellow on the mind map, while she used only three out of the 36 items, shown highlighted in pink. She had been able to generate a large number of items on her word list, 31, which included details of all aspects of the new school building (eg amphitheatre, oval hall, lift, community room) but the written task engaged her interest in a different way.

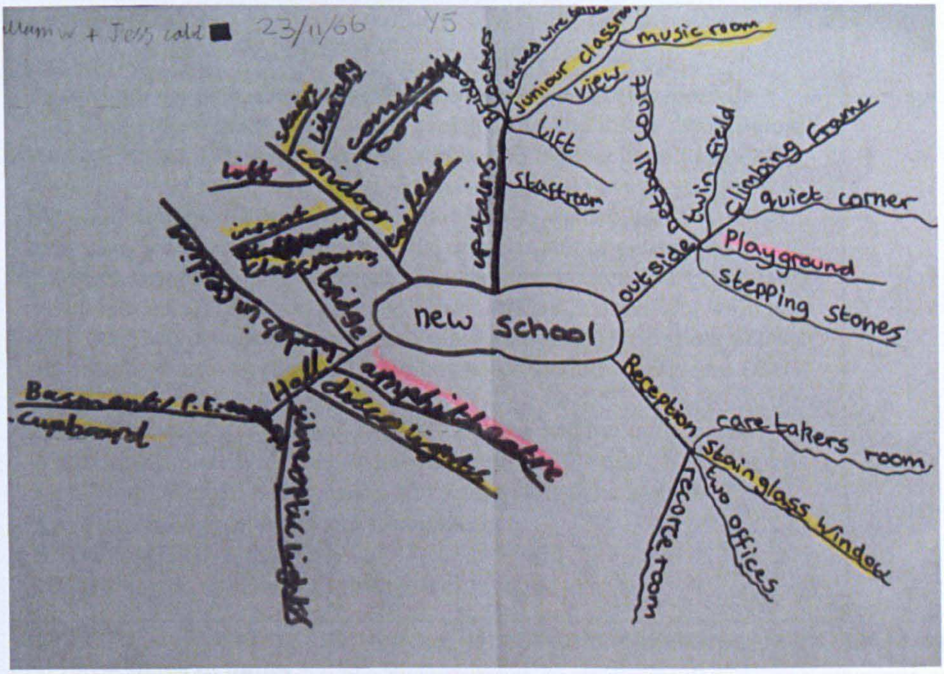

Figure 7.10: JC and CP's mind map; JC's items transferred to writing highlighted in pink

JC a concentrated on the instruction to make it an informal letter to a friend and instead of talking about the new school building became interested in writing to inform her friend about other changes that had happened during the year. The result is a chatty, informal letter, which is personal and engaging, so answers the brief. The imagined reader will be informed about the changes that have happened in school – though most of these are not mentioned on the mind map and many are to do with personalities rather than features of the building. The planning has given her time to consider possible inclusions, but while the mind map encouraged the listing of features found across all the mind maps in this study, she was more concerned with other important events. There is no evidence of any attempt to persuade CP of these during the construction phase and in fact she had not considered these relevant when making her own list of items. Her mind map planning provides little indication of the form her written letter will take.

Hi Alice!
Are you ok?
I'm alright, the new school is amazing we've got a **lift** two *football piches* and loads more space on the **playground** and inside the building! And we've got *Automatic windows and doors*! But we havn't got a *swimming pool* at our school like you have, we still have to go to K.L.C but you might have heard that being done up so we can't go there until next year. It's nearly *Christmas!* What do you want or getting? I'm getting a *new bike* – I've only had hand-me-downs from Jodi! How is the *swimming* going? Are you going to *Heanor*? I am ... hopefully we'll see each other! At school there's a man called *Russel* and he's going to teach the automatic drums. (there £100 to buy some though!) I was like OMG! LOL!
Did you know *Mrs White* has gone and she has had her *baby* called errrr...John Simon White and weighed 8 pounds 12 I can't wait to see Mrs White! We had a lady called *Mrs Jones* whilst she had gone!
Anyway I'll hope to see you at swimming!
Bi xxx from JC
PS: We've got a wicked **amphitheatre!**

Figure 7.11: JC's writing task showing items in common with her mind map in bold and novel items in italics

7.3.4 Results

The following sets of results examine whether there were any differences in the mind maps produced by participants working individually or collaboratively. Results in the following sections, from 7.3.4.1 to 7.3.4.2, look at mind map levels and mind map features, comparing the results in each condition. This is followed by analysis comparing writing levels and the similarity of content occurring both in mind map and written task in sections 7.3.4.3 to 7.3.4.5. As explained in chapter 3 on methodology, where the data met the requirements of normality, homogeneity of variance and co-variance, parametric tests were employed. Where data failed to meet these requirements, nonparametric tests were used as a more appropriate alternative.

7.3.4.1 Mind map levels

The first hypothesis was that collaboratively produced mind maps would be better structured. Mind maps were scored according to the structure present and compared. Map levels were scored according to the coding scheme developed in the exploratory study (see chapter 5) and reapplied throughout the thesis. A second coder (blind to condition) coded

10% of the maps and agreement was judged satisfactory (kappa=0.87, p=<0.001). As these data are rank, analysis is nonparametric.

Table 7.2: Mind map levels produced by individual and collaborative pairs

	Median	Interquartile range
Individual mind maps (n=38)	3	0
Collaborative mind maps (n=38)	3	0

A Mann–Whitney test shows that there was no significant effect of collaboration on the level of mind map produced (U=675.5). Children working with a partner did not produce more structured mind maps than those working individually.

7.3.4.2 Mind map features

The second hypothesis referred to the quantity of items on the mind maps. Would children working in pairs produce richer mind maps? Mind map features were quantified and compared in three independent t- tests; see tables 7.3, 7.4, 7.5. Mind maps were also judged by the use of keywords or longer phrases. This study produced a very low incidence of mind maps with longer phrases. Only four mind maps were judged to evidence this, with an even occurrence in each condition.

Table 7.3: Mean number mind map features produced by individuals or pairs

	Branches
Individual mind maps (n=38)	4.13 (2.29)
Collaborative mind maps (n=38)	4.21 (1.07)

Table 7.3 shows the mean number of branches produced by children in each condition. Analysis by independent t-test revealed no significant difference on the number of branches present on the mind maps in either condition, t=-0.19.

Table 7.4: Mean number of connections produced by individuals or pairs

	Connections
Individual mind maps (n=38)	20.63 (8.04)
Collaborative mind maps (n=38)	24.82 (8.80)

Table 7.4 shows the mean number of connections produced by children in each condition. Analysis by independent t-test revealed a significant difference on the number of connections present on the mind maps. Children in Condition 2 produced significantly more connections on their mind maps than those working as individuals. This difference was significant ($t(74)=-2.16$, $p<0.05$) but the effect size was small ($r=0.06$).

Table 7.5: Mean number of words produced by individuals or pairs

	Words
Individual mind maps (n=38)	36.13 (20.44)
Collaborative mind maps (n=38)	38.50 (16.02)

Table 7.5 shows the mean number of mind map words produced by children in each condition. Analysis by independent t-test revealed no significant difference on the number of words present on the mind maps in either condition, $t=-0.56$.

7.3.4.3 Writing levels

The fourth hypothesis was that writing levels might be improved by collaborative planning. Writing was awarded a score as described in section 7.3.2.4. Writing levels were agreed by a second marker, blind to condition, and an agreement of $k=0.87$, $p<0.01$ for the writing scores was achieved.

Table 7.6: Median writing levels achieved in each condition

	Writing score	
	Median	Interquartile range
Individuals (n=38)	6	4
Collaborating pairs (n=70)	5	4

Table 7.6 shows that writing levels were similar in both conditions. A Mann–Whitney test was used to investigate the writing levels achieved in each condition and found no significant differences between the scores (U=1342.5).

7.3.4.4 Mind maps and writing levels

Previous studies have shown correlations between mind map level, map connections, writing words and writing quality. It was hypothesised that there would be a positive correlation between better written texts and the structure and quantity of content present on the mind map plan. Using a Spearman's test as some of the data are rank, mind map levels and features were correlated with writing level and words to investigate possible relationships.

Table 7.7: Mind map features correlated with writing quality

	1.	2.	3.	4.	5.	6.
1. Map level		0.01	0.35**	0.33**	0.31**	0.21*
2. Branches			0.57**	0.55**	0.18	0.26**
3. Connections				0.84**	0.42**	0.34**
4. Map words					0.49**	0.41**
5.Writing level						0.78**
6. Writing words						

**Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Mind maps with higher numbers of connections had more structure ($r=0.35$, $p<0.01$). Better writing scores were also linked to more structured maps ($r=0.31$, $p<0.01$) and higher numbers of connections ($r=0.42$, $p<0.01$). The connections on the map are a measure of the number of concepts present on the map, which are then available as ideas to transfer into the written texts. Higher numbers of mind map branches were not significantly correlated with higher writing scores ($r=0.18$). A high number of branches would indicate a less organised mind map.

7.3.4.5 Similarities between mind map items and written text items

The final part of the third hypothesis was that there would be greater transfer of content from better constructed mind maps to written text. In order to compare the collaborative and independent conditions, similarities in mind map items and items appearing in written texts were evaluated and in three independent t-tests (see tables 7.8, 7.9 and 7.10).

Table 7.8 shows the mean number of items in common between mind map and written task produced by children in each condition. A second coder, blind to condition, reached an agreement of $r=0.97$, $p<0.01$ on items occurring on mind map and in text. Analysis by independent t-test revealed no significant difference on the number of items in common present in either condition, $t=0.95$.

Table 7.8: Means of items in common between mind map and written text

	Items in common
Individuals (n=38)	10.87 (6.06)
Collaborative pairs (n=70)	9.74 (5.79)

NB Six children absent for writing task.

Table 7.9 shows the mean number of items present on the mind map but missing from the written text produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of items present on the mind maps but missing from the written texts between the two conditions. Children working collaboratively missed significantly more items from their mind maps than those working as individuals. This difference was significant ($t(106)=-3.41$, $p<0.01$) but the effect size was small ($r=0.09$).

Table 7.9: Means of items present on mind map but missing from written text

	Items missing from written text
Individuals (n=38)	9.63 (6.82)
Collaborative pairs (n=70)	14.37 (6.93)

NB Six children absent for writing task.

Table 7.10 shows the mean number of items not present on the mind map but occurring in the written task produced by children in each condition. A second coder reached an agreement of $r= 0.79$, $p<0.01$. Analysis by independent t-test revealed no significant difference on the number of novel items produced by individuals or collaborating pairs, $T=-0.50$.

Table 7.10: Means of items not present on mind map but present in written text

	Novel items
Individuals (n=38)	6.74 (4.40)
Collaborative pairs (n=70)	7.21 (4.86)

NB Six children absent for writing task.

Mind map levels were correlated with the number of mind map connections, items included or omitted from mind maps and novel items included in the text but not on the mind map, using a Spearman's test. There was a significant correlation with mind map level and overall writing score ($r=0.30$, $p<0.01$) but no significant correlation with how many items were the same between mind map and writing task ($r=0.16$). Higher writing scores were significantly correlated with higher numbers of mind map connections ($r=0.39$, $p<0.01$). More structured mind maps were also significantly and positively correlated with novel items introduced into the writing task ($r=0.31$, $p<0.01$). The number of connections present on the mind map correlated significantly and positively with items included ($r=0.50$, $p<0.01$) but also with items omitted from the written task ($r=.0.65$, $p<0.01$). A large number of items in common did not correlate significantly with novel items generated through the writing task ($r=-0.08$). Items in common with the text correlated significantly and negatively with items omitted ($r=-0.21$, $p<0.05$). Novel text items correlated significantly with all categories explored.

Table 7.11: Correlations between mind map features and items in the written text

	1.	2.	3.	4.	5.	6.
1. Mind map level		0.24*	0.16	0.19	0.31**	0.30**
2. Mind map connections			0.50**	0.65**	0.02	0.39**
3.Items in common with text				–0.21*	–0.08	0.42**
4. Items missing from text					0.23*	0.22*
5. Novel items in text						0.35**
6. Writing score						

**Correlation is significant at the 0.01 level (2- tailed)
*Correlation is significant at the 0.05 level (2-tailed)

7.4 Discussion of Study 5

The main aim of this study was to investigate another strategy for supporting children's construction of mind maps, in this case collaboration. There was also further investigation into the relationship between mind map plans and subsequent written tasks.

7.4.1 The collaboration process

Efforts were made to scaffold the collaborative mind map-making process, as the literature shows that group work can be difficult without appropriate structures (Baron, 2003; Mercer, 1999). Children were supported to work collaboratively through a series of procedures which also shed light on the way mind maps were constructed by the collaborating pairs. Examples, included in section 7.3.3, illustrate that collaborative pairs were making decisions about what to include on the mind map and generating new content as they progressed through the construction process. Tracking back from items in the written assignment to mind maps and word lists showed that a variety of decisions had been made about appropriate content for the finished piece of work. Generally the participating children were happy to work in pairs and social aspects had been taken into account by class teachers when deciding on the groupings. Only one complaint was made about unfair distribution of labour during the paired work. Examples also show that children were able to make use of their own and their partners' suggestions on the written task, as illustrated by the exemplars in section 7.3.3.

7.4.2 Discussion of results linked to hypotheses

This section looks at the results in relation to the hypotheses guiding Study 5.

Hypothesis 1: Children working collaboratively would produce mind maps with more structure than individuals

Children in both conditions, collaborative or independent working, were guided to produce mind maps through an inductive process and with the support of both text boxes and templates, which had been shown to have beneficial effects in Studies 3 and 4. Looking at the quantitative results from the study, there was no benefit in working collaboratively on the level of mind map constructed. Children in either condition were able to construct categorised mind maps and very few of the mind maps produced were below a Level 3. This could be seen in the number of branches present on the mind maps which varied little between the two conditions. A relatively large number of mind map branches imply a corresponding lack of structure.

Connections and mind map words were strongly correlated as children were expressing their ideas in keywords and there were very few examples of children using long phrases or sentences to indicate the items on the mind map. This may be a function of using text boxes as a scaffold at the beginning of the construction process (see Study 3). Longer phrases had been a common occurrence on some mind maps produced in Study 1. This is a problem as with an increase in words to express concepts, the mind map form becomes cluttered, loses structure and clarity, and the links and relationships between items become obscured. As links and relationships on node and link diagrams are generally seen as a particular strength of this kind of representation (Novak & Canas, 2006; Vekiri, 2002; Sharples, 1994), their usefulness is impaired.

Hypothesis 2: Children working collaboratively would generate more items for their mind maps than those working individually

One advantage emerged in the paired condition, which was the generation of a wider pool of content, as shown by the small but significant increase in connections on jointly constructed mind maps. This provides a greater fund of ideas available for the subsequent written task. The exemplars show that children could draw from each others ideas in the paired condition.This could lead to better written outcomes as an increase in available content is correlated with a better writing score.

