“Inspiration, Concept Mapping and Inquiry: Supporting Higher Order Thinking for Year 7 and 8 Students.”

Kathryn Walrond

Thesis submitted in partial fulfillment of the requirements of the degree of Master of Teaching and Learning

Christchurch College of Education

September 2004
Acknowledgements

I want to thank Lindsey Conner and Sue Collins for their support and guidance throughout this study. I have appreciated their positive and constructive approaches and I have learnt so much from their combined wisdom.

I am grateful to the principal of Karori Normal School, Diane Leggett and the Board of Trustees who supported my application for a Study Award and granted me leave, allowing me to complete my Master of Teaching and Learning.

The four students who took part in this study were amazing. I am so grateful for their enthusiasm and feel privileged to have worked with them.

The class teacher involved in this study was fantastic to work with. I thank her for her flexibility and commitment to the project.

My brother Carl was an amazing field assistant. I am eternally grateful for his technical skills, his support during this project and his sense of humour.

My husband Carl and our little Possu have provided the inspiration and love that have made the completion of this project possible.
Table of Contents

1 Abstract ..............................................................................................................1

2 Literature Review ...............................................................................................3

2.1 A New Age, A New Way to Learn .................................................................4
2.2 Thinking Skills for Meaningful Learning ......................................................7
2.3 Facilitating the Teaching of Thinking Skills in the Cooperative Learning Environment .................................................................10
2.4 Mediation with Cognitive Tools .....................................................................14
2.5 Concept Maps as Mindtools for Meaningful Learning ..................................17
2.6 Concept Mapping and Higher Order Thinking (Metacognition) .....................23
2.7 Concept Mapping Research ............................................................................27
2.7.1 Summary of Findings ................................................................................30
2.8 Research Questions .........................................................................................30
2.8.1 Definition of Terms ..................................................................................31

3 Methodology .......................................................................................................33

3.1 The Case Study ...............................................................................................38
3.2 Access and Initial Contact .............................................................................39
3.3 Ethical Considerations ....................................................................................40
3.4 The Case ..........................................................................................................43
3.4.1 Selection of Participants ...........................................................................43
3.4.2 The Classroom Teacher ............................................................................45
3.4.3 The Students ............................................................................................46
3.4.4 Preparation ...............................................................................................46
3.5 Data Collection Procedures ...........................................................................46
3.5.1 Participant as Observer ............................................................................47
3.5.2 Semi-structured Interviews ......................................................................48
3.5.3 Document Analysis .................................................................................49
3.6 Analytic Strategies ..........................................................................................49

4 Teaching and Learning Activities ........................................................................52

4.1 Concept Mapping ............................................................................................52
4.2 Unit Structure ..................................................................................................52
4.3 Classroom Setup .............................................................................................53
4.4 Task Progression and Delivery .......................................................................54
4.5 Teacher Management .......................................................................................57

5 Analysis of Results .............................................................................................61

5.1 Managing Information .......................................................................................61
5.1.1 Linking Information ..................................................................................61
5.1.2 Information Monitoring ...........................................................................71
5.2 Managing the Task ..........................................................................................73
5.2.1 Activities and Assessment Sheet ..............................................................73
6 Discussion .................................................................................................................. 87

6.1 Year Seven and Eight students’ use of Inspiration and concept mapping when working in cooperative groups during the process of inquiry ........................................... 87
6.2 Inspiration, concept-mapping and higher order thinking ........................................... 92
6.3 Implications for Teaching and Learning .................................................................... 96
6.4 Recommendations for Future Teaching and Learning ............................................. 101
6.5 Future Research Possibilities ................................................................................ 103

7 Conclusion .................................................................................................................. 105

8 References .................................................................................................................... 108
Table of Figures

Figure 1  A Concept Map for Water showing some related concepts and propositions ................................................................. 19
Figure 2  Convergence of Multiple Sources of Evidence ................................................................. 50
Figure 3  Partial Student Concept Map (L4) ................................................................................. 63
Figure 4  Partial Student Concept Map (L2) ................................................................................. 67
Figure 5  Partial Student Concept Map (L1) ................................................................................. 71

Appendices

Letter of Permission - Principal .................................................................................................. Appendix A
Letter of Permission - Classroom Teacher ................................................................................. Appendix B
Explanatory Statement - Students ............................................................................................ Appendix C
Explanatory Statement - Parents ............................................................................................... Appendix D
Student Consent Form ............................................................................................................... Appendix E
Parental Consent Form ............................................................................................................... Appendix F
Strategies for Introducing Concept Mapping ........................................................................... Appendix G
Steps for Integrating Concept Mapping Software into the Classroom ....................................... Appendix H
Antarctica Unit Plan ................................................................................................................ Appendix I
Action Learning Stages ............................................................................................................ Appendix J
Antarctica Assessment Sheet ................................................................................................... Appendix K
Student Concept Maps ............................................................................................................ Appendix L (1-7)
Extended Abstract ..................................................................................................................... Appendix M
1 Abstract

This thesis discusses the effects of integrating concept mapping using the computer programme *Inspiration* into a cooperative inquiry unit. The research was undertaken as a case study, with four Year Seven and Eight students comprising the case study group.

The project examined how the students used concept mapping as part of the cooperative inquiry process. Higher order (metacognitive) learning outcomes of this integration were analysed. Implications and recommendations for future teaching and learning were also identified.

Findings demonstrated that while concept mapping, the students used the concept map as a Mindtool. Critical thinking was stimulated through the negotiation and ongoing adjustment of information links and organisation in the evolving concept maps.

One student demonstrated an aware level of metacognitive thinking during the concept mapping process. Three of the students demonstrated an aware level of as a result of questioning during post-unit interviews.

The case study group performed as a cooperative learning group throughout the inquiry. They demonstrated commitment to each other and to the group’s success. It is probable that well developed cooperative skills had a positive impact on the cooperative concept mapping process and the role of the concept map as a Mindtool for the group.
In this study the classroom teacher demonstrated trust in and had high expectations for the behaviour and learning of the students in the case study group. These students increasingly managed their own time and the necessary resources for completing the inquiry. They were often given choices about when and where to work and often worked unsupervised by the classroom teacher. The researcher refers to choice theory in suggesting effects of these contextual features on the behaviour and learning of the case study group were significant and warrant further investigation.
2 Literature Review

Due to rapid changes in society and the world, the focus within education is changing. In a world where there has been an information explosion a key focus within education has become managing information, not memorising facts (Speer-Cameron, 1992).

This change is occurring at governmental and administrative levels through policy and curriculum development. However such change must also be addressed with teachers and in classrooms.

Tools for managing information are critical elements of providing students with the skills to collect process and communicate information.

Concept mapping represents one response to a changing world and a changing view of education. Computer-based concept mapping is a cognitive tool that can be used in educational settings to enhance meaningful learning. "Concept maps are intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit" (Novak and Gowin, 1984, p. 15).

This literature review presents the background and rationale for adopting such approaches to teaching and learning now and in the future.
2.1 A New Age, A New Way to Learn

In New Zealand, the education system is futures-responsive, rather than past-driven (Slaughter, 1994) and therefore responds to the challenges of social and economic change. *The New Zealand Curriculum Framework* (Ministry of Education, 1993) presents one such response. Included in this document is the acknowledgement that “the curriculum must help students to be adaptable and to play their full part in this changing environment” (p. 28). Curriculum documents define the role educators should be playing in preparing students for change. However the ultimate responsibility for providing teaching and learning experiences that fulfill this role lies with schools and more specifically with classroom teachers.

In introducing the principles of the curriculum framework, the Ministry of Education (1993, p. 6) acknowledges that the formal, planned curriculum is only one factor amongst many influencing learning. Other factors include “classroom interaction patterns, access to resources, and the expectations, attitudes, and behaviour of family, teachers and peers.” In order to prepare students adequately for the future, teachers must address their own expectations, attitudes and behaviour, as these will have direct impact on the learning experiences of students in their classes.