Hypothesis 3: a) Mind maps with better structure as seen in the use of categorised branch headings, would be associated with better texts

It was expected that more structured mind maps would be associated with better written texts, as the mind map would support the organisation of ideas for the written text. There was a correlation with better texts, which suggested this could be a strategy for helping some children to have thought about ways to organise their ideas before writing.

b) Mind maps with more content, shown as connections, would be associated with better texts

This was also the case. As shown in previous studies, children who were able to generate more ideas in terms of mind map connections were also able to write better texts. Although there was no clear advantage for working in the paired condition in the comparison of writing levels between the groups, this still suggests that there may be an advantage for some children, who will be supported to engage with more ideas through working with a partner.

c) Mind maps with better structure would be associated with greater transfer of content from mind map to writing

It seems reasonable to suggest that if children are engaging with a planning process through constructing a mind map plan, then evidence of this should exist in the form of items transferred from one representation to another. Better texts are associated with more structured mind maps and there is also more transfer of content from mind map to text. The expectation would be that a large proportion would be transferred but that the writing process itself would elicit more content during the transcription phase. This is emphasised by Hayes (1996), whose model shows that planning continues throughout the writing process. This appears to be the case as better texts also have a high number of additional items not present on the mind map. Mind maps with clear superordinate structures could prompt further associations as writing commences.

Children who worked with a partner chose to disregard more items from their mind map than children working individually. There is no way of knowing from the data collected whether this was a result of convergence over the mind map, which was not then carried over to the written task (see Fischer & Mandl, 2005), or children making use of their partner's items at the expense of their own. The writing task was time-limited and children vary in production speed, which may have led to greater numbers of items being omitted than would have been the case if the time to produce the written task had been more extensive.

Results suggest that those children who are able to structure their ideas on a well-constructed mind map are then also using a large number of those ideas in the subsequent written text. This relationship can be used by teachers as an early guide to assess the likely outcome of a written task, with the possibility of focused intervention at this stage. Teachers may also chose to present well-constructed mind maps as a model to support children who find the process challenging.

Hypothesis 4: There was a possibility that discussions over the mind map items and structure might lead to pairs also producing better texts overall than those who worked individually on their mind map

A comparison of overall writing scores showed no advantage for working with a partner to produce a written plan. However, as has been discussed, there was an increase in possible content for the written task. This did not appear to alter the eventual writing level but may have made a difference to other aspects such as the child's confidence in beginning the writing task. Motivational factors were not part of the study, but could be an area for further investigation.

7.4.3 Conclusions

Collaboration in this study appeared to offer few additional benefits when combined with a structured inductive approach to mind map construction. The scaffolding in place through structures such text boxes, templates and the inductive procedure for mind map construction led to well-structured mind maps, in contrast to Study 2 where there was such a high incidence of Level 1 mind maps. There was also a greater quantity of mind maps at Level 4 than in earlier studies. This indicates that the strategies to support children's mind map construction were successful. However, it must be acknowledged that comparing mind maps across studies is problematic as the nature of the task has been shown to have such a strong influence on the type of mind maps produced. Collaboration did not appear to provide additional benefits to mind map construction, possibly because the level of support provided by the scaffolding provided was sufficient.

There was no overall difference in the level of writing produced between the two conditions. Paired discussion had not made a measurable difference to the quality of written work when compared to those planning individually. More sensitive analysis of individual writing achievement may need to be carried out to judge subtle changes.

Higher levels of writing across both conditions are linked to better structured mind maps. This was still the case: the less structured mind maps were fewer in number and there were more frequently occurring examples of Level 4 mind maps showing elaborated categorisation structures Possibly the mind maps had acted to improve the structure of ideas then available for the written task. This has similarities to other research (Riley & Ahlberg, 2004; Meyer, 1982). A greater level of content was also correlated with higher writing scores: having a greater pool of ideas for the written task is important for novice writers (Torrance et al., 2007; Bereiter & Scardamalia, 1987). There appears to be some choice being made about the content generated because higher scoring writing is also correlated with items that are omitted from, as well as included in, the final text. This implies a level of choice and consideration once writing has commenced.

7.5 Study 6: Computer-generated collaborative mind maps

7.5.1 Introduction

The second study reported in this chapter continued to look at collaboration as a means to scaffold the mind map-making process. In this case the mind maps were to be produced by using a computer program, *freemind*, a piece of open source software which was easy to use and as the name suggests freely available.

The rationale behind this decision was to give the children greater flexibility in producing their mind maps, as up until this point all mind maps produced had been hand-drawn. One problem with all hand-drawn maps is the permanence of the decisions made about where to place items, how to structure branches, which branches to use. In Green's terms (1989), the task requires 'premature commitment'. The map-making process itself is ideally an arena for thinking about new ways of structuring knowledge, combining ideas in novel patterns and often placing a structure on an ill-defined domain. These kinds of representation have been described as 'mind tools' – which 'scaffold different forms of reasoning about content' Jonasson et al. (1998). The mapping process can encourage 'cognitively flexible processing skills' (Spiro et al., 2005)). The visibly evolving map provokes further memory searches and associations, which in turn generates ideas. New ideas may also alter decisions about the arrangement of existing items on the part-formed map. Changing your mind over a map is evidence of the mapping process provoking thought and re-evaluation of links between ideas, a valuable effect but often an inconvenient one. Redrawing a hand-drawn map is, of course, possible but also time-consuming and not always worth the effort involved, especially if the map is a preliminary to another task, not an end in itself. These problems are exacerbated when working with a partner; pairs who disagree about the way a map has been constructed, during the actual process have few options for changing their mind when the mind map is hand-drawn.

An obvious way around this problem is to use the computer and software that allows easy editing throughout the mind map-making process, taking advantage of the provisionality available. It then becomes easier for children to change their mind during the construction process, to have meaningful discussions about where to place items and the ability to move whole sections of the mind map as the thinking progresses during the task. Study 5 had not shown any clear advantage for collaboration related to the level of structure present on the mind map, with the possibility of greater flexibility in the mind map-making process, it was possible there would be greater benefits for working in a pair for this task.

Children were again going to work on a piece of thematic writing planned using a computer generated mind map, either in an individual or paired condition. All four primary school classes from Y3–6 took part in the study in the same year as Study 5. It was decided to choose another expository writing task based on common experience rather than linking the work to a particular curriculum area for reasons outlined in section 7.3. Children all had experience of technology, both in school and as part of their everyday lives. The task for Study 6 also consisted of a letter writing activity, in this case to an alien explaining the way technology impacted on their lives. As stated in section 7.3, the hypotheses were:

1) Children working collaboratively would produce mind maps with more structure than individuals.

2) Children working collaboratively would generate more items for their mind maps than those working individually.

3) It was expected that:

   a) Mind maps with better structure, as seen in the use of categorised branch headings, would be associated with better texts.

   b) Mind maps with more content, shown as connections, would be associated with better texts.

c) Mind maps with better structure would be associated with greater transfer of content from map to writing.

d) There was a possibility that discussions over the mind map items and structure might lead to pairs also producing better texts overall than those who worked individually on their mind map.

7.5.2 Method

7.5.2.1 Design

The design was a between-groups design, the independent variable being whether the child worked alone or with a partner on the task. There were three categories of dependent variables: one was the quality of map produced, measured in terms of structure (map level), branches, connections and words; one was the quality of written task measured on a criterion scale linked to national curriculum levels; and one a measure of similarity in content between mind map and written task.

7.5.2.2 Participants

For this study the teacher–researcher again involved the whole key stage 2 cohort consisting of 120 children, aged 7–11years, attending one primary school in Nottinghamshire. The children were in four single year group classes, following different programmes of study.

Children were assigned to the same condition as in Study 5. The conditions remained the same: one condition contained a third of the total number of participants, who worked as individuals on mind map construction; the second condition, consisting of two-thirds of the children, was the collaborative condition where participants worked in pairs on the mind map-making task. Four classes of children were involved in the study, so for easier administration children from the younger classes worked together, as did children from the two older classes. This arrangement led to similar numbers of mind maps being produced by participants in both conditions. The groups were formed as shown in table 7.12.

Table 7.12: Participants in Study 6 constructing computer-aided mind maps

	Individual		Collaborative pairs	
	Girls	Boys	Girls	Boys
Y3	5	5	14	5
Y4	5	4	9	8
Y5	5	2	10	13
Y6	5	9	7	12
Totals	20	20	40	38

7.5.2.3 Procedure

Training sessions: Initially, all children had to be trained to use the computer software available for the study. *Freemind* is a mind map program freely available on the internet and as an open source application regularly updated and improved by a community of java developers. Version 8 was used for the study – a significant improvement on earlier versions. The children were given an introduction to the software in an hour-long class session in the school's ICT suite. They were introduced to the basic tools and functions of the program and then given time to construct maps on subjects of their own choice. The necessary functions of adding text, making child or peer nodes were clearly explained and by the end of each of the four sessions run as class groups, children were familiar with the software and able to produce mind maps. These sessions were run early in January at the start of the spring term.

Session 1: Pairs of mind map sessions were then run for Y5 and 6 on 25th January, and for Y3 and 4 on February 6th. In these 45–50 minute sessions children were placed in the study groups: individual mind mappers worked in one session, followed by the collaborative mind mappers in another session on the same day. Each child or pair produced a map using the *freemind* software, which was to serve as the plan for writing about 'Computers in my world'.

The session began with a scripted introduction to the writing topic about the children's experience of computer technology. They were to write a letter to an alien describing the use of technology in their world. A group discussion was prompted by a series of ten photographs looping round as a slide show on an interactive whiteboard in the ICT suite. There was a deliberate effort made to ensure the photographs did not give a structure to the writing – music players were mixed in with photographs of using computer programs in school, mobile phones with games consoles or children working in the ICT suite. Children had time to make comments on the photographs shown and to express their own experiences to the group.

After the 10–15 minute introduction, children mind mapped their ideas to be used for the writing task. Though plain paper was available, children did not make lists of possible content before beginning the mind map construction process. Individual mind mappers were encouraged not to speak to other children while they constructed their maps. Children working in the paired condition were encouraged to speak about the process and to take turns in adding to the map. To facilitate this, halfway through the session children were instructed to change seats with their partner.

After the maps had been made and saved, copies were printed, to make them available to every child when they came to the individual writing task. Children in the paired condition each had a copy of their jointly constructed mind map.

The researcher led each session and was available to answer questions but not to make suggestions about items for the mind maps. Some assistance was given when required to children who needed help in operating the software, though this was rare.

Session 2: The written task was done in an extended writing session lasting 45–50 minutes, approximately 3–7 days after the mind maps had been made. Children were in their own class groups for the written task, with their regular class teacher. A short introductory script was provided for each teacher and the level of help to be given discussed before the task took place, to make the conditions for the writing task as similar as possible across class groups. Mind maps were printed and distributed to ensure each child had a personal copy as a reference point during the written task. The writing task was completed individually and all scripts and maps were then collected for analysis by the researcher.

7.5.2.4 Measures

The mind maps were analysed examining the use of keywords and categorisation. Mind maps were given a level, and branches, connections and words on the maps were also counted. A second marker achieved satisfactory agreement on mind map levels (kappa=0.76, p<0.001).

Writing was analysed and given a score using the procedure reported in section 7.4.2. A second marker (blind to condition) coded 10% of the written tasks and agreement was judged satisfactory (kappa=0.84). The numbers of words in each text were also counted.

In addition to this, the relationship between the map and the writing was explored in a number of ways as explained in section 7.3.2.4.

7.5.3 Exemplars of mind maps and written work

This section shows examples of mind maps created using *freemind* software and writing from a number of children.

Individual's mind map and written text

JB was working in the individual condition. He has constructed a Level 3 categorised mind map (see figure 7.12), showing his ideas for how computers are important in his life. Mind map items highlighted by the researcher are those mentioned in his written text.

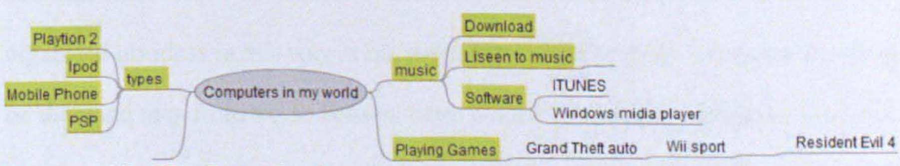

Figure 7.12: JB's Level 3 mind map constructed using *freemind* software

JB's written text is shown in figure 7.13.

> Dear Zige
> Its nice to see you
> I am writing about computers.
> You can do on a computere. You can *search for information* or look for *pictures* on a thing called the *Internet.* Also in the world their is other **types** of computers but as well you can get *consoles*. You can get a **playstation 2, Ipod, mobile phone** and even a **portable hand held playstation**. You can also get **music softwares** to **download** music on a *mp3* or a Ipod or **listen to music**. In are world we have things called **games** theirs other types of game theres *gun games, football games* and *car games.*
> Yours senserly
> J

Figure 7.13 JB's written text with items in common in bold and novel items in italics

JB has used many similar items in his mind map plan and the letter to the alien. Arguably, the items on the playing games branch could be examples of the games he then cited in a more generic way in the letter as gun games (Resident Evil 4), football games (Wii sport) and car games (Grand Theft Auto). He has not mentioned specific software available to play music, again leaving it more generic in the letter as 'music softwares' rather than citing itunes or windows media player. This could be seen as a regard for his imaginary audience, an alien who would not be aware of specific game titles. During the written task he has considered the internet and related activities, but his main focus remains on using technology for leisure rather than school-based learning.

Collaborative pair's mind map and written texts

CT and SR were two Y6 boys working together. The mind map was a difficult one to categorise until the written work was considered. SR has structured his writing by first dividing his use of computers into two categories – work and fun. If the mind map is viewed in this way it is a Level 4 mind map showing categorisation into two main branches and then sub-divided into a number of areas, such as school, internet, ipod. CT has not organised his ideas in this way in his written task. Working his way down the items listed on the mind map from top to bottom, there is a use of clustering ideas but not as an elaborated categorisation so the mind map could be seen as a Level 3.

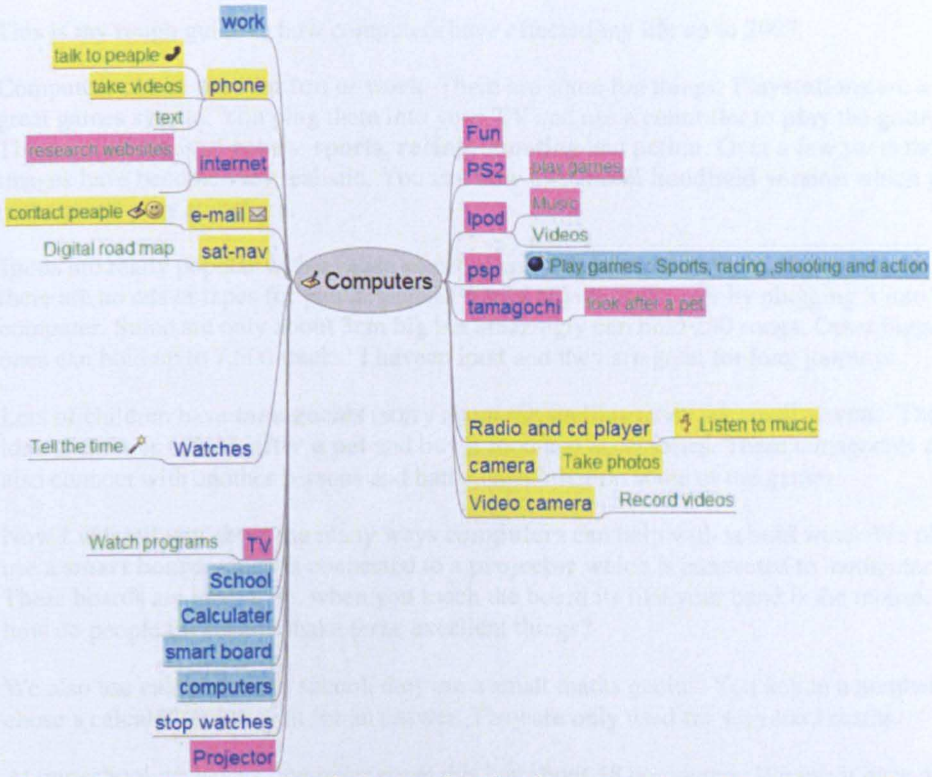

Figure 7.14: SR and CT's mind map showing items used in writing (key – yellow items used by C; pink items used by S; turquoise items used by both)

SR written text begins by identifying the two areas of his life where computers have an effect, fun and work. He works through the first branch about games, music and tamagotchis, before considering the ways computers are used in school, the work side of the mind map. He is able to add explanations to clarify the technology he is describing and his own opinion to make the letter interesting for his imagined reader.

Dear Mr Alien,

This is my rough guide to how computers have effected my life up to 2007.

Computers can be used for **fun** or **work**. There are some fun things. **Playstations** are a great games system. You plug them into your **TV** and use a controller to **play** the **game**. There are all types of games: **sports, racing, shooting** and **action**. Over a few years the images have become very realistic. You can now by a **small handheld version** which you pick up and **play** anywhere.

Ipods are really popular with a range of people now. Ipods are small **music** players. But there are no cds or tapes for you *download tracks* of your computer by plugging it into the computer. Some are only about 3cm big but amazingly can hold 250 songs. Other bigger ones can hold up to 7,500 tracks! I havean ipod and they are great for long journeys.

Lots of children have **tamagochis** (sorry about the spelling) they are small screens. The idea of these is to **look after a pet** and buy it food and accessories. These tamagochis can also connect with another persons and battle each other on some of the games.

Now I will tell you about the many ways **computers** can help with **school** work. We often use a **smart board** which is connected to a **projector** which is connected to computer. These boards are incredible, when you touch the board its like your hand is the mouse. Just how do people invent and make these excellent things?

We also use **calculators** in school, they are a small maths genius. You key in a number and chose a calculation and wait for an answer. They are only used for very hard maths.

At our school we have a *computer room* this has about 18 computers. We use it once a week. It is fun as it is totally different from using a pen and paper. We can **research** all sort of information on the **internet.** The internet is like a huge book with each page a new **website**. There are lots of *search engines*; websites which give you other websites to look on. The main two search engines are: *Google* and *Ask Jeeves.*

That is my guide to the wonderful world of computers they are in my opinion a excellent thing which has many uses.

Your sinserly

S

Figure 7.15: SR's written task showing items in common in bold and novel items in italics

CT's written task starts with items from the top of the mind map and then uses items in the order they appear on from the mind map when viewed as a list. Items are selected from both the work and fun branch. The initial categorisation evident in the work of SR is not how CT has structured his letter. He does not include so much explanation directed towards his imaginary reader or express many of his own opinions. The letter is a collection of items that engage his interest.

Dear Mr Alien 2007

I am writing to you now to tell you all about computers and the way they have effected our lives, Computers can be usefull for many things for example. You can **talk to people** online this is called **email** or you can even **play online games** there are different kinds of games such as. **sports, racing, shooting, action** and many more. Not all computer stuff is online for example: you could have a **sat-nav** which is in your car the sat-nav tells you how to get to places that you don't know, or there is a **phone** which you talk to people on.

You can even use your **computers at work** not just at your job but also at school like **calculators** to work out our hard sums. Or even your **smart board** that is a type of computer you can also **listen to music** or even the news on the **radio** that is also a type of computer.

There is a computer that you can take photos on this is called a **camra**. And when you have took all your **photos** you print of your camra and into real photos.

And last but not least there is a computer that you make **videos** on this is called a **video recorder**. And like the camra when you have done all your videos you make them into *little discs* out of the video recorder.

Figure 7.16: CT's writing showing items in common with the mind map in bold and novel items in italics

7.5.4 Results

7.5.4.1 Mind map levels

Map levels were scored according to the coding scheme developed in the exploratory study (see chapter 5), and reapplied throughout the thesis. A second coder (blind to condition) coded 10% of the maps and agreement was judged satisfactory (kappa=0.76, p=<0.001). As these data are rank, analysis is nonparametric.

Table 7.13 Mind map levels produced by individual and collaborative pairs

	Median	Interquartile range
Individual mind maps n=38	3	2
Collaborative mind maps n=37	3	1

nb 6 children absent.

A Mann–Whitney test shows there was a significant effect of collaboration on the level of mind map produced: U=466, p<0.006, r=–0.32. Children working with a partner produced more structured mind maps than those working individually.

7.5.4.2 Mind map features

Mind maps were examined for the use of keywords. The majority of mind maps produced were constructed using keywords; only five mind maps were found to use longer phrases. Three were produced by children working individually, two in the paired condition. Additional mind map features were quantified and compared in three independent t- tests; see tables 7.14, 7.15, 7.16.

Table 7.14: Mean number mind map branches produced by individuals or pairs

	Branches
Individual mind maps n=38	6.53 (5.27)
Collaborative mind maps n=37	4.19 (2.08)

nb 6 children absent.

Table 7.14 shows the mean number of branches produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of branches present on the mind maps. Children working as individuals produced mind maps with significantly more branches than those working collaboratively. This difference was significant (t(73)=2.51, p=0.14) but showed a small effect size (r=0.08).

Table 7.15: Mean number of mind map connections produced by individuals or pairs

	Connections
Individual mind maps n=38	20.39 (11.81)
Collaborative mind maps n=37	28.78(14.89)

nb 6 children absent.

Table 7.15 shows the mean number of connections produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of connections present on the mind maps. Children working collaboratively produced significantly more connections on their mind maps than those working as individuals. This difference was significant (t(73)=–2.71, p=0.01) but again the effect size was small (r=0.08).

Table 7.16: Mean number of mind map words produced by individuals or pairs

	Words
Individual mind maps n=38	34.26 (20.91)
Collaborative mind maps n=37	44.54 (23.02)

Nb 6 children absent

Table 7.16, shows the mean number of words produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of words present on the mind maps. Children working collaboratively produced significantly more words on their mind maps than those working individually. This difference was significant (t=(73)-2.03, p=0.05), with an effect size of r=0.05.

7.5.4.3 Writing levels

A second marker (blind to condition) coded 10% of the written tasks and agreement was judged satisfactory (kappa=0.84).

Table 7.17: Writing levels achieved in each condition

	Writing score	
	Median	Interquartile range
Individuals n=36	4	3
Collaborative pairs n=72	5	4

Nb 10 children absent for writing task.

Table 7.17 shows that writing levels were similar in both conditions. A Mann-Whitney test was used to investigate the writing levels achieved in each condition and found no significant differences between the scores (U=1182.5).

7.5.4.4 Mind maps and writing levels

Mind map levels and features were correlated with writing level and words to investigate possible relationships, using a Spearman's correlation

Table 7.18: Mind map features correlated with writing quality

	1.	2.	3.	4.	5.	6.
1. Map level		–0.34**	0.53**	0.37**	0.43**	0.39**
2. Branches			0.05	0.08	0.04	0.18
3. Connections				.90**	0.62**	0.53**
4. MapWords					0.53**	0.44**
5. Writing level						0.79**
6. Writing words						

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Mind map levels correlated significantly and positively with higher numbers of connections(r=0.53, p<0.01), mind map words (r=0.37, p<0.01) and writing scores (r=0.39, p<0.01). Mind map levels were correlated significantly and negatively with mind map branches (r=–0.34, p<0.01). Better structured mind maps have fewer branches as content is organised. Better writing scores were also correlated with more structured maps (r=0.43, p<0.01), higher numbers of connections (r=0.62, p<0.01) and mind map words (r=0.53, p<0.01). The connections on the map are a measure of the number of concepts present on the map which are then available as ideas to transfer into the written texts.

7.5.4.5 Similarities between mind map items and written text items

Similarities in mind map items and items appearing in written texts were quantified and compared in three independent t-tests; see tables 7.19, 7.20 and 7.21. A second coder marked the work and there was an agreement of r=0.95 for items present on both mind map and in the writing, and an agreement of r=0.87 for novel items present in the text but not on the mind map.

Table 7.19 shows the mean number of items in common between mind map and written task produced by children in each condition. Analysis by independent t-test revealed no significant difference between individuals or collaborative pairs on the number of items in common between the mind map and the written texts, t=–1.29

Table 7.19: Means of items in common between mind map and written text

	Items in common
Individuals n=36	11.94 (6.71)
Collaborative pairs n=72	14.39 (10.34)

Nb 10 children absent for writing task.

Table 7.20 shows the mean number of items present on the mind map but missing from the written text produced by children in each condition. Analysis by independent t-test revealed a significant difference in the number of items present on the mind maps but missing from the written texts between the two conditions. Children working collaboratively missed significantly more items from their mind maps than those working as individuals. This difference was significant ($t(106)=-2.13$, $p<0.05$) but the effect size was small ($r=0.04$).

Table 7.20: Means of items present on mind map but missing from written text

	Items missing from writing text
Individuals n=36	8.94 (8.88)
Collaborative pairs n=72	14.03 (12.86)

Nb 10 children absent for writing task.

Table 7.21 shows the mean number of items not present on the mind map but occurring in the written task produced by children in each condition. Analysis by independent t-test revealed no significant difference on the number of novel items present in either condition, t=–0.41

Table 7.21: Means of items not present on mind map but present in written text

	Novel items
Individuals n=36	6.44 (3.95)
Collaborative pairs n=72	6.83 (5.01)

Nb 10 children absent for writing task.

Mind map levels were correlated with the numbers of mind map features, using a Spearman's correlation (see table 7.22). This included mind map connections, items on mind maps included or omitted from written texts, novel items included in the text but not on the mind map, and writing quality. There was a significant, positive correlation with mind map level and the number of connections present on the mind map ($r=0.53$, $p<0.05$). Mind map level also correlated both with items in common ($r=0.36, p<0.01$) and missing items ($r=0.35$, $p<0.01$) between mind map and written task. Better structured mind maps also correlated with higher writing scores ($r=0.43$, $p<0.01$). Higher writing scores were significantly correlated with higher numbers of mind map connections ($r=0.62$, $p<0.01$). In this study there was a significant correlation between novel items and writing quality ($r=0.42$, $p<0.01$). The number of connections present on the mind map correlated significantly and positively with items included ($r=0.47$, $p<0.01$), but also with items omitted from the written task ($r=0.73$, p,0.01). A large number of items did not correlate significantly with novel items generated through the writing task ($r=0.09$).

Table 7.22: Correlations between mind map levels, items included or omitted from the written text, novel items in the written text and writing quality

	1.	2.	3.	4.	5.	6.
1. Mind map level		0.53*	0.36**	0.35**	0.17	0.43**
2. Mind map connections			0.47**	0.73**	0.09	0.62**
3.Items in common with text				-0.08	0.08	0.48**
4. Items missing from text					0.03	0.42**
5. Novel items in text						0.42**
6. Writing score						

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

7.5.5 Discussion of Study 6

The goal of the study was to explore whether children could collaborate successfully to produce richer and more structured mind maps using computer software, judged both by the numbers of items present on the maps and the levels of organisation. Children were working in the same condition as for Study 5, individually or with the same partner. There was an attempt made to ensure children had equal access to the computer in the paired condition, and the groupings appeared to be successful. This study also looked at the quality of the written work associated with the mind map plans.

7.5.5.1 Discussion linked to hypotheses

Hypothesis 1: Children working collaboratively would produce mind maps with more structure than individuals

The study resulted in showing a significant advantage for children working in the paired condition in producing well-structured and populated mind maps. Children both working individually or in a pair chose to construct mind maps using a deductive method. This is encouraged by the software, as the starting point is the central concept of the mind map, followed by choices about the main branches or 'child nodes'. The interface does not allow for a list of items to be recorded onscreen before the nodes are drawn. Making a list of possible items would have been possible using paper and pencil or word processing, but children preferred to begin constructing mind maps using the software provided.

Children working in pairs produced more structured mind maps. This is evidenced by a comparison of the type of mind map produced in each condition and by the significantly higher number of branches present on mind maps constructed individually. A higher number of mind map branches tend to suggest a less organised structure. The software does not allow the process of construction to be investigated, but the outcomes show that collaborating pairs were more successful in producing mind maps with greater structure. This could have been as a result of discussion prior to items being placed or because of the ease of editing provided by the software. Children working individually may have been less motivated to make changes to their developing mind maps, as they were not challenged by a partner's point of view. All three processes of articulation, conflict resolution and co-construction (Crook, 1994) could have been involved. Examining this in more detail would have involved a different form of data collection and could provide an area for further study.

Another possible benefit for the paired condition could be linked to a more abstract use of language, which could inform the content of branch headings. A study by Schwartz (1995) demonstrated a tendency for greater abstraction in collaborative cognition. More detailed analysis of children's conversations would be necessary to support this theory.

Both groups were able to populate their mind maps with keywords. The software also supports this, as the text boxes that appear on screen to contain concepts are small, though these expand as typing commences. Children in both conditions were able to use keywords to construct their mind maps and a very small number of mind maps contained longer phrases.

Hypothesis 2: Children working collaboratively would generate more items for their mind maps than those working individually

This proved to be the case. Pairs were able to generate more ideas for their maps, shown by larger numbers of connections present. Discussion between the pairs and a pooling of ideas had resulted in more concepts recorded on the maps. More detailed recording of paired work would be necessary to ascertain individual contributions to the shared mind map, but there was a productivity effect.

Hypothesis 3: a) Mind maps with better structure as seen in the use of categorised branch headings, would be associated with better texts

As in Studies 2 and 5, there was a significant correlation between writing quality and mind map level. Children who were able to produce a well-structured mind map were also more likely to produce a better piece of written work. This could be seen as an ability to organise content logically in both representations and be linked to general ability. Writing is a complex task and the scoring system used in the study takes account of many different aspects. This includes organisation, but this aspect can be strengthened due to the planning process while other features, such as spelling or sentence construction, mean the overall mark remains low. Planning can only be said to offer support for some aspects of a writing task, arguably leaving more cognitive space to deal with other issues of transcription, but improvements in overall writing score tend to be obtained over an extended period. Each writing level used for these studies is a measure of 6–8 months' expected progress. The results offer indications that well-structured planning can be implicated in better writing, but no unequivocal evidence has emerged. There was no negative impact on writing scores as these tended to stay in-line with those children achieved generally at the time of the studies.

b) Mind maps with more content, shown as connections, would be associated with better texts

There was again a correlation between the number of connections generated and the quality of the written task. Children need a rich fund of ideas on which to draw for a written task. This was supported by working in collaboration. Children working collaboratively had a higher number of items on which to draw for their writing, which in turn led to more items being discarded than in the individual condition. Children were able to make choices once the writing was underway.

c) Mind maps with better structure would be associated with greater transfer of content from mind map to writing

Items present on the mind map which were then transferred to the written text tended to be high. Better texts again showed a high level of transfer. This can be seen as indicating the child's ability to plan using this kind of representation. Better writers also appeared to be selective, deciding to incorporate some items, omit others and create novel content once the writing task was underway.