In addition to educational frameworks and policy, response to rapid change in society has resulted in changes in educational pedagogy and practice. One such change has been the rise in popularity of constructivist perspectives and methods.
Speer Cameron (1992, p. 34) claims that the traditional classroom “no longer prepares children to be productive citizens in the global, technological society of the twenty-first century. Today's children live in a world in which the information explosion requires that citizens learn how to manage information, not memorize facts.” The New Zealand Ministry of Education, (1997) acknowledges this shift through the inclusion of the inquiry process as one of three processes in the Social Studies curriculum document. The overriding achievement objective for this process is that “Students will demonstrate skills as they collect, process and communicate information about human society”.

Lambert, Walker, Zimmerman, Cooper, Lambert, Gardner and Ford Slack (1995, cited in Daley, 2002, p. 21) identify principles of constructivist learning theory. These include:

- Knowledge and beliefs are formed within the learner;
- Learners personally imbue experiences with meaning;
- Learning activities should cause learners to gain access to their experiences, knowledge and beliefs;
- Learning is a social activity that is enhanced by shared inquiry and
- Reflection and metacognition are essential aspects of constructing knowledge and meaning.

Within this constructivist view, knowledge has taken on new definitions. Jonassen (2000) explains three types of knowledge within the constructivist paradigm: declarative, procedural and structural. A brief outline of each is provided below.
Declarative

- What you remember
- Awareness of an object, event or idea

Procedural

- Knowledge of how to use declarative knowledge
- What you know how to do

Structural

- Connects declarative and procedural knowledge
- “Knowledge of how the ideas within a domain are integrated and interrelated” (Diekhoff, 1983 cited in Jonassen, 2000, p. 61).
- Other terms for structural knowledge include cognitive structures, conceptual knowledge, and semantic networks.

(Jonassen, 2000)

Hyerle (1996) explains that many students find the process of building concepts and skills from parts to wholes very difficult. Often they stop trying to see the wholes and focus on small, memorisable aspects of units, never creating a bigger picture. Within the constructivist paradigm, Hyerle (1996) sees a need to actively build student’s abilities to integrate knowledge and see the “whole” before they try to make sense of the parts.

The notion of “meaningful learning” is embedded in constructivist theory and the idea of knowledge integration. Jonassen, Reeves, Hong, Harvey and Peters (1997, p. 290) align meaningful learning with Ausubel’s (1968) assimilation theory, which is based on the
assumption that “human thinking involves understanding concepts as well as the relationships between them.” Similarly Jonassen et al. (1997, p. 290) explain that in meaningful learning, “the learner links new, specialized concepts to more generalized concepts which the learner already knows, which become the foundation for the learner’s cognitive structure”.

Novak, Gowin and Johansen (1983, p. 625) contrast meaningful learning with rote learning. They define meaningful learning as occurring when the learner “consciously and explicitly ties new knowledge to relevant concepts or propositions they already possess” whereas rote learning “results when new knowledge is arbitrarily incorporated into cognitive structure”.

In order to create a meaningful learning experience, Novak (n.d., p. 2/10) suggests that there are three conditions required:

1. The material to be learned must be conceptually clear and presented with language and examples relatable to the learner’s prior knowledge.
2. The learner must possess relevant prior knowledge.
3. The learner must choose to learn meaningfully.

2.2 Thinking Skills for Meaningful Learning

Rhoades and McCabe (1992) extend the idea of meaningful learning claiming that thinking skills or strategies are used as a basis for new understandings. Teachers can
expand students’ frames of reference through provision of opportunities for experiencing and learning a range of skills and strategies.

Through experiencing different ways of thinking, new strategies or paths are added to a learner’s repertoire. Rhoades and McCabe (1992) explain that the way we view and interpret the world around us is dependent on the network of thinking paths we have available.

Rhoades and McCabe (1992) conclude that through helping students develop thinking skills that help them to learn how to learn, we give them the most powerful skill possible in this information age, since these skills enable cognitive modification.

Hyerle (1996, p. 72) describes the “thinking skills movement” as being driven by this notion of cognitive modifiability and states that extensive cognitive science and brain research shows “that we, as educators, can facilitate and improve students’ intellectual abilities”. This idea is not a new one. Vygotsky (1978, p. 126) states “If one changes the tools of thinking available to a child, his mind will have a radically different structure.”

Costa (1991) notes that it is often assumed that students have the necessary thinking skills implied in subject matter and in the teaching and learning process. Costa (1991) asserts that students often have no idea what it really means to perform these thinking skills.
Costa (1991) recommends the direct teaching of thinking skills. Content then becomes the vehicle for thinking. Students need to be developmentally ready for the new form of thinking and the thinking skills that must be relevant to and used repeatedly and with success in immediate and future learning. de Bono (1984, cited in Costa, 1991) and Whimbey (1985, cited in Costa, 1991) found that direct teaching of thinking skills seemed to increase students’ achievement.

Everyday thinking is often plagued by the defaults of hasty, narrow, fuzzy or sprawling thinking, and “Thinking Organizers” can act as a solution (Swartz & Perkins, 1992). “Thinking organizers are verbal or graphic symbols that remind us how to reorganize our thinking … and guide us along as we think” (Swartz & Perkins, 1992, p. 55).

The development of thinking skills and using “thinking organizers” acts as a form of teacher mediation in the learning process. Whether formal or informal, Rhoades and McCabe (1992) emphasise that effective teaching of thinking requires three key elements: an investment of time, a level of complexity beyond just the facts, and the conscious intent of the mediator.

Rhoades and McCabe (1992, p. 47) state that cooperative learning “inherently facilitates the teaching of thinking skills”. Investigation into cooperative learning as theory and as a learning environment provides evidence for this claim.
2.3 Facilitating the Teaching of Thinking Skills in the Cooperative Learning Environment

Rhoades and McCabe (1992) claim that because the teacher no longer exists as the sole mediator of learning in cooperative learning environments, each student in the cooperative group becomes a mediator and contributes to the thinking path development of other group members. They achieve this through having to think about and explain their own thinking, sharing their internal dialogue (consistent self-talk going on in the mind) and sharing what and how individual conclusions are reached.

Brownlie (1992, p. 23) describes attributes of today’s ‘thoughtful classroom’. Brownlie (1992) labels it a ‘thinking club’ where the crucial elements in establishing the rightness of an answer lie in the learner’s ability to explain their connections or thinking and to make explicit the ways in which information has been chosen information to create an understanding.

Through cooperative learning, students are provided access to the range of thinking paths and strategies possessed by their peers. Increasing the number of thinking paths available to each student must therefore result in access to a greater number of thinking paths for the cooperative group as a whole. Mediation provides more thinking paths, increasing the ways a person has to deal with new perceptions, experiences and information (Rhoades and McCabe, 1992). Thinking paths are directed by internal dialogue and sharing this self-talk facilitates more mediation.
In making such claims, it is important to examine the foundations for and definitions of cooperative learning and the cooperative learning group.

Johnson and Johnson (1999) describe three general theoretical perspectives as having guided the development of cooperative learning research and practice and as providing triangulation for the validation for cooperative learning. These include social interdependence, cognitive development and behavioural learning theories.

Social interdependence theory includes the idea that the way social interdependence is structured influences the way individuals interact which then determines outcomes (Johnson and Johnson, 1999).

Cognitive development theory is based largely on the theories of Piaget, Vygotsky and Johnson and Johnson (Johnson and Johnson, 1999).

From a Piagetian perspective, cooperative learning aims to accelerate students’ intellectual development through “...forcing him or her to reach consensus with other students who hold opposing points of view...” (Johnson and Johnson, 1999, p. 187).

Vygotsky (1978) describes each function in a child’s cultural development as appearing twice, initially on a social and later, on a psychological level: Firstly between people and then inside the child. Vygotsky (1978) views learning as a social process, emphasizing dialogue and the variety of roles that language plays in instruction and in mediating
cognitive growth. A central concept of Vygotsky’s (1978, p. 84) theory is the “zone of proximal development.” This represents the area between what a student can achieve on his or her own and what the student can achieve in an instructed environment or when working in collaboration with more capable peers. The essence of this concept is that only through working collaboratively can students grow intellectually.

Johnson and Johnson (1999) present controversy theory where the learner in a cooperative group is present with different points of view, creating uncertainty and resulting in reconceptualisation and further searching for information. The outcome of this process is “a more refined and thoughtful conclusion” (Johnson and Johnson, 1999, p. 187).

A behavioural learning perspective assumes that learners will work hard on tasks for which they will receive a reward and they will not work hard on tasks for which there is no reward or which yields punishment (Bandura, 1977, Skinner, 1968, cited in Johnson and Johnson, 1999).

Johnson and Johnson (1999) define cooperative learning groups through comparison with traditional learning groups. Table 1 below depicts this comparison.
**Table 1 Comparison of Learning Groups**

<table>
<thead>
<tr>
<th>TRADITIONAL LEARNING GROUPS</th>
<th>COOPERATIVE LEARNING GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low interdependence. Members take responsibility only for self. Focus is on individual performance only. Individual accountability only.</td>
<td>High positive interdependence. Members are responsible for own and each other’s learning. Focus is on joint performance. Both group and individual accountability. Members hold self and others accountable for high quality work.</td>
</tr>
<tr>
<td>Assignments are discussed with little commitment to each other’s learning.</td>
<td>Members promote each other’s success. They do real work together and help and support each other’s efforts to learn/</td>
</tr>
<tr>
<td>Teamwork skills are ignored. Leader is appointed to direct member’s participation.</td>
<td>Teamwork skills are emphasized. Members are taught and expected to use social skills. All members share leadership responsibilities.</td>
</tr>
<tr>
<td>No group processing of the quality of its work. Individual accomplishments are rewarded.</td>
<td>Group processes quality of work and how effectively members are working together. Continuous improvement is emphasized.</td>
</tr>
</tbody>
</table>

Johnson and Johnson (1999, p.73)

Johnson and Johnson (1999, p. 72) highlight that the ultimate aim in implementing cooperative learning strategies is the facilitation of the “high-performance cooperative learning group.” The high performance cooperative group meets all the criteria for a cooperative learning group (see Table 1) with two additional characteristics:

- Group members have a greater level of commitment to each other and the group’s success (Johnson and Johnson, 1999, p.72)

- The group outperforms reasonable expectations for the task at hand as a result of this commitment
Taking these definitions into consideration it can be assumed that most effective mediation of thinking would occur for the high performance cooperative group. Johnson and Johnson (1999) also highlight that not all groups represent cooperative groups. The adherence to the criteria identifying the features of the cooperative group must therefore be an important consideration for teachers aiming to mediate thinking in the cooperative learning environment.

In the cooperative learning environment, the members of the cooperative group mediate thinking and learning. Cooperative learning provides a learning environment that is grounded in theory and aimed at improving the cognitive abilities of learners. Cognitive tools are concrete mediation tools that share a similar aim.

2.4 Mediation with Cognitive Tools

Cognitive tools are intended to engage and facilitate cognitive processing in the learner through controlled mediation (Stoyanova and Kommers, 2002).

Signs and artifacts mediate all human relations with the outside world (Stoyanova and Kommers, 2002). Vygotsky (1978, p. 39) explains that signs can be simple acts like tying a knot or marking a stick as reminders. These acts change the structure of the memory process: “They extend the operation of memory beyond the biological dimensions of the human nervous system and permit it to incorporate artificial, or self-generated, stimuli…”
The aim of cognitive tools is to act as signs (Vygotsky, 1978) and allow learners to “interact with their own understandings” through an external manifestation of these understandings (McAleese, 1998, p. 260).

Hyerle (1996) recommends that in transition from behaviourism to constructivism, cognitive tools represent practical strategies that aid in the facilitation of student-centered construction of knowledge.

Jonassen, Reeves, Hong, Harvey and Peters (1997, p. 293) explain that cognitive tools have existed for thousands of years. They describe their primary use as enhancing the “cognitive powers of human beings during thinking, problem-solving, and learning” and they may take the form of something as simple as a grocery list or as complex as a mathematical formula.

Gage (1974, cited in McTighe & Lyman, 1992, p. 73) formulated a theory of tool-based instruction. Within his theory, “tools of the trade” represent “tangible teaching/learning devices that are the material embodiment of theoretically valid teaching/learning ideas”. McTighe and Lyman (1992) highlight the four characteristics of such tools within Gage’s theory. They include:

- Psychological validity in which tools reflect what is known about teaching and learning;
- Concreteness or embodiment of the knowledge in materials and equipment;
• Relevance or practical value to teachers facing the daily pressures and challenges of the classroom;

• And differentiation by type of learning, a relationship between the type of tool and the way that a skill, concept, process or attitude is best learned.

(McTighe and Lyman, 1992, p. 73)

McTighe and Lyman claim that cognitive tools fulfill these criteria providing “a practical medium for blending theory and practice” (1992, p. 74).

Duffy (1993, cited in De Simone, Schmid & McEwen, 2001) suggests the learning tools teachers provide to learners must be flexible and should aid in the scaffolding of information, materials and processes (Vygotsky, 1978) necessary to progress.

Concept maps, also known as cognitive maps or organisers, semantic networks, or visual/graphic organisers (Guastello, 2000) act as cognitive tools enhancing the interdependence between declarative and procedural knowledge to form structural knowledge (Dabbagh, 2001). Computer-based concept mapping software such as Inspiration 7 enables much easier and possibly more powerful production of concept maps (Jonassen et al., 1997).

Lajoie and Derry (1993, cited in Jonassen et al. 1997) explain that computer software programmes present examples of exceptionally powerful cognitive tools. When
programmes are used for the specific function of acting as cognitive tools, Jonassen (1996, cited in Jonassen, et al. 1997, p. 293) labels them “Mindtools”.

Jonassen et al. (1997) explain that when computer programmes are used as cognitive tools, learners use software for analyzing problems or tasks, interpreting and organizing solutions or knowledge and presenting their learning and understanding to others.

Jonassen et al. (1997, p. 304) hypothesize that the integration of concept mapping software as one of a range of knowledge representation tools “embedded in constructivist learning environments, will be much more successful than their use in the context of traditional teacher-centred pedagogies.”

In order to examine the concept map’s role as a cognitive tool or “Mindtool” (1996, cited in Jonassen et al., 1997, p. 293) in constructivist learning environments, it is necessary to analyse the background and specific features of concept mapping.

2.5 Concept Maps as Mindtools for Meaningful Learning

Through the creation of concept mapping, Novak (1998) helped operationalise constructivist learning theory (Daley, 2002).

The concept map is a form of graphic organiser. Novak and Gowin (1984) cite the development of graphic organisers as a result of Ausubel’s (1960) research into the beneficial effects of using concept maps to enhance readers’ acquisition of new
knowledge. Positive results led to continuing investigation into the use of advance organisers (Merkley and Jeffries, 2000).

The term “advanced organizer” changed to “structured overview” and eventually, the term “graphic organiser” was coined (Dunstan, 1992, Griffin, Simmons & Kampenai, 1991, cited in Merkley and Jeffries, 2000).

Semantic networking theory and schema theory underlie concept mapping (Jonassen et al., 1997). Semantic networking theory hypothesizes the cognitive structure is comprised of the semantic organisation of memory, where meaningful relationships (schemata) are created between ideas (schemata) (Jonassen, 1993). Quillian (1968, cited in Jonassen, 1997) defines the arrangement of networks of these ideas or schemas as constituting semantic networks.