Hypothesis 4: There was a possibility that discussions over the mind map items and structure might lead to pairs also producing better texts overall than those who worked individually on their mind map

The subsequent writing scores did not show an overall advantage for working with a partner at the planning stage. The writing scores across conditions remained similar and there was no significant difference in writing score between working individually on planning and working with a partner. The example included shows that a collaborative plan can be used in very different ways once a writing task commences. As previously stated, there was no detrimental effect of combined planning. The mind map plans offer the teacher an insight into the text at an early stage in the process. The results of this study suggest that mind maps containing rich, well-organised content will also be associated with well-written texts.

7.5.6 Discussion of collaborative Studies 5 and 6

The effects of collaboration in these two studies varied. In Study 5 collaboration offered the children the space to discuss ideas and led to greater generation of content for the mind map but there was no improvement in the overall structure. The inductive method of production and visual prompts provided by text boxes and templates gave children the guidance required to construct mind maps. There was a more beneficial effect for collaboration in Study 6. Children using the computer-based mind map program were supported by collaboration to produce more structured mind maps. In this study children used a deductive method to construct mind maps and did not chose to list items in advance. Arguably, the discussion that took place between the pairs resulted in decisions being made about branch headings and content, aided by the ease of editing provided by the software. Closer analysis of the process, outside the scope of these investigations, would be necessary to investigate the nature of the collaboration.

Both studies showed that collaboration provided support for an increase in the number of connections included on paired mind maps. In both studies, the mean numbers of connections were higher in the paired condition. In addition,the two studies showed very similar numbers of connections produced for both tasks. A sharing of ideas meant that children in the collaborative condition had a greater pool of ideas to use in their written work. This is important because the number of connections present on a mind map has been shown to correlate with better quality texts in Studies 2, 5 and 6. This would suggest that children showing a good range of items on a mind map plan are more likely to write a better text. Collaboration has benefits to support children at this stage in the writing process. There is also the possibility for focused teacher intervention at this point as the mind map is a visible record which can be discussed.

Mind maps provide a record of the potential content for a written task. In both studies, about half the mean numbers of items recorded on the mind map plan were used in the final task. Children in the paired condition tended to discard more items than those working individually, but this was from a greater pool of items.

These studies support the view that children are using the mind map as a planning space to record possible ideas and in many cases organise these ideas before writing. Many of these ideas then go on to inform the written task. This is a development away from the list-like planning reported by Bereiter & Scardamelia (1987), as children are generating a fund of possible ideas from which selections are made, rather than simply reproducing a more elaborated list. This appears to be true for the majority of children, though there were examples in individual cases where the mind map plan becomes an almost totally separate task from the written work (figure 7.11).

The two studies suggest that there are benefits for collaboration in providing children with a greater fund of ideas on which to draw for their written task. Better structured mind maps were the result of two processes. One was a set procedure to scaffold the production process as shown in Study 5, where collaboration appeared to offer little further support for the construction process. Another strategy was the use of specialised software together with collaborative support, which produced a greater number of structured mind maps.

As planning tools, children's mind maps in the majority of cases show the main themes that will be explored in the written task, providing an opportunity for focused teacher intervention before the writing commences. It is also evident from the examples of written work selected that once writing is underway other strategies come into effect. Arguably the planning process has clarified content and organisation in order for children to begin the writing task with more confidence. These are relatively short writing tasks and the main points can be held in memory once the task is underway. Children did not tend to return to the plan once made. The written task can take on a trajectory of its own once commenced, which can lead to the writing and plan appearing to be separate and unrelated documents in some instances. However, generally the strong similarities between mind map plan and written task show that many children were able to use this representation to generate content and structure for the associated written tasks.

Chapter 8: Discussion and implications for further research

8.1 Introduction

This study began as an investigation into children's ability to learn, construct and use a novel representation, specifically linked to planning writing tasks. Mind maps were chosen because literature presented benefits for this kind of representation (Cavilgloni & Harris, 2002, 2000; Buzan, 2000; Jonassen, 1998). However, research examples which examined the ability of children to produce these kinds of representations were more difficult to find, and actual examples of primary-aged children's constructions rarely reported. Chapter 8 will discuss the findings of the six studies carried out in relation to the four research questions. This will be followed by a discussion of possible implications for the primary school classroom arising from this work and directions for further research.

8.2 Can 7–11 year old children create mind maps?

Mind maps were chosen as a particular form of node and link diagram as they were felt to be a relatively simple organisational tool. As discussed in the literature review, chapter 2, it was felt that concept maps were a more sophisticated type of node and link diagram, which might prove difficult for the majority of primary school children to master. Evidence from Kinchin and Hay's (2000) study also suggested that older children experienced difficulties in producing fully structured concept maps. On this basis the studies presented in the thesis asked children to make the simpler mind map diagram.

Mind maps require the author to identify a domain, break this down into a series of main categories, or 'Basic Ordering Ideas' (Buzan, 2000: p. 84), and using these as the branches of the mind map, populate these divisions with content, which can be further sub-divided into relevant categories as necessary. All of these ideas or concepts are expressed as concisely as possible in single words or short phrases, known as keywords. These concepts are identified as the connections on the mind map, as each is written on the connecting line rather than in a separate box as in many node and link diagrams (see figure 2.1). The resulting diagram is a series of tree diagrams organised around a central theme.

In order to create this diagram, children have to be able to express their ideas using keywords and to be able to understand the basic ordering principles of a tree diagram. Concise use of keywords requires children to access vocabulary, which can express both the concepts at the level of examples and at a more abstract level for the labelling of branch headings. Vocabulary was identified as an area of possible concern early in the exploratory study, and results from all six studies show some evidence to suggest children find this aspect challenging; see section 8.2.1 for further discussion.

Children have been shown to be able to read tree diagrams to four levels of structure (Deneault & Ricard, 2005; Greene, 1994), but it was not clear if children would be able to construct their own tree diagrams. Reseach shows the ability to read a diagram does not guarantee that the learner will be able to construct a similar diagram independently, (Ainsworth, 2006; Cox, 1999).

All six studies also show that encouraging children to construct a multi-levelled mind map was an area that needed additional support once the initial training period was complete, and was particularly affected by the nature of the writing task. Sections 8.2.1 and 8.2.2 will discuss the findings across the studies related to the use of keywords and categorisation.

8.2.1 Children using keywords

During the initial training sessions given at the beginning of the exploratory work, as outlined by Caviglioni & Harris (2000), and in training sessions delivered as Study 2 commenced, the need to use keywords to construct the mind map was explained. Mind maps as planning tools were introduced as a way of expressing ideas as concisely as possible in an ordered structure. Economy was seen as an advantage of this type of planning, as children did not need to use whole sentences or to record a great number of words to express their basic ideas for the written task. This was a particularly important consideration for the individuals who were reluctant to write or plan, a common response to writing identified in the literature (Torrance et al., 2007; De la Paz, 1999; Troia, 1999) and through classroom experience. Training outlined by Caviglioni and Harris (2000) provides a number of suitable exercises to support the understanding of how concepts can be expressed through the use of keywords. These exercises were successfully completed by the majority of the children involved during the training period. It became evident once the children were producing their own mind maps independently, especially when linked to a written task, that the keyword aspect was being lost in some cases.

In the exploratory study reported in chapter 4, children in both groups, Y4 and Y5, tended to increase the number of words on their mind maps in their second task. This was obvious visually from the mind maps produced and was reflected by the statistical analysis, where, although the numbers of mind map words increased between tasks, the numbers of connections, a measure of actual concepts represented, remained very similar. It appeared that most children were more accustomed to writing concepts using longer phrases and returned to this strategy. The principles outlined during the period of training were not secure.

This tendency was apparent in the results of the second study. Study 2 showed a large difference between the two tasks in the way connections were constructed. Although the Brochure task had a very small proportion of mind maps where keywords were not used, the Amenities task resulted in over half the mind maps containing longer phrases to construct the connections. Numbers of mind map words were not correlated with better texts in the Amenities task, which indicated that using longer phrases to express mind map connections was not beneficial. Though these mind maps often contained more words, fewer concepts were being recorded. The tendency to use longer phrases was more common on less structured mind maps and often appeared on mind maps with fewer connections. Recognising this tendency as a problem, led to approaches to encourage children to use keywords and scaffolding strategies to support their mind map construction, discussed in sections 8.3.1 and 8.3.2.

8.2.2 Children creating categories

It was felt that children needed a concise form of planning tool to prepare for written tasks, but, arguably more important, was a planning tool that provided a format for organising items of possible content, especially when organisation was not based on a narrative, chronological form. Many expository written tasks are based around thematic structures and this is recognised by practitioners and researchers as a more difficult form of writing for children (Mallet, 2003; Wray & Lewis, 1997). Mind maps were seen as the kind of 'mind tool' (Jonnasen, 1998) that could potentially inform the organisation of thematic texts. In order to do this effectively, children had to be able to create categories to structure their mind maps.

This was part of the original training. Children in the two classes participating in the exploratory study were introduced to the principle of creating categories using lists of words, which could be grouped in a variety of ways. This was followed by an exploration of tree diagram organisation through a number of tree diagram exercises. These were part of the training given following the scheme presented in Caviglioni & Harris (2000). A number of worksheets were completed by the children, which consisted of incomplete tree diagrams to complete with progressively more levels of hierarchy. Corresponding mind maps with missing connections were completed as part of the task, to show the relationship between the two structures. Children completed these exercises easily. This appears to support the findings (Deneault & Ricard, 2005; Greene, 1994) that young children are able to understand hierarchical levels of organisation. Both the research mentioned and the training exercises taken from Caviglioni & Harris (2000) looked at children's ability to complete or infer information from pre-constructed or partly constructed tree diagrams.

Once children began to produce their own mind maps, it became evident that a diagram based on categorisation was more difficult to construct than to read. This led to a variety of mind map structures. One result of the exploratory study was a classification scheme to describe these differences, which informed data collected for the five subsequent studies. Mind maps were given a level from 1 to 4 which indicates the level of structure and categorisation present, ranging from an ungrouped spider diagram, termed an association star, to a mind map showing sub-groups on branched content, an elaborated semantic cluster.

Can children create mind maps as planning tools for writing?

Children found making their own categorisations to group information challenging. This was evident at the beginning of the exploratory study. A small number of the practice mind maps made as part of the initial training did not use categories effectively. Some children needed additional support to invent suitable category headings. In Medland's (2007) terms this demonstrates hierarchical knowledge and children were sometimes struggling to find appropriate vocabulary to classify a group of items.

The problems with categorisation became more evident when children began to produce mind maps as plans for writing narrative tasks. Study 1 saw the majority of children able to produce mind maps with a central idea, a number of branches populated by content linked to the branch heading. These were given the label of Level 3 mind maps, a semantic cluster. However, there were a number of cases of Level 2 mind maps, where the branches show connections departing from the branch heading in a chain of associations. This type of mind map occurred more frequently in response to a complicated narrative task for the Y5 children. In a number of cases, categorisation had broken down on areas of these mind maps, as the children adapted the form to introduce a timeline structure to order narrative events. This would suggest that the mind map structure may not be the most efficient planning tool for a narrative form, where chronology rather than theme is most important. In other cases, however, the chaining effect was judged to be a misunderstanding of the mind map form. The visual aspects of the mind map diagram were often reproduced but the semantic organisation was missing.

As a response to these difficulties, Study 2 attempted to link mind map planning to a more suitable written task, one that was based around thematic rather than chronological organisation. This was not as successful as anticipated and children created a large proportion of less structured mind maps. Many of these mind maps were judged to be Level 1, an association star, where content was generated but remained as a collection of ideas with no superordinate organisation into branches. This type of mind map did not occur in Study 1. Level 1 mind maps were most frequent in response to the Amenities task, where over half the mind maps produced were of this type. At this stage it was felt that children required some additional support or scaffold to assist with the mind map construction process, especially as it was found that better structured mind maps had a significant correlation with better written texts. There was also a question over whether children were still relatively unfamiliar with the mind map representation or whether it was a fundamental problem for children of this age to group concepts into categories.

8.3 How can the mind map construction process be supported?

The first two studies had looked at children's capacity to produce a graphical representation which was relatively new and required language and organisational skills. Results from many of the children were positive but there were problems with the use of keywords and categorisation. The purpose of Studies 3 and 4 was to support the children's construction of mind maps. These studies were not linked to written tasks. The findings from these two studies went on to inform Studies 5 and 6, which returned to the main investigation of using mind maps as planning tools for written tasks,

8.3.1 Support for use of keywords

Study 3 was designed to look at children's ability to generate keyword lists and to group the resulting lists into categories. Children at this point were using a deductive approach when constructing mind maps. This involved beginning with the topic and finding in Buzan's (2000) terms 'Basic Organising Ideas' (p. 84) to group content on the mind map. During the training period and in subsequent instruction given as part of the second study, children had been introduced to an alternative strategy, which involved generating a list of ideas before attempting to decide on particular categories. This inductive method was not adopted independently by children. The second study saw only two children begin to mind map in this way. Study 3 encouraged children to use an inductive approach with some success. This procedural approach could be said to scaffold children's learning (Azevedo et al., 2003).

Before constructing a mind map on the topics given, children were told to make lists of relevant concepts. There was no requirement to think of categories at this point, just to make word lists. To support this activity, sheets containing text boxes were designed. A comparison was made between children having a sheet containing text boxes with a blank piece of paper. Text boxes were a device to encourage the generation of a large number of items as the sheet contained 30 boxes, but also as a means to remind children that individual words or very short phrases were required as the text boxes were relatively small. This could be viewed as a scaffold, being a physical artefact to support learning, (Sherin et al., 2004) and with an intention to remove the support as the children's skill levels improved. It was found that children approaching the process of creating a mind map by initially generating lists, with or without text boxes, were able to use keywords to identify relevant concepts. This then transferred onto the mind maps constructed from these initial lists. In Study 3, from a total of 51 mind maps, there was only one example created through this process which used longer phrases.

The effectiveness of this method could be compared with Study 4, which involved the same participants and was conducted in the following term, a few weeks later. Study 4 was principally concerned to support the categorisation and structure present on the mind maps. In this case, where children did not have the procedural support, about a quarter of the resulting mind maps were produced using longer phrases.

Study 5 also guided the children to work by generating lists before making their mind maps. This procedure again resulted in the majority of mind maps being constructed with keywords. A total of five mind maps out of the 76 in the study used longer phrases instead of keywords to construct connections and, as the statistical analysis showed, there was no difference between collaborative or individual condition. Children were adequately supported to use keywords through this inductive approach.

Study 6 did not guide children to generate lists before mind mapping; however in this study children were using computer software to construct mind maps. The *Freemind* program interface presents small text boxes to contain concepts, which arguably acted as the textboxes used in Study 3 and 5 as a visual reminder to use short phrases. This study also saw the majority of mind maps produced using keyword connections; in this case, only seven of the 75 mind maps produced used longer phrases.

Over the course of the six studies it appeared that using text boxes in some form – either as a list generated before the mind map was created if working on paper or through the use of computer software to encourage the concise naming of concepts to create mind map connections – was a successful support strategy.