In outlining their nature and use, Novak and Gowin (1984, p. 15) describe concept maps as being “intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit”. Novak and Gowin (1984) emphasize the hierarchical organisation of concept maps. An example of a concept map for water is given in figure 1.
In addition to representing these meaningful relationships, concept mapping is believed to:

- Provide a visual image of cognitive structure (Jonassen, 1993)
- Represent the assimilation of structural knowledge (Jonassen, 2000)
- Provide a close correspondence with psychological constructs (Stoyanova & Kommers, 2002)
- Present an external expression of one's own "Radiant Thinking" (Buzan, 1993, p. 57).
• Facilitate the organisation of knowledge into hierarchical frameworks (Novak, n.d.)
• Serve as a template to help organise and structure knowledge (Novak, n.d.)

While the first four points above refer to the concept map as a representational device the last three points provide the critical link between concept mapping and meaningful learning.

Novak and Gowin (1984) adhere to constructivist definitions of meaningful learning, claiming that the construction of new knowledge begins with observations made through concepts already possessed by the learner. Learners need to understand how and why new knowledge relates to what they already know. When learners actively create their own concept maps, the concept map acts as a tool in meaningful learning. Learners have to create their own meanings (Novak & Gowin, 1984) through the creation of a hierarchy of propositional links and cross-links, meanwhile assimilating new knowledge into their existing cognitive structure (Jonassen, et al., 1997).

McAleese (1998, p. 260) explains that when learners use computer-based mind mapping software such as Inspiration over a period of time, the programme acts as a Mindtool and allows the learner to engage in an ongoing process of “reflection in action and reflection on action” (italics in the original), in regard to a certain topic. The computer-based
concept map is easy to manipulate and allows the learner to take part in a cyclical process of creating, reflecting on, re-evaluating and adjusting linkages and organisation in the evolving map.

The role of the concept map as a complete externalisation and visual image of this knowledge structure is problematic for some theorists. Jonassen et al. (1997) claim that many advocates of concept mapping believe in the existence of a complete representation of structural knowledge within the mind. They also believe that this can be accurately mapped using a technique such as concept mapping. Jonassen et al. (1997, p. 303) explain that concept maps can only represent “what we think is in the mind”. Jonassen et al. (1997, p. 303) provide the following reasons:

- The dynamic nature of structural knowledge,
- The complexity of the propositional networks and conceptual links within the mind and
- The dimensional complexity of cognitive structures.

Differences in opinion over the representational abilities of the concept map have led to questioning of the ability to adequately mark or score the maps. Some theorists have rejected the quantitative scoring protocol adopted by Novak and Gowin (1984). The inability to reduce the intricacies and subtleties of the learner-constructed map to a numerical score is central to this problem (Caine & Caine, 1994, cited in Kinchin, 2001).
These differences in opinion introduce a problem in using the concept map as a teaching and learning tool. If the concept map does not truly represent what is in the mind, it cannot be used for accurate evaluation or assessment. A number of theorists address this issue.

Kinchin (2001, p. 1260) criticises the scoring of ‘valid links’ in Novak and Gowins’ protocol and describes it as being not only unsupportive of the learning process, but, “at odds with the constructivist philosophy that underlies the use of concept mapping as a learning tool.” Kinchin (2001) focuses on alternative, qualitative measures that can be used for scoring concept maps. Kinchin (2001, p. 1260) claims that the scoring of only “valid links” misses the point that “invalid” links may be valuable through supporting more valid links, contributing to the overall knowledge structure that the student is using as a basis for further learning. Further to this argument, Kinchin (2001, p. 1260) argues, “invalid links may reveal much about students’ thought processes.” Kinchin (2001) also highlights that problems can occur in the consistency of scoring schemes for concept maps.

McAleese (1998, p. 254) describes concept mapping as a “learning environment” where the creator of the map is working in a specific knowledge arena. McAleese (1998, p. 258) focuses on the role of the concept map in allowing “off-loading” of thinking, depicting the result of the knowledge construction process, rather than being a snapshot of what is known.
Theorists and researchers interested in the use of concept mapping with cooperative groups echo this focus on the concept map as part of a process of knowledge construction rather than the end product. Crook (1998) highlights the importance of the concept map in cooperative learning environments claiming that the more abstract the problem, the more useful it may be to have external representations that support the construction of shared understandings.

In a study completed by Roth and Roychoudhury (1992), the authors found that in completing concept maps as cooperative groups, the concept mapping became an interactive tool, and a means of negotiating meaning allowing multidimensional communication. Roth and Roychoudhury (1992, p. 551) concluded “the process of mapping concepts as a group activity may be more important than the concept map itself”.

2.6 Concept Mapping and Higher Order Thinking (Metacognition)

Despite discrepancies over scoring and interpretation of concept maps, there is widespread agreement that concept mapping is beneficial to metacognitive processes in learners.

Before discussing the relationship between concept mapping and metacognition it is necessary to highlight definitions of the latter.
Flavell, (n.d., cited in Perkins, 1995, p. 85) coined the original term and defined metacognition as, “meaning people’s knowledge of and management of their own cognitive functioning.”

Costa (1991) defines metacognition as an awareness of one’s own thinking, “to know what we know and what we don’t know. It is our ability to plan a strategy for producing what information is needed, to be conscious of our own steps and strategies during the act of problem solving, and to reflect on and evaluate the productiveness of our own thinking” (Costa, 1991, p. 87). Costa (1991) includes metacognition as one of a list of 14 characteristics of intelligent behaviour. Costa (1991, p.23) claims that, when asked, students who are becoming more aware of their own thinking should be able to:

- Describe what they know and what they need to know
- Describe what data are lacking and their plans for producing those data
- Describe their plan of action before they begin to solve a problem
- List the steps and tell where they are in the sequence of a problem strategy
- Trace the pathways and blind alleys they took on the road to problem solution.

According to Costa (1991, p. 87), metacognition occurs first as inner dialogue in the brain, eventually becoming a “key attribute of formal thought”. It does not occur at a formal level of operation in all humans (Chiabetta, 1976, cited in Costa, 1991).

Fogarty (1997, p. 183) describes metacognitive thinking as “the mind watching itself”. It involves learners in planning, monitoring and evaluating their own thinking and learning.
Fogarty (1997) separates metacognition into two distinct areas: the reflection of the learning and the assessment of the learning. Reflection involves the mind making meaning of the learning, then being able to generalize the learning ‘for transfer to similar and novel situations.’ Assessment involves “summative measures and dynamic data that both lend credence to the extent and quality of the learning” (Fogarty, 1997, p. 183). Self-assessment techniques are deemed as integral, involving the learner gaining an awareness and control over their learning (Fogarty, 1997, p. 184).

Perkins and Swartz (1990, p. 64) describe four rungs on a ladder of metacognition, climbing from least to most powerful. These levels include: Tacit, Aware, Strategic and Reflective use of different types of thinking. Perkins and Swartz (1990, p. 64) discuss the importance of helping students to develop metacognition as a facet of teaching thinking. This metacognition should be ideally “top rung” where it involves, “critical examination and creative revision of one’s own thinking practices.”


Jonassen et al. (1997) claim that concept mapping is predictive of higher order thinking. They base this claim on the need for well organised, domain specific knowledge in higher
order thinking, especially problem solving. Concept mapping facilitates this development and allows representation of domain knowledge.

Similarly, Dabbagh (2001) notes the dependence of structural knowledge development on cognitive and metacognitive strategies the learner uses while acquiring knowledge. Dabbagh (2001) suggests that comprehension strategies involving self-questioning and the use of advance organisers such as concept maps will most likely result in higher order learning outcomes (Bloom, 1956).

As a key element of metacognition, McAleese (1998, p. 252) highlights the processes of reflection as being integral to a learning environment where the learner is in control of their meaning making and learning. He describes reflection as “the self regulatory process that is under control of the learner”. McAleese describes self-regulation as the control mechanism making individuals goal-directed and assisting in implementing intentionality (Zimmerman & Schunk, 1989, cited in McAleese, 1998) where self-regulation mechanisms may operate from internal or external sources. Rotter (1956, cited in McAleese, 1998) refers to the balance sought and achieved between these forces as locus of control (LoC). LoC has been identified as creating complex tension in students (McAleese, 1998) which Craig, Franklin and Andrews (1984 cited in McAleese, 1998) maintain may be controlled if students are able to reflect on their state and disposition. Concept mapping, McAleese (1998) claims, facilitates this control.
2.7 Concept Mapping Research

In this final section of the literature review findings from relevant studies on concept mapping that helped define the research questions and design of this study are presented.

Very little past research located during this study focused on primary aged students using concept mapping as a tool to support their learning. Novak, Gowin and Johansen (1983) questioned whether seventh and eighth grade students could learn to use concept mapping and Vee mapping strategies in conjunction with regular science programmes. They also questioned whether acquisition of science knowledge and problem solving performance changed as a result of instruction in these strategies. Key findings of this study were that “Classroom teachers motivated to use new metacognitive learning strategies can be successful in employing concept mapping and Vee diagramming tools with junior high school science students” (p. 41) and that concept mapping resulted in improved problem-solving skills.

Results of Novak’s (1990, p. 37) teaching of concept mapping strategies to upper elementary and secondary school students led to the finding that, “in general, students from grades four onward were successful in constructing concept maps”.

Guastello (2000) investigated the effects of using concept-mapping techniques with low achieving seventh grade students. Assessment results showed that concept mapping could be expected to improve the comprehension scores of low achieving seventh graders by approximately six standard deviations over traditional teaching methods.
The research reviewed on concept mapping with this age group and most of that conducted with adult students focuses on assessment results as indicators of success. As McAleese (1998) highlights, if concept mapping is being used as a constructivist teaching and learning tool, the process of map construction itself should be emphasised and analysed, rather than purely the results of the mapping process. McAleese (1998) found that the use of computer-based concept mapping over prolonged periods of time, allows concept maps to be adjusted and reorganised, stimulating reflection on both the topic and the process of mapping.

Jonassen et al. (1997) highlight the impossibility of hypothesizing all of the cognitive outcomes of using concept mapping (and specifically concept mapping software) as cognitive tools. Instead, they recommend rigorous qualitative methods in order to reveal some of the complexities of learning with these tools.

Daley (2002) presents a combined approach to investigating the effects of concept mapping. Daley’s (2002) study aimed to enhance adult students’ learning through the provision of strategies fostering a constructivist approach to learning. The adult students learned to use concept maps and the extent to which this contributed to changes in the students’ learning strategies was assessed. Although evaluation was carried out through the scoring of concept maps over a one-year period participants were also interviewed about the experience of concept mapping. Participants reported feeling they gained a more holistic view of what they were learning, enjoyed a focus on organisation, analysis
and understanding, and increased their understanding of their own learning processes. They developed an understanding of how to link concepts, develop interrelationships, create meaning schemes and construct a knowledge base.

Concept mapping in cooperative learning environments has proven to be conducive to more meaningful learning (Okebukola & Jegede, 1988) and higher achievement (Okebukola, 1992). Okebukola (1992) studied the use of concept mapping with secondary school biology students. Results showed that students engaged in cooperative learning did significantly better as represented in post-test scores than students who worked on their maps individually. The author concluded, “flavoring concept mapping with cooperative interaction appears to give it added strength” (p. 221).

More efficient and more effective exchange and processing of information take place in cooperative rather than in competitive or individualistic situations (Johnson and Johnson, 1999). Stoyanova and Koomers (2002) investigated concept mapping as a medium of shared cognition in computer-supported collaborative problem solving for university students. One conclusion reached through this study was that computer-based concept mapping is beneficial as a mediating tool for group collaborative learning, both at group and individual level.

Heterogeneous grouping is important in cooperative learning (Baloche, 1998) as “the more homogenous the group members, the less each member adds to the group’s resources” (Johnson & Johnson, 1999, p. 74).
2.7.1 Summary of Findings

In the inquiry process students use a range of skills to “collect, process and communicate information about human society” (Ministry of Education, 1997). Concept mapping is a tool that may facilitate the skilful achievement of this objective. Concept mapping is a technique for externalising new and existing concepts and propositions (Novak & Gowin, 1984) and modeling the way the human mind organises knowledge (Stoyanova & Kommers, 2002). Externalising concepts on a concept map allows the integration of new, collected information (Novak & Gowin, 1984). In organizing that information into hierarchies and creating links, effective processing of information may be facilitated (Novak & Gowin, 1984). Computer generated concept maps allow ongoing adjustment and reorganisation of maps (McAleese, 1998) and in cooperative learning environments, the computer generated concept map is beneficial as a mediating tool (Stoyanova & Kommers, 2002). The cooperative learning environment provides strength to the concept mapping process (Okebukola, 1992).

2.8 Research Questions

The researcher developed the following questions for research:

- How do Year 7 and 8 students use Inspiration and concept mapping when working in cooperative groups during the process of Inquiry?

- In the group studied, how does students’ use of Inspiration as a concept-mapping tool affect higher order thinking?
What are the implications for teaching and learning? I.e. What recommendations can be made to assist teachers in the process of teaching inquiry using concept mapping and *Inspiration*?

The researcher aimed to explore how the students used *Inspiration* and concept mapping but not to analyse *Inspiration* as a concept-mapping tool.

### 2.8.1 Definition of Terms

**Students**

For the purpose of this study, student refers to a child who is enrolled in the state education system, attending a public school on a day-to-day basis. A student may be male or female.

**Higher Order Thinking**

Higher Order Thinking refers to the metacognitive processes of planning, monitoring and evaluating one’s own thinking and learning.

**Learning**

Learning refers to the process of making meaning and creating knowledge.

**Concept Map**

Concept map refers to two or more concepts (propositions), labeled and linked by words in a semantic unit.
Mindtool
A computer programme aimed at enhancing the cognitive powers of humans during thinking, problem solving and learning (Jonassen et al., 1997)

Inspiration®

Inspiration refers to the registered, computer based, visual thinking tool allowing users to create concept maps.

The Inquiry Process
The Inquiry Process refers to structured investigation where students collect, process and communicate information as outlined in Social Studies in the New Zealand Curriculum (Ministry of Education, 1997).

Co-operative Group
A co-operative group refers to a small heterogeneous group of students working interdependently to achieve a common goal or task.
3 Methodology

This chapter presents an outline of the methods chosen for the research and the rationale behind their use.

The research setting, ethical considerations and analysis of findings are presented as part of this discussion.

The study undertaken was qualitative in design and conducted from within a constructivist, interpretive paradigm (Denzin & Lincoln, 1998).

Ontology inherent in constructivism is relativist (Denzin & Lincoln, 1998) where the existence of an objective reality is denied and it is instead asserted that there are as many existing constructions of reality as there are individuals, even though many of these will be shared (Guba & Lincoln, 1989). Guba and Lincoln (1989) argue that if all realities are constructed, then there cannot be immutable natural laws governing these constructions.

Working from within the constructivist paradigm, it is also important to consider epistemological and methodological implications. Epistemologically, constructivism is subjectivist (Denzin & Lincoln, 1998), where the possibility of subject-object dualism is denied (Guba & Lincoln, 1989). Instead, constructivism can be described as transactional (Denzin & Lincoln, 1998) where the findings of a study are said to exist because there is an interaction between the observer and the observed, creating what emerges from the inquiry (Guba & Lincoln, 1989). Methodological implications of these assumptions
include a rejection of the controlled and manipulative approaches of science (Guba & Lincoln, 1989) where varying constructions are interpreted using conventional hermeneutical techniques and are “compared and contrasted through a dialectical interchange” (Denzin & Lincoln, 1998, p. 207).