8.3.2 Support for categorisation

Children had been seen to produce a large number of Level 1 mind maps or association stars in Study 2. It was not clear whether this was an inherent difficulty in accessing suitable vocabulary or could be improved by the use of support strategies. Study 3 encouraged children to use an inductive method to produce mind maps, as described in section 8.3.1, first starting with a list of possible content. The lists generated were then grouped under category headings. Once lists had been generated, there appeared to be little difficulty for the majority of children to divide these into suitable categories. Defining categories appeared to be facilitated by having identified a group of items to classify, rather than first creating category headings. The mind maps were then constructed using these headings. Once headings were in place, there was some evidence to suggest these branch headings provided prompts to further associations adding to mind map content. This was seen in the growing number of items or concepts produced by children as each stage in the inductive mind map construction process was completed.

In addition, the procedure of Study 3 encouraged children to use a 'catch all' category of 'Other' as a heading for any items generated on their list for which they failed to find a relevant category heading. This miscellaneous category was used by many children and equally for both of the topics covered – Food and Egyptians. This may be a useful strategy to record content that has not been linked to a particular category but may still be useful to acknowledge. The presence of items that have not been totally integrated into a mind map structure may still prove useful once a written task is underway.

There were no differences in children's ability to provide categories for the content generated between the more familiar topic of Food and the recently taught topic of Egyptians. Children were able to label category headings for either topic, which suggested that understanding the concept of categorisation was not a problem. Children were able to divide content into categories and could see how their items shared aspects that could be defined by a superordinate in most instances.

Finding appropriate vocabulary for categorisation was also dependent on the kind of knowledge to be represented on the mind map. Some commonly used category headings are embedded into a subject domain and children are able to use these. This became apparent in Study 4. This study was conducted with the same participants as Study 3. Children in this study created mind maps through their preferred deductive process, starting with the basic organising ideas. The main purpose in this case was to investigate the impact of using a mind map template to support categorisation, another type of physical artefact to scaffold learning (Sherin et al., 2004). This was found to have a beneficial effect on the structure of mind maps produced. Mind maps produced using the template were more structured than those without.

In this case, there was a difference between a domain where a specific vocabulary of classification is used routinely, a scientific study of animals, and the human geography topic of a life in an Indian village. There was less impact of the template on the animal mind map. Resources used by the children gave a categorisation structure, as information was already divided into headings such as 'diet', 'habitat'. These headings were prevalent across the resources used to assess information, both online at appropriate websites and in the information books provided. The human geography topic, as presented to children, was less clear about categories of information. In addition, the information had come from visual as well as textual sources, such as photographs and video, which complicated the task. Children had to invent or infer their own classifications for the knowledge represented. The benefit of the template was more pronounced for the geography topic, where more support was necessary.

The results of these two studies would suggest that most children in this age group, 7–11years old, are able to construct their own categorisations of content, but that this can be supported in a variety of ways. The inductive approach, where content is generated and categorised before the mind map is developed, ensured that most mind maps were produced with structured branches. If using a deductive approach, templates acted as a visual reminder to produce branch headings populated by associated connections. However, in some cases, children will be aware of existing conventions where categories are routinely used and additional support may not be necessary.

8.3.3 Collaboration as a form of support for mind map construction

Collaboration was investigated in Study 5 and 6 as a further strategy to support mind map construction. Study 5 investigated whether when working with a partner, using text boxes, the inductive method described in Study 3 and mind map templates, led to an increase in well-structured mind maps. This did not prove to be the case. Collaboration did not lead to a greater number of well-constructed mind maps under these conditions compared to working as an individual. Working with a partner was effective in producing more items, measured by the number of mind map connections present, but there was no improvement in the structure or use of keywords in mind maps produced by pairs. It could be argued that support for the task was adequately served by the procedural prompts and collaboration could add little more to the process.

Study 6 again investigated the impact of collaboration, but in this case a computer program was used to produce the mind maps. Children were able to choose how to approach the task and all chose to work deductively, deciding on branches and populating them with connections. There was no initial generation of items using text boxes and no additional support to guide the structure on the mind map. Children did not begin by making lists of any kind, though the opportunity to do so existed.

In this study, the collaboration between pairs appeared to support better organisation of items on the computer-generated mind maps, and a greater quantity of well structure mind maps were produced in the paired condition. This may have been a result of more abstraction (Schwartz, 1995) in the type of language used to form branch headings. Another possibility would be that children explaining to their partner where to put content on the mind map may have led to disagreements and a necessity to justify decisions. A greater understanding of the categorised form could have developed because of the opportunity to articulate the choices made to a partner. The mechanisms of articulation, conflict resolution and co-construction (Crook, 1994), or convergence (Fischer & Mandl, 2005), may have been implicate in this.

Computer software offers the advantage of provisionality. Pairs working with computer software had a better opportunity to edit and revise mind maps than those employing pen and paper methods, as in Study 5. This may have led children to be more open to processes of revision during the task. It could be argued that children working individually on this task would also have been able to edit or revise their work, but this would not have been prompted by the presence of a partner. Detailed observation of the pairs would have been necessary to make specific judgments about the process of construction, which was not part of the investigation. Analysis of the outcomes showed that mind maps produced by children working in pairs were more structured.

It was also noted that both individuals and collaborative pairs were able to use keywords effectively, which was probably an effect of the text box interface used by the software, mentioned in section 8.3.1.

Collaboration appeared to be more effective when combined with the use of computer software rather than paper and pen methods. However, there was also a difference in approach by the participants. Study 6 saw children using the deductive method of mind map construction. With less procedural support for construction, the impact of collaboration became an important factor and showed a positive effect.

In summary, it appears that mind map construction can be supported by the use of various interventions. Children can be encouraged to make lists of possible content before working placing items on the mind map structure. This can be seen to encourage the use of keywords and supports categorisation. Mind map templates act as visual reminders of the mind map form and support categorisation. If computer software is used, collaboration appears to offer a support for the production of better structured mind maps, either through the possibilities for discussion or the benefits of provisionality.

8.4 Can mind maps be used as a planning tool to improve written tasks?

Investigating children's capacity to create mind maps was one aspect of the studies presented in this thesis. The other major concern was the impact that using mind maps as a planning strategy could have on written tasks. Both Buzan (2000) and Caviglioni & Harris (2002, 2000) make claims that mind maps can be used to plan written tasks. The branches on a mind map can be used to identify main themes and the connections show possible content related to these themes. The exploratory study was designed to gauge the children's response to this way of planning writing and to investigate the potential for mind maps as a planning tool. There were three studies following the exploratory work, which investigated the impact of using mind map plans on subsequent written texts. The findings from these studies will be discussed in sections 8.4.1 to 8.4.2

8.4.1 Children's response to planning with mind maps

Experience in school and research shows that children are generally unwilling to plan (De la Paz, 1999; Troia et al., 1999; McCutchen, 1988). In contrast to this, advice given to teachers recommends planning as a means to improve written work (Andrews et al., 2006; Beard, 2000), and a space for planning is included in the national writing test papers for children in primary schools. One encouraging early finding was that pupils, normally reluctant to make plans, were engaged by the mind map planning strategy and most children were enthusiastic about preparing their plans. Questionnaires from the first study showed that many children felt that mind maps could be useful, some mentioning the fact it helped them to clarify their ideas before writing. Children were also seen to continue to use this form of planning in independent work outside the studies reported here.

The fact that children are willing to engage with this type of planning activity means that they are supported to take more time in thinking about writing before engaging in the transcription phase. Hayes (1996) points out that expert writers generally spend more time considering the task, which he argues is a more important factor than any particular form of planning strategy. Constructing the mind map plan means that children spend time thinking about possible content, which in turn should have a beneficial effect on the writing process. In addition, the resulting representation gives the opportunity for teacher or peer intervention at this point in the writing process.

8.4.2 Mind maps as plans for written tasks

Study 1 focused in on mind maps as planning tools for narrative writing tasks. Children were directed to complete a mind map to use as a plan before starting their written tasks and data were collected twice from each group during the academic year in which the study took place. As discussed in section 8.2.2, a variety of mind maps resulted from these tasks, leading to the categorisation of mind map levels from 1 to 4.

Over the year in Study 1, each separate writing task appeared to have an influence on the type of mind map produced. Children in Y4 showed improvement over time, as mind maps produced for the second writing task were better structured. This improvement could be explained by the children becoming more familiar with the representation. However, the second task involved planning a character rather than a complete narrative. Aspects of the character, such as appearance, interests, family, were given categories which gave structure to the mind map. The narrative trajectory was not planned on the mind map.

The mind maps collected from Y5 showed a different pattern. The second collection of mind maps made later in the year of the study was less structured than the first set. Given a complex narrative to plan, Y5 children had often adapted the mind map structure to accommodate a timeline to provide support for planning the chronology of the written text. This had interfered with the structure of the mind map and led to a higher number of association chains, Level 2 mind maps in the study.

The findings suggested that some aspects of planning a narrative might be best served by an alternative form of representation, one that emphases chronology such as a storyboard or timeline. Planning different aspects of a story might need to employ different representations; a basic outline of character, main event, setting might be appropriate on a mind map, with the chronology of the plot developed on a timeline.

The results from Study 1 suggested that, although the mind map form may not be altogether suitable for planning narratives, the demands of the writing task had an impact on the mind maps produced. The variety of mind maps produced appears to lend weight to the assertion that children were considering the writing task as they constructed their mind map plans. Children in the study ranged from 8–10 years old, about the age that Bereiter & Scardamalia (1987) considered children beginning to be able to plan written work rather than merely compose a slightly shorter rehearsal of the written task.

Recognising that graphical representations need to be carefully chosen in relation to the task (Ainsworth, 2006; Scaife & Rogers, 1996), the second study investigated children making mind map plans for expository tasks. This is an area that proves challenging for primary school children (Mallet, 2003; Wray & Lewis, 1997). The tasks chosen were thematic in nature rather than based on chronology, and it was hoped that the mind map would provide an appropriate structure to generate and group relevant content which could be used for the written text.

In addition to providing more suitable tasks for planning on a mind map structure, Study 2 made a direct comparison between planning using paired discussion with making a mind map plan on the subsequent written task. Children completed two writing tasks that were designed to be equivalent, one using a mind map plan and one planning in discussion with a partner. The tasks were both written as persuasive pieces, one to explain requirements for the new school grounds, the Amenities task, and the other a Brochure task explaining the use of technology in school.

The resulting mind maps showed a wider degree of variation than had appeared in the exploratory study. This included the simplest form of mind map, an association star, which has ungrouped content. This level of mind map had not appeared in the exploratory study. The Amenities task, in particular, elicited a large number of association stars which had no categorisation. Children who had made well-structured practice mind maps created less structured mind maps in response to this writing task.

Reasons for this lack of structure for this particular writing task were difficult to explain. Given the opportunity to describe their ambitions for the new school grounds, children were quick to produce unstructured lists. One requirement of the task was to provide reasons for their choices. In many association stars, this led to a row of choices around the central node followed by a further row of reasons for the choice. This gave the appearance of a double-wheel. Reasons for including items, such as 'it will be fun' were often repeated a number of times on the same mind map, each time linked to a new item rather than providing a branch heading which could have been a means to organise content. This did not appear to be a problem with lack of experience. Children who had been involved in the exploratory study were as likely to produce Level 1 mind maps as those who had less experience. There were similar numbers of unstructured mind maps produced by older children as the younger age group. Consequently, it appears that task demands have a strong impact on the type of mind maps produced. Children had again adapted the mind map structure to fulfil a perceived need, recording a list of ideas with a list of reasons for the choice.

Mind maps produced for the Brochure task also showed a range of structure, which included mind maps from each of the four categories but, overall, mind maps were better structured than those for the Amenities task. Children generally were grouping the content into branches rather than creating association stars.This could have been connected to the training given, where aspects of the school were used to construct a practice mind map. Some of these categories were then appropriate for the Brochure task and used in the mind maps produced.

The comparison between planning with mind maps and discussion showed no advantage for planning using a mind map, as judged by the writing quality. This could be seen to support Hayes' (1996) argument that it is not the planning technique that bestows a particular advantage but the time spent in considering the task. This was very similar for children planning through discussion or by making a mind map plan. Although there appeared to be no particular improvement in the quality of written work, the mind map planning had no detrimental effect on the subsequent writing. The mind map was a record that could be accessed by a teacher, to provoke intervention before the writing commenced or to be examined with the written work after the task.

Studies 5 and 6 also investigated mind maps as planning tools. This time the comparisons were between children planning together and those planning individually. The writing outcomes were very similar for children working in either condition; planning with a partner appeared to offer no advantage over planning as an individual.

In summary, planning with a mind map appeared to offer no measurable benefits to the novice writer over other strategies such as discussion. However, the planning produced in this way leads to a visible record of the process, which can be useful for teacher intervention at an early stage in the writing process. Improvements in children's written work take time; the holistic scoring system used may not be sensitive enough to quantify subtle changes because children are expected to progress one sub-level over a six to eight-month period. A closer examination of the relationships between mind map plan and written task was conducted to see how much of the mind map content was reproduced in the written task and how this related to the quality of the writing.

8.5 Is there a relationship between the structure or content of a mind map and the subsequent writing task?

The following sections look at the relationships between aspects of the mind map plan and the resulting written work.

8.5.1 Mind map structure

Studies 1 and 2 showed there was an impact on the structure of mind map produced depending on the written task. Study 1 showed no relationship between the quality of the writing and the level of structure on the mind map. In Y4 children were able to structure their mind maps increasingly well but this did not relate to the quality of the writing. The second task produced a majority of Level 3 mind maps, but these were used to plan one aspect of the written task, the character profile, rather than the whole narrative and the category headings were largely provided by the teacher. Y5 made generally well-structured mind maps when planning their Ideal Day and there was no relationship between quality of writing and the mind map structure.In both these cases there was little variation in the level of mind map produced.

In Y5's second task, mind maps had been adapted by the children to incorporate timelines for the complex narrative. This meant there was a wider variety of mind map level, but in many cases the narrative timelines introduced on to the mind map structure gave support for the writing task, although the mind map level was reduced as a consequence. This meant there was no relationship between mind map level and writing quality.

In Study 2, where there was a greater range of mind map produced, a relationship between better structured mind maps and writing quality emerged. Over both writing tasks, Amenities and Technology, better structured mind maps were related to better quality texts. The effect was more pronounced for the Amenities task where so many of the mind maps had been association stars.

The link between better structured mind maps and quality of writing remained evident in both Studies 5 and 6. The effect was stronger in Study 6, where again there was a greater variation in mind map level, as individuals tended to produce less structured mind maps than those working in the paired condition.

The results suggest that children who can organise their ideas into appropriate categories on a mind map will also be able to produce better texts. However, this is not always the case as much depends on the aspects of the writing that are planned in this way. The character profile produced by Y4 led to well-structured mind maps but was a small part of the writing task and did not necessarily relate to better written texts. Some well-structured mind maps directly lead to a paragraph structure, as in EB's written work (see figure 5.14), but others rely on a different organisational strategy once writing commences, as in JF's work, (figure 5.15).

8.5.2 Mind map connections

One aspect of the relationship between mind maps and writing is the presence of categorised structure, as previously discussed. Another aspect is the quantity of content as represented by the number of connections populating the mind map. In Study 1, for children in Y4 there was no correlation between numbers of connections and writing quality. This could be explained by the fact that many of the mind maps created for the first task were not completed and the children were still becoming familiar with the representation. This was also true for the second task for Y4.This task was linked to planning a character and many of the connections would not necessarily be used in the resulting narrative.

There was a different pattern for the tasks completed by Y5. These tasks showed a positive correlation between writing quality and the number of connections. Both mind maps were plans for the overall writing task rather than any one specific component. In these two tasks children populating their mind maps with more material were also likely to produce better quality texts.

This positive correlation continued to be evident in Study 2. There was a correlation between the number of mind map connections and better written texts. This was true for both the Amenities and the Brochure writing task. Studies 5 and 6 showed similar patterns. Children who could generate more content on the mind map were also more likely to write better texts.

Study 3 had found the use of text boxes useful in supporting the generation of content, and this was continued in Study 5 where children created lists before making a mind map. Collaboration was found to support productivity, which again was evident in both Studies 5 and 6. Paired work, either following an inductive procedure where lists of content are developed or through collaboration with computer software, appeared to assist the generation of content.

The results suggest that mind map plans are indicative of aspects of the written task. Fewer connections are linked to poorer outcomes in many cases. Problems related to content generation would be visible at the planning stage, when an intervention by the teacher or the support of a peer could prove effective.

8.5.3 Similarities in content between mind map and writing task

The relationship between mind map and written task was also investigated by tracking the mind map content to the written task. This shows the possible links between the two representations and allows a judgment to be made on how much influence one representation appears to have on the other. In order to do this, concepts present on the mind map as connections were traced through to the written task. The term given to both was 'items' and these were counted. Items in common were judged to be the same concept appearing on the mind map as a connection and in the written text. These items varied widely; some could represent topics such as 'wildlife area', while others could be examples such as 'pond'. Occasionally close paraphrases could be used and here judgments had to be made. In practice, the items appearing on both mind map and in the written text were not difficult to track as they tended to be very close and agreement with a second marker was very high.

In the exploratory study there had been an investigation of how much content transferred to the writing by a calculation involving the number of branches used in the written text. This was not a particularly sensitive measure and only the Y4 task writing about a character showed any correlation between branches used and writing quality. Study 2 investigated content in more detail by looking at the similarity in items present on both mind map and the written text. Fort both tasks, Amenities and Brochure, there was a positive correlation between the items transferred from mind map to written text and writing quality. Children who tended to be better writers were able to generate appropriate content on their mind map plan.

There were similar findings in Studies 5 and 6. Children who were writing better texts had more items in common between their mind map plan and their written text. However, in these two studies, better writing was also correlated with items present on the mind map but missed from the text and novel items produced during the writing process. Children working collaboratively in these two studies generated more content and had a greater fund of content from which to choose. It is also not surprising that better writers are able to create relevant content as the writing task proceeds.

The results showing similarity between the items on the mind map and the written task is a useful indication that the mind map plan has a strong relationship to the subsequent written task. It is also suggested that better writers tend to include more from the original plan. This can be useful for a teacher monitoring children's progress. Individual children's work can also provide a model for peers to gain more expertise in the planning process.

8.6 Planning and writing

The evidence gathered through the four studies that particularly look at mind maps and written texts suggests that children are engaged in a planning process when they construct their mind maps. The changes in the mind map form, the varying levels of structure and adaptations made show that the construction of the mind map is made with view to the subsequent writing task. There is a recognisable level of transfer from the mind map to the written task and this shows a correlation with better writing in a quarter to a third of cases. Children who can generate larger quantities of content, shown as mind map connections, also tend to write better texts.

Children who were better writers had the ability to think through their intended text in some detail before writing commenced. The mind map was a record of this, but may not have necessarily provided a transformational thinking space, or a useful extension of memory (Scaife & Rogers, 1996). At this level of writing, texts are relatively short and more able children are capable of holding the main features of their text in mind before and during the writing process. Less able writers may have used the plan more, but children making reference to the mind map as they wrote were rare. J appeared to be the only child to have systematically marked his mind map plan as he wrote his text.

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Writing remains a very complex and challenging task (Torrance, 2007; Flower & Hayes, 1981) and the children's writing produced in these studies shows that once involved in transcription a variety of strategies emerge. In Studies 2 and 5, many scripts used a 'virtual tour' approach to describing the school grounds. In other cases, such as JC's work, figure 7.11, the original mind map had very little connection to the written task, as the writer became more concerned with telling news she found more significant to her friend. Children planning together (figure 7.14) could go on to produce very differently organised written tasks.

There was a tendency to produce texts that had a list-like format. This was the case in Studies 2, 5 and 6, where the weaker texts continued to make lists of items rather than embedding them in a more interesting context using a greater variety of cohesive ties. Better texts not only described items in the school or the impact of technology, but gave emotional responses or explanations. Mind maps can be seen as having a tendency to encourage the default list structure in children's work, which weaker writers continue to use. This tendency not to develop clear links between items was seen in the work of older students using diagrams rather than outlines (Piolat & Roussey, 1996). The requirement to work with keywords on the mind map may add to this tendency, where concepts are expressed in short phrases and weaker writers transfer these without developing their ideas further.

This planning technique offers some advantages but would need to be one of a number of possible options available to children. It was also clear that there were individual differences and that some children across the 7–11 age range were more able to plan ahead than others. Showing children the underlying structure of non-fiction texts, as Meyer (1982) suggests, could add to the understanding of this planning technique to be used in children's own work. The writing process remains a complicated one. Content generation and organisation can be provided by mind maps but the quality of written work needs more than this. Children who wrote well were orchestrating many skills, including being able to consider their audience and use literary devices, aspects which would not necessarily be charted on a mind map.

8.7 Implications of studies

The following two sections will consider the implications for theory and practice of the findings presented.

8.7.1 Implications for theory

Children taking part in these studies were able to construct and make use of mind maps. With some structured support, primary aged children, 7-11 years, could construct mind maps which included categorisation and keywords. There was not a steady course of improvement with either experience or maturity on the ability to produce well-structured representations. The differences in mind maps resulting from these studies had more to do with the task environment than with the maturity or experience of the participants.

Children were quick to understand the visual aspects of the mind map structure, but the underlying semantic structure proved more difficult to assimilate. This relates to research into argument diagrams, where the visual aspect of the diagram is understood,, but the representation is not used as a basis for deeper discussion (Munneke et al. 2007). The mind map form in these studies was adapted by children to fulfil a perceived need, rather than appearing to structure a particular thought process or work as a 'mindtool' (Jonassen et al., 1998). The apparent difficulties children had over categorisation also depart from the concept of the mind map form being implicitly 'natural' (Buzan, 2000).

8.7.2 Implications for practice

Introducing mind maps into the primary school curriculum was judged to have a number of advantages. It proved to be a popular way of representing ideas with the children, who were happy to produce these diagrams as plans for writing or as alternative forms of presenting information. The advantage being the relatively small amount of transcribing involved in representing a relatively large amount of information. Children enjoyed embellishing their mind maps with pictures and using a range of coloured pens to identify the different branches. The software package, *Freemind* was also well-received and had the advantage of being editable and producing a polished final draft. This was a particular advantage for children whose presentation skills were still developing. Children remained happy to construct these diagrams and there was evidence of children spontaneously using mind maps as planning tools for written work when given choice about planning strategies once the studies had ben completed.

Children did engage in a planning process. As the finding reported show the finished mind maps did not consistently support the structure of a written text by organising potential content, but children were engaged in spending time considering the content about to be presented. The similarity between mind map connections and ideas in the written texts could inform a teacher's intervention before the transcription phase conmmenced.

In order to achieve more from this planning procedure the children needed to have continuing and more explicit instruction in how the mind map plan could inform a written task. Examples of children's work where the plan and writing showed the benefits of prior organsisation, such as EB's (figure 5.13) and SR's (figure 7.14) were relatively rare. More specific modelling of the process would be needed with possibly a staged approach using pre-constructed headings for some children. There might also need to be more experience in using the representation together with analysis of existing text structures before children become adept.

A number of successful strategies to support the construction of mind maps have been identified. These can be procedural – encouraging children to make initial lists before deciding on categories, the use of artefacts such as text boxes and templates and social – collaborative work including the use of computer software.

Children's writing at this stage of education tends to be relatively short, but learning to plan simple texts at this stage may prove a useful foundation for later work, when expectations are for longer and more challenging written texts.

8.8 Limitations of the studies and directions for further research

These studies took place in one school context and investigations with other school populations would be necessary to generalise the findings more widely. The researcher was also a member of staff which may have had an impact on the results, though every effort was made to check data and coding procedures. In introducing any intervention there is a danger of the Hawthorne effect (Cohen et al., 2007), which may work to influence the results. In this case children were aware the work was being used for a research project, which could have influenced their motivation in positive or negative directions.

Written tasks were short. Most written tasks in primary school tend to have a defined time frame owing to the requirements of national testing, but some tasks do take place over longer periods. Looking at the impact of planning on longer tasks may have shown more positive results. This might have come closer to answering whether there was any causal link between better mind maps, judged by structure or richness of content and a written text.

In addition general ability appeared to be a strong indicator of how well a child could write and produce a well-structured mind map. Work using a bigger sample of children would be necessary to control for this and to assess if the mind map could influence the production of better written texts.

Questions remain about the thinking process involved in constructing a mind map. To analyse this process would involve a different set of methods, perhaps the use of thought protocols or individual interviews. The effect collaboration has on the planning process could also be investigated in more detail. Discourse analysis could be used to investigate the process of collaboration to add to the outcomes reported in this thesis.

8.9 Concluding words

This study has engaged me in an investigation which started with a naïve ambition to improve children's writing by the use of a graphical representation, recommended to practitioners from a variety of sources. The ensuing journey of discovery has increased my knowledge of how people learn, and the role representations play in that learning process, methods of analysis and planning. I have discovered, on a personal level, a lack of planning ability, but a talent for revision which can compensate for this shortcoming. The outcome of this research is not the simple answer I may have hoped to find, but a more sophisticated understanding of children's learning and a great deal of sympathy for anyone involved in the process of composing written text.

Appendix 1 Mark scheme designed by Derbyshire Literacy Team

	1C	1B	1A	2C
Phonics and spelling	Uses recognisable letters/words to convey meaning.	As 1C plus Writes recognisable words. Spells familiar CVC words and common irregular words from list 1 in NLS framework.	As 1B plus Can segment to spell words containing consonant clusters in initial and final position.	Can segment to spell words containing vowel phonemes (digraphs).Spells common irregular words from List 1. Alternative spellings show a reliance on phonic strategies.Some recall of visual strategies.
Handwriting	Some commonly used letters are correctly orientated bu may be inconsistent in size and orientation.	Most letters are clearly shaped and orientated. Size becoming more consistent. Forms upper and lower case letters with some control	Upper and ;lower case letters are clearly shaped and correctly orientated. Forms lower case letters correctly in a script that will be easy to join later.	Begins to use basic handwriting joins.
Style: Language effect		Begins to use some story language.	Some choices of appropriate vocabulary.	Some appropriate use of words related to the subject of the writing. Word choices effective.
Style:Sentence Construction	Begins to write simple sentences	Writes some phrases and simple statements to communicate ideas.	Writes phrases and simple statements to convey ideas. Writes simple sentences independently. Can write questions and statements appropriately.	Writes simple sentences using some prepositions. Individual ideas are developed in short sections. Communicates meaning beyond a simple statement.
Punctuation	Recognises full stops and capital letters when reading and names them correctly	Begins to show understanding of how full stops are used.	Makes some use of full stops and capital letters.	Some evidence of full stops and capital letters to demarcate units of meaning. Begins to use question mark.
Purpose and Organisation	Makes marks or symbols to communicate meaning. Shows awareness that marks or symbols convey meaning. Shows awareness of different purposes of writing.	As 1C plus Structures simple words and phrases to communicate ideas. Writes simple captions and labels.	As 1B plus Writes simple recount or narrative.	Uses narrative or non narrative structure but may not be sustained. Texts can be re-read.
Process	Thinks about wht to write ahead of writing. Uses own experiences as a basis for writing	As 1C plus Uses language and structures from reading when writing.	As 1B plus Begins to orally rehearse sentences before writing and re-reads during and after writing.	Orally rehearses sentences before writing. Spots errors.

Appendix 1 Mark scheme designed by Derbyshire Literacy Team

	2B	2A	3C	3B
Phonics and spelling	As 2C plus Knows main choices for each vowel phoneme. Uses awareness of visual patterns and recall of letter strings. Phonetically plausible attempts to reflect growing knowledge of whole word structure.	As 2B plus Accurate spelling of common monosyllabic words. Spells two syllable words including some words with prefixes and suffixes. Plausible attempts at longer polysyllabic words. Begins to use apostrophe for omission. Can spell all words from list 1 NLS.	Attempts to spell unfamiliar words using a range of strategies including phonemic, morphemic and etymological. Uses apostrophe for omission. Spells words containing common prefixes and suffixes. Spells words from list 2.	As 3C plus Distinguishes spelling of common homophones.
Handwriting	Shows use of basic handwriting joins in independent writing. Application of joins inconsistent.	Uses 4 basic handwriting joins with confidence in independent work.	Handwriting is joined and legible.Consistency in size and proportion of letters.	Develops fluency, speed and legibility through practice.Consistency in spacing of words.
Style: Language effect	Considers and selects from alternative word choices. Word choices are sometimes ambitious	Uses appropriate and interesting vocabulary. Links ideas or events clearly.Gives detail to engage the reader.	Conveys meaning clearly through appropriate choice of vocabulary and style of writing. Uses simple adjectives or adverbs appropriately to add interest to the writing.	Uses interesting vocabulary; varies use of adjectives and verbs for impact.Selects nouns to be specific. Some words or phrases are particularly well- chosen for interest or precision.
Style: Sentence Construction	Begins to use conjunctions to form compound sentences and simple subordinators – when, if, because.Variation is evident in sentence structure.	As 2B plus uses sentence models from text to support own writing. Use of simple subordinators – if, so, while, though, since.	Moving away from simple spoken language structures. Variety of sentence structure including simple, compound, and some complex sentences.	As 3C plus grammatical structure of sentences usually correct. Begins to use relative clauses. Sequences of sentences extend logically.
Punctuation	Evidence of capital letters, full stops and where appropriate question marks. Beginning to use commas in a list.	Growing understanding of punctuation used. Capital letters and full stops to mark correctly structured sentences. Use of commas in lists.	Punctuation is used to mark sentences accurately – full stops etc. Beginning to use speech marks. Beginning to use punctuation within the sentence. Beginning to use apostrophe for possession.	As 3C plus use of apostrophe for possession.
Purpose and Organisation	As 2C plus Narrative or non-narrative structure shows some consistency. Evidence of text cohesion through connectives and some use of consistent tense and person. Sufficient detail to engage the reader and organisation reflects the purpose of the writing.	As 2B plus narrative or non-narrative writing uses structure of chosen form consistently. Shows awareness of reader and holds readers interest.	Communicates meaning in a lively way. Meaning beginning to be organised and clear. Consistent use of 1st or 3rd person and tense. Range of connectives used to signal time. Some signs of adaptation for audience. Beginning to use paragraphs. Ending defined.	As 3C plus meaning is organised and clear. Main features of form in most cases used appropriately. Detail sustains interest.

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Process	As 2C plus Re-reads during writing, identifies where improvements might be made and begins to make some adaptations.	As 2B plus Begins to mentally rehearse writing and cumulatively re-read making adaptations and corrections. Writes initial jottings, notes and ideas before writing.	Is able to improve own writing and correct errors. Mentally rehearses and re-reads writing. Uses different planning formats	As 3 C plus mentally rehearses and re-reads as a matter of habit. Eits in relation to audience and purpose.