The researcher chose the inquiry process as a basis for study. For the researcher, the decision to use an inquiry task as a context for ongoing concept mapping was based on the premise that such a tool may support students in collecting, processing and communicating information (Ministry of Education, 1997) in a world where such skills are becoming vital for success (see section 2.1).

In this study, the effects of using a teaching and learning intervention tool embedded in inquiry were investigated within the context of a class unit on Antarctica.

The researcher chose a qualitative approach for conducting this investigation. Instead of hypothesizing learning gains, the researcher looked to in-depth observations and interviews for evidence of how concept mapping was used and evidence of metacognitive outcomes. Evidence from concept maps was then used for triangulation with interview and observation data.

The research aim was to investigate how students used concept mapping as a process, rather than examining the results of concept mapping. Concept mapping was integrated
into the inquiry unit. Students were required to work on concept maps throughout the unit and they constituted one product of the inquiry.

Year Seven and Eight students were chosen as the subjects for this study due to reported success in teaching concept mapping to this age group (see section 2.7). This decision was also made due to the small amount of research located investigating the process of concept mapping with this age group.

The cooperative group was chosen as a unit for case study design due to the positive results of concept mapping in such groups exhibited in previous research (see section 2.7).

It was not clear until after the research had been conducted, whether or not the students would actually behave as a cooperative group as defined by Johnson and Johnson (1999). Purposive sampling was used for selection of case study group members with advanced social and cooperative skills. The aim of this selection process was to increase the likelihood of the creation of a cooperative learning group as defined by Johnson and Johnson (1999). Cohen et al., (2000) define a purposive sample as one that is selected through the researcher targeting a group that simply represents itself, where no attempt to generalize is desired. Cohen et al. (p. 102) describe the sample as therefore “unashamedly biased and selective”.

35
In making the decision to base the purposive sample on cooperative skills, the researcher and class teacher aimed to maintain the heterogeneous nature of the cooperative group while enhancing its effectiveness. Miller & Harrington (1992) have suggested qualities that contribute to such effectiveness:

- Developing and working towards shared goals
- Equal participation by all group members
- A balance of leadership and control within the group
- Mutual respect and sharing

The case study is deemed useful in situations where research is explanatory, situational and deals with the tracing of operational links over time (Yin, 1994). It allows the study of phenomenon in real-life contexts, especially when the boundaries between phenomenon and contexts are not clearly evident (Yin, 1994), recognizing that the context is a powerful determinant of causes and effects (Cohen, Manion & Morrison, 2000).

The researcher decided to use participant observation to investigate the case study group during the process of concept map creation, reorganisation and improvement over a period of five weeks. A research assistant filmed each of ten inquiry sessions over the five-week period.

in the participant observation approach when data are being collected on non-verbal behaviour. This is an advantage that was of particular relevance to this study as the researcher endeavored to analyse verbal and non-verbal student interaction with computer software (*Inspiration*) with hard copy concept maps and with each other.

To some extent, effects of the close involvement of the researcher with the case study group were addressed through the involvement of the field assistant and the filming of inquiry sessions. However this cannot be seen as a complete solution to the problem of observer bias or interpretation as Silverman (2001, p. 33) highlights, “...even when people’s activities are audio or video recorded and transcribed, the reliability of the interpretation of transcripts may be gravely weakened by a failure to note apparently trivial, but often crucial, pauses, overlaps or body movements.”

Erickson (1992, cited in Cohen et al., 2000) notes the use of audio-visual recording equipment as powerful when used in addition to detailed field notes. Supporting this combination of observation tools is the fact that “Comprehensive audio-visual recording can overcome the partialness of the observer’s view of a single event and can overcome the tendency towards only recording the frequently occurring events” (Cohen et al., 2000 p. 313).

Cohen et al. (2000) claim that the use of audiovisual equipment can affect theoretical sensitivity in that both dependence on prior interpretations by the researcher and the possibility of only recording events that happen frequently can be reduced.
Silverman (2001, p. 162) notes three advantages of tapes and transcripts compared with other kinds of qualitative data:

- Tapes are a public record
- Tapes can be replayed and transcripts improved
- Tapes preserve sequences of talk.

Sacks (1992) however, points out the technical problems involved in such things as camera positioning that often accompany the use of videos in observation. (Silverman, 2001, p. 162). This was not considered a problem in this study where there were only four members of the case group and where they were working together cooperatively.

The computer programme Inspiration was chosen for concept mapping and for use as a Mindtool (Jonassen, et al. 1997) in the context of cooperative inquiry. The choice of this computer-based concept mapping software was made as this programme was installed as version six or seven, on all computers in the school that provided the setting for the research.

3.1 The Case Study

The case study was evaluative, where the researcher aimed to explain any causal links relating to the intervention. In this study the intervention was of electronic concept mapping as a tool in cooperative inquiry.
3.2 Access and Initial Contact

The researcher knew the staff and many of the children in the school. The researcher was a teacher in the Senior Syndicate of the school for the two years prior to the research and was on leave for one year to complete tertiary studies. Holding this position of insider provided a range of advantages. Firstly, the principal of the school and senior management team acted as the gatekeepers and were crucial to access (Denzin & Lincoln, 1998). Permission was gained from both of these parties to carry out the research (Appendix A and B).

Explicit prior knowledge of the researcher's background and intentions as a teacher and tertiary student meant access was allowed and in the case of the principal, encouraged. The principal made explicit reference to this knowledge and its implications during initial, informal meetings. This reaction is aligned with Denzin and Lincoln's (1998) claim that the reputation of the researcher's institutional background can be of considerable importance in the opening and closing of doors. Commitment to returning to the school after a year of study leave also meant that the researcher remained a stakeholder in the research setting (Guba & Lincoln, 1989) whilst gaining the temporary freedom to act as researcher, coming and going to the research setting as required (Bogdan & Biklen, 1998).

The retained position of the researcher as a known stakeholder in the research setting allowed the researcher considerable advantage in conducting "Responsive Evaluation" as first proposed by Stake (1975, cited in Guba & Lincoln, 1989, p. 38). In this approach,
parameters and boundaries for research are determined through an “interactive, negotiated process that involves stakeholders” (Guba & Lincoln, 1989, p. 38-39). Ongoing consultation with the principal and teacher involved in the research facilitated the discovery of potential claims, concerns and issues of the stakeholders (Guba and Lincoln, 1989). During this process, it was felt that the researcher’s empathy and understanding was enhanced due to familiarity with the personnel, practices and context surrounding them.

The participants’ prior knowledge of and relationships with the researcher may have helped to overcome the Hawthorne Effect (Cohen et al, 2000) to a certain extent. This effect threatens to “contaminate experimental treatments in educational research when subjects realize their role as guinea pigs” (Cohen et al, 2000, p. 127). The researcher taught all four of the students, albeit on a short-term basis. They were accustomed to the researcher as a teacher and this may have been an advantage in the avoidance of the participants seeing their role as ‘guinea pigs’ and behaving accordingly.

3.3 Ethical Considerations

Despite the known status of the investigator, all research can be described as secret in some ways and to some degree (Roth, 1970, cited in Lofland & Lofland, 1995). This may be especially the case in dealing with children where there is an existing power differential between themselves and adults (Cohen et al., 2000) therefore making the degree of this secrecy more difficult to define.
In the first instance ethical concerns were addressed through meetings and permission gained from the school principal and the teacher of the class within which the research was to take place. Copies of the letters of consent from these two parties are included as Appendices A and B.