Appendix 1 Mark scheme designed by Derbyshire Literacy Team

	3A	4C	4B	4A
Phonics and spelling	As 3B plus Use the apostrophe accurately for words ending in s	Spells the words from List 2. Has strategies for spelling unstressed vowels in polysyllabic words. Spells words with complex prefixes and suffixes.	As 4C plus Spelling including that of polysyllabic words that conform to regular patterns is generally accurate.	As 4B plus Begins to apply knowledge of spelling rules and exceptions
Handwriting	Use joined handwriting for all writing. Selects appropriate forms of handwriting as and when required.	Letters are always accurately formed and consistent in size.	Ascenders and descenders are in proportion and predominantly parallel.	Handwriting fluent, joined and legible. Developing own style.
Style: Language effect	Uses adjectives, adverbs and powerful verbs selectively. Uses terminology appropriate to text type.	Uses phrases and vocabulary to engage the reader and appropriate grammatical features. Word choices are adventurous and are chosen for effect.	Uses language precisely and selectively in relation to text type. Vocabulary is varied and appropriate including use of technical and specific words to enhance precision and economy.	Uses powerful verbs to show character or add impact. Precise use of language conveys effectively the writer's intended meaning.
Style: Sentence Construction	As 3B plus Writes complex sentences, selecting and using a wide range of subordinators. Adds phrases to enhance meaning.	Writes complex sentences using subordinate clauses to add information give reasons and explain. Selects appropriate word order in sentences to create interest and to increase precision. Uses direct and reported speech effectively.	As 4C plus complex sentences are used to achieve different effects. Begins to use the conditional sentences and the passive tense.	As 4B plus has control of complex sentences
Punctuation	As 3B plus Punctuation reliable and accurate. Beginning to use colon and semi-colon, dashes and hyphens where appropriate.	As 3A plus Uses colons and semi-colons, dashes and hyphens where appropriate. Evidence of correct use of commas to show divisions between phrases and clauses and items in a list.	As 4C plus using apostrophe for omission and possession accurately. Uses punctuation effectively to signpost meaning in longer and more complex sentences.	As 4B plus uses punctuation accurately in complex sentences.
Purpose and Organisation	As 3B plus Main features of form used appropriately Adapted to audience. Beginning of logical organisation. Uses paragraphs to structure writing.	Writing in a range of forms is lively and thoughtful. Ideas are sustained and developed. Uses pronouns and tenses accurately Uses a range of connecting words and phrases appropriately in different text types. Organised for the purpose of the reader. Paragraphs used to structure writing logically.	As 4C plus writing demonstrates appropriate pace.	As 4B plus Writing is coherent, well paced and balanced.

Process	As 3B plus Justifies choices when editing. Maps text structures and lines of development.	Reviews and edits writing to produce final form, matched to the needs of an identified reader. Plans quickly and effectively, including the conclusion or ending.	Refines own writing and evaluates work.	Discusses and selects appropriate style and form to suit specific purpose and audience, drawing on knowledge of different texts.

References

Abi, E. M. I., & Adb, E. K. F. (2008). The Influence of Mind Mapping on Eighth Graders' Science Achievement. *School Science and Mathematics, 108*(7), 298-312.

Ainsworth, S. (2006). DeFT: A Conceptual Framework for Considering Learning with Multiple Representations. *Learning and Instruction, 16*(3), 183-198.

Alvermann, D. E. (1981). The compensatory effect of graphic organizers on descriptive text. *The Journal of Educational Research, 75*(1), 44-48.

Alvermann, D. E., & Boothby, P. R. (1986). Children's transfer of graphic organizer instruction. *Reading Psychology, 7*(2), 87-100.

Anderson, G. L. (2002). Reflecting on Research for DoctorReferncesal Students in Education. *Educational Researcher, 31*(7), 22-25.

Andrews, R., Torgerson, C., Low, G., McQuinn, N., & Robinson, A. (2006). *Teaching argumentative non-fiction writing to 7-14 year olds: a systematic review of the evidence of successful practice*. London: EPPI- Centre, Social Science Research Unit, Institute of Education, University of London.

Andriessen, J., Baker, M., & Suthers, D. (2003). *Arguing to learn: Confronting cognitions in computer-supported collaborative learning environments*: Springer Netherlands.

Andriessen, J. E. B. (2006). Arguing to Learn. In K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences*. Cambridge: Cambridge University Press.

Applebee, A. N. (1978). *The Child's Concept of Story - Ages Two to Seventeen*. Chicago and London: University of Chicago Press.

Armbruster, B., Anderson, T., & Meyer, J. (1991). Improving Content Area Reading using Instructional Graphics. *Reading Research Quarterly, 26*(4), 393-416.

Armbruster, B. B., Anderson, T. H., & Ostertag, J. (1987). Does text structure/summarization instruction facilitate learning from expository text? *Reading Research Quarterly, 22*(3), 331-346.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1968). *Educational psychology: A cognitive view*: Holt, Rinehart and Winston New York.

Azevedo, R., Cromley, J. G., & Seibert, D. (2003). Does adaptive scaffolding facilitate students' ability to regulate their learning with hypermedia? . *Contemporary Educational Psychology, 29*, 344-370.

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. *The psychology of learning and motivation, 8*, 47-90.

Barab, S., & Squire, K. (2004). Design-Based Research:Putting a Stake in the Ground. *The Journal of Learning Sciences, 13*(1), 1-14.

Barron, B. (2003). When Smart Groups Fail. *Journal of the Learning Sciences, 12*(3), 307 - 359.

Baumann, J. F., & Bergeron, B. S. (1993). Story map instruction using children's literature: Effects on first graders' comprehension of central narrative elements. *Journal of Literacy Research, 25*(4), 407-437.

Beard, R. (2000). *Developing Writing 3-13*. London: Hodder and Stoughton.

Bell, M., Cordingley, P., Isham, C., & Davis, R. (2010). *Report of Professional Practitioner Use of Research Review: Practitioner engagement in/or with research*. Coventry: Curee, GTCE, LSIS, NTRP.

Bell, P., Koschmann, T., Hall, R., & Miyake, N. (2001). Using argument map representations to make thinking visible for individuals and groups. *CSCL 2: Carrying Forward the Conversation*, 449–485.

BERA (Ed.). (2004). *Revised Ethical Guidelines for Educational Research 2004*. Southwell UK: BERA.

Bereiter, C., & Scardamalia, M. (1985). Cognitive coping strategies and the problem of "inert knowledge.". In L. B. Resnick (Ed.), *Thinking and learning skills: Research and open questions* (Vol. 2, pp. 65-80). Hillsdale NJ: Lawrence Erlbaum Associates.

Bereiter, C., & Scardamalia, M. (1987). *The Psychology of Written Composition*: Lawrence Erlbaum Associates Inc.

Blatchford, P., Kutnick, P., Baines, E., & (2007). *Pupil grouping for learning in classrooms: Results from the UK SPRinG Study*

Paper presented at the American Educational Research Annual Meeting.

Brehony, K. J. (2005). Primary schooling under New Labour: The irresolvable contradiction of

excellence and enjoyment. *Oxford Review of Education, 31*(1), 29-46.

Brown, A. L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *Journal of the Learning Sciences, 2*(2), 141 - 178.

Burtis, P. J., Bereiter, C., Scardamalia, M., & Tetroe, J. (1983). The Development of Planning in Writing. In B. M. Kroll & E. Wells (Eds.), *Explorations in the Development of Writing* (Vol. 1, pp. 153-174). Chicester: Wiley, J.

Buzan, T., & Buzan, B. (2000). *The Mind Map book* (Millennium ed.). London: BBC Worldwide Limited.

Calkins, L. M. C. (1986). *The Art of Teaching Writing*: Heinemann Educational Books Inc., 70 Court St., Portsmouth, NH 03801 ($16.00).

Caviglioli, O., & Harris, I. (2000). *Mapwise Accelerated Learning through Visible Thinking* (1st ed.). Stafford: Network Educational Press.

Caviglioli, O., Harris, I., & Tindall, B. (2002). *Thinking Skills and Eye Cue*. Stafford: Network Educational Press.

Chang, K., Sung, Y., & Chen, I. (2002). The Effect of Concept Mapping to Enhance Text Comprehension and Summarization. *The Journal of Experimental Education, 71*(1), 5-23.

Chmielewski, T. L., Dansereau, D. F., & Moreland, J. L. (1998). Using common region in node-link displays: the role of field dependence/independence. *The Journal of Experimental Education, 66*(3), 197-207.

Christie, F. (1989). *Curriculum genre in early childhood education : a case study in writing development*. Unpublished Doctoral, Sidney, Sidney.

Cochran-Smith, M., & Lytle, S. L. (1999). The Teacher Research Movement: A Decade Later. *Educational Researcher, 28*(7), 15-25.

Cohen, L., Manion, L., & Morrison, K. R. B. (2007). *Research methods in education*: Psychology Press.

Collerson, J. (1988). *Writing for Life*. Newtown, NSW: PETA.

Cope, B., & Kalantzis, M. (Eds.). (1993). *Powers of Literacy: a genre approach to teaching writing*. London: Falmer Press.

Cox, R. (1999). Representation construction, externalised cognition and individual differences. *Learning and Instruction, 9*(4), 343-363.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage Publications, Inc.

Crook, C. (1994). *Computers and the Collaborative Experience of Learning*. London New York: Routledge.

Dansereau, T., & Moreland, J. L. (1998). Using Common Region in Node-Link Displays: the Role of Field Dependence/Independence. *Journal of Experimental Education, 66*(3), 197-207.

De La Paz, S. (1999). Self-Regulated Strategy Instruction in Regular Education Settings: Improving Outcomes for Students With and Without Learning Disabilities. *Learning Disabilities Research & Practice, 14*(2), 92 - 106.

Deneault, J., & Ricard, M. (2005). The effect of hierarchical levels of categories on children's deductive inferences about inclusion. *International Journal of Pyschology, 40*(2), 65-79.

Desforges, C. (2004). *Powerful questions and significant impact*. Paper presented at the Teachers' Research Conference.

DfEE. (1998). *The National Literacy Strategy: Framework for Teaching*. London: DfEE.

DFEE/QCA. (1999). *The National Curriculum: Handbook For Primary Teachers In England*. London: HMSO.

DfES. (2006). *Primary Framework for Literacy & Numeracy*. London: DfES.

Dillenbourg, P. (1999). What do you mean by 'Collaborative Learning'? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches*. (pp. 1-19). Oxford: Elsevier.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three Worlds of CSCL: Can we support CSCL* (pp. 61-91). Heerlen: Open Universiteit Nederlands.

diSessa, A. A. (2004). Metarepresentation: Native Competence and Targets for Instruction. *Cognition and Instruction, 22*(3), 293 - 331.

Duffy, T. M., & Jonassen, D. H. (1992). *Constructivism and the technology of instruction: A conversation*: Lawrence Erlbaum.

Dunston, P. J. (1992). A Critique of Graphic Organizer Research. *Reading, Research and Instruction, 31*(2), 57-65.

Earl, L., Watson, N., Levin, B., Leithwood, K., Fullan, M., & Torrance, N. (2003). Watching and learning 3: Final report of the external evaluation of England's national literacy and numeracy strategies. *Toronto: Ontario Institute for Studies in Education, University of Toronto.*

Erkens, G., Jaspers, J., Prangsma, M., & Kanselaar, G. (2005). Coordination processes in computer supported collaborative writing. *Computers in Human Behavior, 21*(3), 463-486.

Field, A. (2005). Discovering Statistics Using SPSS Thousand Oaks, CA: Sage Publications.

Fischer, F., & Mandl, H. (2005). Knowledge Convergence in Computer-Supported Collaborative Learning: The Role of External Representation Tools. *The Journal of the Learning Sciences, 14*(3), 405-441.

Flower, L. S., & Hayes, J. R. (1981). Plans that guide the composing process. In C. H. Frederickson, M. F. Whiteman & J. F. Dominic (Eds.), *Writing: the nature of development and teaching of written communication* (Vol. 2). Hillsdale NJ: Erlbaum.

Frankfort-Nachmias, C., & Nachmias, D. (2007). *Research Methods in the Social Sciences Study Guide*: Worth Pub.

Gallagher, M., & Pearson, P. D. (1989). *Discussion, comprehension, and knowledge acquisition in content area classrooms*: Beranek and Newman.

Garadill, M. C., & Jitendra, A. K. (1999). Advanced Story Map Instruction: Effects on the Reading Comprehension of Students with Learning Disabilities. *The Journal of Special Education, 33*(1), 2-17.

Gardner, H., & Hatch, T. (1989). Educational Implications of the Theory of Multiple Intelligences. *Educational Researcher, 18*(8), 4-10.

Graham, S., & Harris, K. (2000). The Role of Self-Regulation and Transcription Skills in Writing and Writing Development. *Educational Psychologist, 35*(1), 3 - 12.

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*(3), 445.

Graves, D. H. (1983). *Writing: Teachers and Children at Work*: Heinemann Educational Books, 4 Front St., Exeter, NH 03833 ($10.00).

Green, T. R. G. (1989). Cognitive dimensions of notations. *People and computers V*, 443-460.

Greene, T. (1994). What Kindergartners Know about Class Inclusion Hierarchies. *Journal of Experimental Child Psychology, 57*, 72-88.

Guastello, F., Beasley, M., & Sinatra, R. (2000). Concept Mapping Effects on Science Content Comprehension of Low-Achieving Inner-City Seventh Graders. *Remedial and Special Education, 21*(6), 356-364.

Halliday, M. A. K. An Introduction to Functional Grammar. 1985. *London: Edward Arnold.*

Harris, K. R., & Graham, S. (1996). *Making the writing process work: Strategies for composition and self-regulation*. Cambridge Massachusetts: Brookline Books.

Harrison, C., Comber, C., Fisher, T., Haw, K., Lewin, C., Lunzer, E., et al. (2002). *ImpaCT2: the impact of information and communication technologies on pupil learning and attainment.* . Coventry: Department for Education and Skills.

Hayes, J. R. (1996). A new model of cognition and affect in writing. *The science of writing. Hillsdale, NJ: Lawrence Erlbaum.*

Hayes, J. R., & Flower, L. S. (1980). Identifying the Organisation of Writing Processes. In L. W. Gregg & E. R. Steinberg (Eds.), *Cognitive Processes in Writing* (pp. 3-30). New Jersey: Lawrence Erlbaum Associates.

Hendry, H. (2009). *A study of primary PGCE trainees developing pedagogy for children learning English as an additional language*. England.

Holly, C. D., & Dansereau, D. F. (1984). *Spatial learning strategies: Techniques, applications, and related issues.* Orlando FL: Academic Press.

Horan, P. (2002). *A new and flexible graphic organiser for IS learning: The Rich Picture.* Paper presented at the Informing Science conference & IT Education Conference, Cork, Ireland

Horton, P. B. (1993). An Investigation of the Effectiveness of Concept Mapping as an Instructional Tool. *Science Education, 77*(1), 95-111.

Irani, P., Tingley, M., & Ware, C. (2001). Using perceptual syntax to enhance semantic content in diagrams. *IEEE Computer Graphics and Applications, 21*(5), 76-85.