In order to ensure the participants understood as fully as possible the extent and intentions of the research, the researcher conducted two meetings with the students.

At the first of these meetings, there was a general discussion about the new role of the researcher as such and the break from teaching that this required. It was intended that the students develop a new awareness of this changed role. One of the forms secrecy can take in research is that of the people involved in the study not always believing and/or remembering that the researcher is a researcher (Mitchell, 1993, Peneff, 1985 and Thorne, 1980, 1979, cited in Lofland & Lofland, 1995).

A brief overview of the focus of the research was given at this stage and students were given information sheets both for themselves (Appendix C) and their parents (Appendix D). Separate information sheets for each group were provided in order to communicate to students and parents directly and comprehensively, in appropriate language.

This differentiation in the provision of information to students and parents is aligned with the views of Fine and Sandstrom (1988, cited in Cohen et al., 2000, p.52) who suggest,
“while it is desirable to lessen the power differential between children and adult researchers, the difference will remain and its elimination may be ethically inadvisable.”

Students were invited to think about and discuss the research with their parents and each other. The initial meeting was followed by another three days later, at which time the students were free to ask questions and were given separate consent forms for themselves (Appendix E) and their parents (Appendix F) to take home and complete.

At each of these meetings the fact that students could choose to withdraw from the research at any stage was reinforced.

The researcher deemed it important that students be given some time between the provision of information and the request for consent so that adequate reflection could occur on the implications of involvement. This time provided opportunities for the students to consider whether they wanted to take part in the research or not. It was hoped that questioning and reflection would occur for the students individually and also in discussions with parents.

All data collected during fieldwork was coded using pseudonyms for the participants. It will be held at the Christchurch College of Education for five years according to research guidelines.
At no time was the name of the school mentioned. Any information included from third parties such as the classroom teacher was included with permission and verification from those concerned.

The case study occurred within the parameters of the normal classroom and syndicate programmes. Thus, participants encountered minimal disruption to their learning.

For the protection of the researcher, field assistant and students, at no time was either adult alone with the students in an unsupervised area of the school.

3.4 The Case

The case study included detailed examination (Bogdan and Biklen, 1998) of a cooperative group of Year Seven and Eight students carrying out the inquiry process as outlined in Social Studies in the New Zealand Curriculum (Ministry of Education, 1997). The researcher intended to investigate how the group used the computer programme Inspiration for concept mapping during this process and how this affected higher order thinking.

3.4.1 Selection of Participants

The researcher made contact with one teacher within the Year Seven and Eight syndicate requesting the inclusion of her class and specifically one group of four students in the study. The researcher made the decision to contact the particular teacher concerned based on prior knowledge of her recent enthusiasm for integration of computer-based learning tools and her strong interest in metacognitive learning strategies. These traits were
recognised by the researcher through a collegial relationship with the teacher over the two years prior to the study.

With cooperative learning theory as the basis for decision-making, purposive sampling was chosen as the method for selecting case participants.

The classroom teacher selected cooperative group members who had demonstrated highly developed cooperative skills in the classroom. The social and cooperative skills outlined in the Essential Skills section of *The New Zealand Curriculum Framework* (Ministry of Education, 1993, p. 19) were used as a basis for these selection decisions. These include, that students will:

- Develop good relationships with others, and work in cooperative ways to achieve common goals;
- Take responsibility as a member of a group for jointly decided actions and decisions;
- Participate appropriately in a range of social and cultural settings
- Learn to recognize, analyse, and respond appropriately to discriminatory practices and behaviours;
- Acknowledge individual differences and demonstrate respect for the rights of all people;
- Demonstrate consideration for others through qualities such as integrity, reliability, trustworthiness, caring or compassion (aroha), fairness, diligence, tolerance (rangimarie), and hospitality or generosity (manaakitanga);
• Develop a sense of responsibility for the well-being of others and for the environment;
• Participate effectively as responsible citizens in a democratic society;
• Develop the ability to negotiate and reach a consensus.

The researcher considered the teacher a trustworthy judge of the social and cooperative skills (Ministry of Education, 1993) of the students in the class. This was due to her reported frequent use of cooperative structures in designing teaching and learning activities allowing observation and assessment of social and cooperative skills and also a thorough knowledge and understanding of the students gained after almost six months working with them.

3.4.2 The Classroom Teacher

The classroom teacher had twenty years teaching experience. The first seventeen of these were spent teaching in South Africa and the latter three in a New Zealand school.

The researcher’s experience working with this teacher as a colleague showed that in this time the teacher had developed an excellent working knowledge of the New Zealand curriculum and related documents.

This teacher quickly and enthusiastically embraced an entirely new system and curriculum when arriving in New Zealand. The researcher observed this attitude and ability repeatedly during the time working with the teacher as a colleague.
The teacher consistently demonstrated a positive and capable approach to new theory and approaches to teaching and learning.

It was this prior knowledge and past experience that led the researcher to approach this teacher in regard to participation in this study.

3.4.3 The Students

The case study group was comprised of four students. Two of these students were in Year Seven and two were in Year Eight. A boy and a girl from each age group were selected, however sex was not a criterion for selection. The students were given pseudonyms to protect their identities. These and the age group of each student are listed below:

Megan Year 8
Matthew Year 8
Kate Year 7
Tom Year 7

3.4.4 Preparation

The classroom teacher taught the students in her class how to construct concept maps using Inspiration prior to the case study. They then gained experience concept mapping for a variety of purposes in a range of curriculum areas (see section 4.1).

3.5 Data Collection Procedures
This research represents an observational case study (Bogdan & Biklen, 1982) in which the major data gathering technique was participant observation, supplemented with semi structured interviews and a review of relevant documents. These documents included the concept maps constructed by the group as products of the inquiry. An updated version of the concept map was collected from the group at the end of each session where additions or modifications to the concept map/s were made.

3.5.1 Participant as Observer
The researcher acted as a participant observer throughout the inquiry unit. Detailed field notes were recorded during these sessions.

3.5.1.1 The Field Assistant and Filming
The case study group was filmed throughout the inquiry. This involved the employment of a research assistant who filmed each session. Videotapes were transcribed by the researcher and combined with observation notes taken during the inquiry sessions.

The research assistant was introduced to the students in the study in the introductory sessions held by the researcher. At the same time there was an explanation about the use of the video equipment. Possible effects of being filmed were discussed with the students and reactions to the experience gauged through informal discussion throughout the study.

The researcher organised that if the group did split, the field assistant and researcher would attempt to follow the separating factions of the group. This helped overcome such
technical problems and the selectivity that can be incurred when movable video cameras are used in observations.

3.5.2 Semi-structured Interviews

Students in the cooperative group were interviewed individually about their experience of the unit, the cooperative group structure, concept mapping and the use of Inspiration during the inquiry.

Interviews were conducted in a senior school classroom and were recorded on minidisk. Times for these interviews were negotiated with the each student in consultation with the classroom teacher. All interviews were conducted in the morning between 11.00am and 12.00 midday. Three of the interviews were conducted on the same day. The interview with Kate was conducted in the same time slot but after the school holidays as Kate was absent in the final week of the study and of the school term.

The students responded to the following questions and requests in semi-structured interviews:

Tell me about your experience of the Antarctica unit.
What do you think your group did well?
How did you organise your group?
How did you ensure that everyone knew what to do?
What did you do to make sure the group was on track?
Tell me about the ways you organised the information that you found?

Tell me about your concept maps.

What did you find useful about concept mapping?

What difficulties did you have when you were concept mapping?

What did you like about using Inspiration?

What didn’t you like about using Inspiration?

How do you think the Antarctica unit could be improved?

### 3.5.3 Document Analysis

Concept maps were collected at the ends of sessions in which the students worked on them. Six concept maps were collected in total.