Isnard, N., & Piolat, A. (1993). The effects of different types of planning on the writing of argumentative text. In G. Eigler & T. Jechle (Eds.), *Writing Current Trends in European Research* (pp. 121-132). Freiburg: HochschulVerlag.

Johnson, D. W., & Johnson, R. T. (1987). *Learning together and alone: Cooperative, competitive, and individualistic learning* (2nd ed.). New Jersey: Prentice-Hall.

Jonassen, D. H., Beissner, K., & Yacci, M. (1993). *Structural knowledge: Techniques for representing, conveying, and acquiring structural knowledge*: Lawrence Erlbaum.

Jonassen, D. H., Carr, C., & Yueh, H.-P. (1998). Computers as Mindtools for Engaging Learners in Critical Thinking. *TechTrends, 43*(2), 24-32.

Kellogg, R. T. (1988). Attentional overload and writing performance: Effects of rough draft and outline strategies. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 14*(2), 355-365.

Kinchin, I. M., & Hay, D. B. (2000). How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. *Educational Research, 42*(1), 43-47.

King, B. M., & Minium, E. W. (2003). *Statistical reasoning in psychology and education*: John Wiley & Sons Inc.

Kozma, R. B. (1991). The Impact of Computer-Based Tools and Embedded Prompts on Writing Processes and Products of Novice and Advanced College Writers. *Cognition and Instruction, 8*(1), 1 - 27.

Kress, G., & Knapp, P. (1992). Genre in a social theory of language. *English in Education, 26*(2), 4-15.

Kress, G. R., & Van Leeuwen, T. (2006). *Reading images: The grammar of visual design*. London & New York: Routledge.

Kulhavy, R. W., & Stock, W. A. (1996). How Cognitive Maps are Learned and Remembered. *Annals of the Association of American Geographers, 86*(1), 123-145.

Lambiotte, J. G., & Dansereau, D. (1992). Effects of Knowledge Maps and Prior Knowledge on Recall of Science Lecture Content. *The Journal of Experimental Education*

60(3), 189-201.

Larkin, J., & Simon, H. (1987). Why a Diagram is (Sometimes) worth Ten Thousand Words. *Cognitive Science, 11*, 65-99.

Leat, D., & Higgins, S. (2002). The role of powerful pedagogical strategies in curriculum development. *Curriculum Journal, 13*(1), 71 - 85.

Levy, M. C., & Ransdell, S. (Eds.). (1996). *The Science of Writing: Theories, Methods, Individual Differences and Applications*. New Jersey: Lawrence Erlbaum Associates.

Lewis, M., & Wray, D. (1996). Writing frames Scaffolding children's non-fiction writing in a range of genres. Retrieved 24/05/10, from http://hdl.handle.net/10068/418586

Lim, S. E., Cheng, P. W. C., Lam, M. S., & Ngan, S. F. (2003). Developing Reflective and Thinking Skills by Means of Semantic Mapping Strategies in Kindergarten Teacher Education. *Early Child Development and Care, 173*(1), 55-72.

Lohse, G. L., Biolsi, K., Walker, N., & Rueter, H. (1994). A classification of visual representations. *Commun. ACM, 37*(12), 36-49.

Lunzer, E., Gardiner, K., Davies, F., & Greene, T. (1984). *Learning from the Written Word*. Edinburgh: Oliver and Boyd.

Mahlamaki, K. S., & Kallio, L. (2000). Integrating CD-ROM, Literacy and Writing into Vocational Education.

Mallett, M. (2003). *Early years non-fiction: a guide to helping young researchers use and enjoy information texts*: Routledge.

Malloy, T. E. (1987). Teaching Integrative Thought: Techniques and Data. Paper presented at the Annual Meeting of the Conference on College Composition and Communication. Atlanta from E-journal link

Margulies, N. (2002). *Mapping inner space: Learning and teaching visual mapping*: Zephyr Press, W, Tucson,.

Martin, J. R. (1985). *Factual Writing: exploring and challenging social reality*. Victoria: Deakin University.

Martin, J. R., & Rothery, J. (1980). Writing Project Report, 1980, 1981. *Working Papers in Linguistics, 1*.

Martin, J. R., & Rothery, J. (1986). What a functional approach to the writing task can show teachers about 'good writing'. *Functional approaches to writing: Research perspectives*, 241–265.

Mayer, R. (2001). *Multimedia learning*. New York: Cambridge University Press.

McAleese, R. (1998). The knowledge arena as an extension to the concept map: Reflection in action. *Interactive Learning Environments, 6*(3), 251-272.

McAleese, R., Grabinger, S., & Fisher, K. (1998). The knowledge arena as an extension to the concept map: Reflection in action. Interactive Learning Environments,. *Interactive Learning Environments, 6*(3), 251-272.

McCutchen, D. (1988). " Functional Automaticity" in Children. *Written Communication, 5*(3), 306-324.

McGuiness, C. (1999). *From Thinking Skills to Thinking Classrooms: a review and evaluation of approaches for developing pupil's thinking*: DfEE.

McKendree, J., Small, C., Stenning, K., & Conlon, T. (2002). The Role of Representation in Teaching and Learning Critical Thinking. *Educational Review, 54*(1), 57 - 67.

McNiff, J., Lomax, P., & Whitehead, J. (2003). *You and your action research project*: Routledge.

Medland, M. B. (2007). Tools for knowledge analysis, synthesis, and sharing. *Journal of Science Education and Technology, 16*(2), 119-154.

Mercer, N., Wegerif, R., & Dawes, L. (1999). Children's Talk and the Development of Reasoning in the Classroom. *British Educational Research Journal, 25*(1), 95-111.

Meyer, B. J. F. (1982). Reading Research and the Composition Teacher: The Importance of Plans. *College Composition and Communication, 33*(1), 37-49.

Miller, K. F. (2000). Representational Tools and Conceptual Change: The Young Scientist's Tool Kit. *Journal of Applied Developmental Psychology, 21*(1), 21-25.

Muijs, D. (2004). *Doing quantitative research in education with SPSS*: Sage Publications Ltd.

Munneke, L., Andriessen, J., Kanselaar, G., & Kirschner, P. (2007). Supporting interactive argumentation: Influence of representational tools on discussing a wicked problem. *Computers in Human Behavior, 23*(3), 1072-1088.

Nathan, N., & Kozminsky, E. (2004). *Text Concept Mapping: the contribution of mapping characteristics to learning from texts*. Paper presented at the First International Conference on Concept Mapping.

Naykki, P., & Jarvela, S. (2008). How Pictorial Knowledge Representations Mediate Collaborative Knowledge Construction in Groups. *Journal of Research on Technology in Education, 40*(3), 359-387.

Nesbit, J. C., & Adesope, O. O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research, 76*(3), 413.

Novak, J. D., & Canas, A. J. (2006). *The Theory Underlying Concept Maps and How to Construct Them*: Florida Institute for human and Machine Cognition.

Novak, J. D., & Gowin, B. (1984). *Learning How to Learn*: Cambridge University Press.

O'Donnell, A., Dansereau, D., & Hall, R. (2002). Knowledge Maps as Scaffolds for Cognitive Processing. *Educational Psychology Review, 14*(1), 71-86.

Ofsted. (2009). *English at the crossroads:an evaluation of English in primary and secondary schools, 2005/08*: Crown copyright.

Paivio, A. (1986). *Mental representations: A dual coding approach*

. Oxford: Oxford University Press.

Paivio, A. (1990). *Mental representations: A dual coding approach*: Oxford University Press, USA.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal Teaching of Comprehension-Fostering and Comprehension-Monitoring Activities. *Cognition and Instruction, 1*(2), 117 - 175.

Pearson, M., & Somekh, B. (2000). *Concept-mapping as a Research Tool: A Study of Primary Children's Representations of Information and Communication Technologies (ICT).* Cardiff, Cardiff.

Peterson, A. R., & Snyder, P. J. (1998). Using Mind Maps To Teach Social Problems Analysis.

Piolat, A., & Roussey, J.-Y. (1996). Students' Drafting Strategies and the Text Quality. *Learning and Instruction, 6*(2), 111-129.

Pitcher, E. G., & Prelinger, E. (1963). *Children tell stories; an analysis of fantasy*: International Universities Press.

Ralston, J., & Cook, D. C. (2007). Collaboration, ICT and Mind Mapping. *Reflecting Education, 3*(1), 61-73.

Reed, S. K. (2010). *Thinking Visually*. New York: Taylor & Francis.

Reutzel, D. R. (1985). Story maps improve comprehension. *The Reading Teacher, 38*(4), 400-404.

Riley, N. R., & Ahlberg, M. (2004). Investigating the use of ICT-based concept mapping techniques on creativity in literacy tasks. *Journal of Computer Assisted Learning, 20*, 244-256.

Robson, C. (2002). *Real World Research.* (Second ed.). Oxford: Blackwell Publishing.

Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *Journal of the Learning Sciences, 2*(3), 235-276.

Ruddell, R., & Boyle, O. (1989). A study of cognitive mapping as a means to improve summarization and comprehension of expository text. *Reading Research and Instruction, 29*(1), 12-22.

Salomon, G., & Perkins, D. N. (1998). Individual and Social Aspects of Learning. *review of Research in Education, 23*, 1-24.

Salzburg Ludwig, K. (2008). *Scholarly research on mind maps in learning by mentally retarded children.* Paper presented at the European Conference on Educational Research.

Scaife, M., & Rogers, Y. (1996). External cognition: How do graphical representations work?,. *International Journal of Human-Computer Studies,, 45*, 185-213.

Scardamalia, M., & Bereiter, C. (1991). Higher Levels of Agency for Children in Knowledge Building: A Challenge for the Design of New Knowledge Media *Journal of the Learning Sciences, 1.*

Schwartz, D. L. (1995). The Emergence of Abstract Representations in Dyad Problem Solving. [Psychology/ learning]. *The Journal of the Learning Sciences, 4*(3), 321-354.

Sharp, J., Byrne, J., & Bowker, R. (2008). The Trouble with VAK. *Educational Futures, 1*(1), 89-97.

Sharples, M. (1994). Computer Support for the Rhythms of Writing.

Shayer, M., Adey, P., & Venville, G. J. (2002). *Learning intelligence cognitive acceleration across the curriculum from 5 to 15 years*. Buckingham; Philadelphia: Open university press.

Sherin, B., Reiser, B. J., & Edelson, D. (2004). Scaffolding analysis: Extending the scaffolding metaphor to learning artifacts. *Journal of the Learning Sciences, 13*(3), 387-421.

Slavin, R., Sharon, S., Kagan, S., Lazarowitz, R. H., Webb, C., & Schmuck, R. (Eds.). (1985). *Learning to cooperate, cooperating to learn*. New York: Plenum Press.

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology, 21*, 43-69.

Smith, A., & Call, N. (2001). *The Alps Approach Resource Book: Accelerated Learning in Primary Schools* Stafford: Network Educational Press Ltd.

Snow, C. E., Hemphill, L., Barnes, W. S., Goodman, I. F., & Chandler, J. (1991). *Unfulfilled expectations: Home and school influences on literacy*: Harvard University Press Cambridge, Mass.

Spiro, R. J., Feltovich, P. J., Jacobson, M. I., & Coulson, R. L. (2005). Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced Knowledge Acquisition in Ill-Structured Domains.

Sturm, J. M., & Rankin-Erickson, J. L. (2002). Effects of hand-drawn and computer-generated concept mapping on the expository writing of middle school students with learning disabilities. *Learning Disabilities Research & Practice, 17*(2), 124-139.

Suthers, D. (2001). Towards a Systematic Study of Representational Guidance for Collaborative Learning Discourse. *Journal of Universal Computer Science, 7*(3), 254-277.

Suthers, D., & Hundhausen, C. D. (2003). An Experimental Study of the Effects of Representational Guidance on Collaborative Learning Processes. *Journal of the Learning Sciences, 12*(2), 183-218.

Suthers, D. D., & Hundhausen, C. D. (2002). The Effects of Representation on Students' Elaborations in Collaborative Inquiry. *Computer Support for Collaborative Learning: Foundations for a Cscl Community (Cscl 2002 Proceedings)*, 472.

Torrance, M., Fidalgo, R., & Garcia, J. N. (2007). The Teachability and Effectiveness of Cognitive Self-Regulation in Sixth-Grade Writers. *Learning and Instruction, 17*(3), 265-285.

Troia, G. A., Graham, S., & Harris, K. R. (1999). Teaching Students with Learning Disabilities to Mindfully Plan When Writing. *Exceptional children, 65*(2), 235-236.

van Amelsvoort, M. (2006). *A Space for Debate.How diagrams support collaborative argumentation-based learning.*

van Amelsvoort, M., Andriessen, J., & Kanselaar, G. (2008). How students structure and relate argumentative knowledge when learning together with diagrams. *Computers in Human Behavior, 24*(3), 1293-1313.

van Drie, J., van Boxtel, C., Jaspers, J., & Kanselaar, G. (2005). Effects of representational guidance on domain specific reasoning in CSCL. *Computers in Human Behavior, 21*(4), 575-602.

Veerman, A. L., Andriessen, J. E. B., & Kanselaaar, G. (2000). Learning through synchronous electronic discussion. *Computers and Education, 34*(1-2), 1-22.

Vekiri, I. (2002). What is the value of graphical displays in learning? *Educational Psychology Review, 14*(3), 261-312.

Venter, I. M., Blignaut, R. J., & Stoltz, D. (2001). Research Methodologies Explored for a Paradigm Shift in University Teaching. *South African Journal of Higher Education, 15*(2), 162-169.

Verdi, M. P., & Kulhavy, R. W. (2002). Learning with maps and texts: An overview. *Educational Psychology Review, 14*(1), 27-46.

Vygotsky, L. S., Vygotsky, L. S., & Cole, M. (1978). *Mind in society: The development of higher psychological processes*: Harvard Univ Pr.

Vygotsky, L. (1962). *Thought and Language*. Cambridge: M.I.T.

Webb, N., & Mastergeorge, A. (2003). Promoting effective helping behaviour in peer directed groups. *International Journal of Educational Research, 39*, 73-97.

Wheeldon, J. (2010). Mapping Mixed Methods Research: Methods, Measures, and Meaning. *Journal of Mixed Methods Research, 4*(2), 87-102.

Wiegmann, D. A., Dansereau, D. F., McCagg, E. C., Rewey, K. L., & Pitre, U. (1992). Effects of knowledge map characteristics on information processing. *Contemporary Educational Psychology, 17*(2), 136-155.

Wilson, R. (2003). *Strategies for Immediate Impact on Writing Standards*. Wakefield: Andrell Education.

Wing Jan, L. (1991). Write ways: Modelling writing forms. *South Melbourne, Vic.: Oxford University Press Australia*.

Wood, D., Bruner, J. S., & Ross, G. (1976). The Role of Tutoring in Problem Solving. *Journal of Child Psychology and Psychiatry, 17*(2), 89-100.

Wood, D., & O Malley, C. (1996). Collaborative learning between peers. *Educational Psychology in Practice, 11*(4), 4-9.

Wray, D., & Lewis, M. (1997). *Extending Literacy: children reading and writing non-fiction*. London and New York: Routledge.

Zhang, J. (1997). The nature of external representations in problem solving. *Cognitive Science, 21*(2), 179-217.

Zhang, J., & Norman, D. A. (1994). Representations in distributed cognitive tasks* 1. *Cognitive Science, 18*(1), 87-122.