### 3.6 Analytic Strategies

Triangulation of data sources was used as a method of improving the construct validity of the study (Yin, 1994, p. 92). Interview data was used for triangulation of facts with observation and specific examples taken directly from concept maps in order to develop “converging lines of inquiry” (Yin, 1994, p. 92) or “convergence between independent measures of the same objective” (Campbell & Fiske 1959, cited in Cohen et al., 2000, p. 114). Information from multiple sources was collected in order to corroborate the same fact or phenomenon (Yin, 1994). This process and the data sources used are depicted in figure 2 below.
Convergence of Multiple Sources of Evidence
(Single Study)

Adapted from Yin (1994, p. 93)

In analyzing the research data, research questions were used in order to focus attention on some data and to ignore other data (Yin, 1994).

"Explanation Building" (Yin, 1994, p. 110) was used for data analysis where the "goal is to analyse the case study data by building an explanation about the case" (Yin, 1982b, cited in Yin, 1994).

Data from the study were stored as hard copies of concept maps and transcripts of observations and interviews. Observations transcripts were numbered as sessions in accordance to the order in which they occurred. Specific utterances or events are referred to using relevant session and page numbers.
Analysis of observations and interviews began with initial scanning and categorising of data. The researcher recorded self-memos in the margins of transcripts. Recurring themes were noted and recorded electronically. Categories were also developed in relation to the use of Inspiration for Concept mapping and reflecting the research questions. Data was then sorted and analysed electronically around those themes.

Sample quotes were used to illustrate themes throughout the Results/Analysis section of this document. The following conventions were used for transcription:

a. **Bold-faced**, to mark emphases in speech.

b. Square brackets “[...]” to add words that would facilitate the comprehension of the transcript.

c. Parentheses “(...)” to indicate non-verbal cues and actions.

d. **Underlining** to mark overlapping speech.

e. Commas “,” and period “.” To indicate breaks in the flow of speech.

f. Question mark “?” if the context allowed the speech act to be interpreted as a question.

(Modified from conventions outlined by Roth & Roychoudhury, 1992)
4 Teaching and Learning Activities

This chapter outlines the structure and delivery of the teaching included in the study. This began with the teaching of concept mapping. The planning and teaching of the Antarctica unit followed.

4.1 Concept Mapping

Instruction in concept mapping was carried out prior to participant observations. The classroom teacher integrated the teaching of concept mapping into her classroom programme using the guidelines set out by Novak and Gowin (1984), (Appendix G). The teacher also used Jonassen’s (1996, cited in Jonassen, 1997) suggested steps for facilitating the integration of concept mapping software into a classroom learning environment (Appendix H).

By the time the Antarctica unit and formal observations/filming began the students had completed concept maps in three different subject areas over a period of six weeks.

4.2 Unit Structure

The classroom teacher and the researcher planned the Antarctica unit collaboratively. The unit plan is included as Appendix I.

The teacher and the researcher designed the planning format used. It was based on the needs of the classroom students as perceived by the teacher and the planning requirements of the school.
The Action Learning Process (Gawith, 2000) (Appendix J) was used as a basis for the progression and stages within the inquiry.

The key features of the unit for the purposes of this research were that it contained the progressive construction of a concept map by the case study group and that the task was structured cooperatively.

The classroom teacher understood these features of the unit. Other aspects of the unit plan were hence seen as a guide and not as prescriptive for the unit’s delivery.

4.3 Classroom Setup

The class teacher set up the classroom with support from the researcher in accessing and retrieving resources such as pictures, display materials and signs.

One entire wall of the classroom was used as a display area for the Antarctica unit. A large sign reading, “Chill out in Antarctica” was cut out of Dacron and stapled across the centre of the display space. Surrounding it were a variety of large colour prints of scenes from Antarctica.

The wall display included a diagram outline of the Action Learning Process (Gawith, 2000). The process was set out as a research timeline. Questions intended to stimulate evaluative thinking in the students were placed alongside each stage of the process.
At one end of the display was a sign “Try a Thinking Path” with hints and outlines for using the variety of graphic organisers and thinking organisers introduced throughout the unit. These were in individual, labeled pockets and were available to the students throughout the unit. There was also a section of the wall space entitled “Needing Inspiration?” dedicated to Inspiration and providing hints and ideas for concept mapping.

Before the researcher’s arrival at the introductory lesson for the Antarctica unit, the class teacher had organised the students into their inquiry groups and seating had been arranged according to these. The students were all seated in groups of four with two desks placed in front of another two, allowing students to face each other. This seating arrangement was maintained throughout the unit.

The inquiry groups were provided with coloured manila folders at the beginning of the unit. An “Activities and Assessment Sheet” (Appendix K) was glued to the front of each of these and the groups designed and wrote a group name on the back of their folder. These were for storing all group resources gathered during the inquiry. The teacher asked that these be handed in at the end of each and every inquiry session for checking.

4.4 Task Progression and Delivery

The class teacher used her professional discretion when delivering the structure and content of lessons as outlined in the unit plan. She completed the preparatory activities outlined on the unit plan (Appendix I). A discussion of the inquiry and action learning
processes was observed and filmed during session one. The lesson highlighting and reviewing the necessary skills for cooperative work was not completed.

The introductory lesson, including the teacher/researcher skit, the exploration of Antarctica resources and the completion of the group brainstorm were carried out in close correspondence with the unit plan. At this stage, the delivery of the unit began to diverge from the planned lessons due to a number of factors.

One example of this divergence was evaluative questioning used by the teacher. Although this was mentioned in the conclusions to the planned lessons, feedback about progress was requested and guidance from the class teacher was given at a variety of times and in a variety of ways and the final, evaluative lesson of the unit was not completed.

The researcher observed student feedback on progress gained using teacher questioning to the whole class and to the case study group individually. However discussion of planning and next steps for groups was usually undertaken with individual groups and through instructions rather than questioning. This was consistently the case once time became restricted after the announcement of the class teacher’s imminent departure. Both of these processes were illustrated during session eight of the inquiry. The teacher addressed the whole class in gaining feedback on each group’s progress with their research questions. Each group was asked to share their chosen issue for study, one of their “fat questions” and information they had found to answer that question so far. This
class sharing was followed by a discussion with the case study group where the teacher asked them to use the session to spend time researching their question about what transport they would need as scientists in Antarctica and to find some information on flying in Antarctica.

Another example of divergence from planning occurred in lesson one of the unit plan (session three of the unit). The introductory activity using the Hamburger article to practice generating fat and skinny research questions actually took up the whole lesson. The teacher made the decision to allow this to occur.

The researcher did not observe the planned introductions of lessons two through to seven during the unit. Discussions with the class teacher highlighted time constraints as being the key reasons for this. The teacher did note that she had used some of the introductory ideas at other times of the day and during other subjects.

One of the reasons time constraints became an issue was the news received the day session four was observed. The teacher announced to the class that she had won a position teaching at an International school in Germany and that she would be leaving at the end of the term. The teacher had intended from the beginning of the unit, to allow the unit to flow over into term three if time constraints became too restrictive. This news meant that the unit would have to be completed by the end of the term.
The news of the classroom teacher's imminent departure had the following consequences for the unit:

- Students were allowed to choose sections of the day when they would like to work on the inquiry and when other work was up to date. (These had to be checked with the teacher).

- The case study group had to make these decisions at least one hour before they intended to work on the unit so that the researcher and field assistant had time to get to the school.

- Resources actually became more easily accessible to students through this flexible timetabling as there were fewer students requiring the resources at any one time.

- Sometimes the case study group missed out on class discussions on progress or planning through being allowed to work in other areas of the school.

- The teacher spent time with individual groups reflecting on progress and planning their next steps.

4.5 Teacher Management

When the teacher was working with the whole class and alone with the case study group a number of features of the teacher's manner and approach became evident.

The teacher demonstrated trust and expectations of responsibility in the students. In session four, the teacher told the case study group that, as they did not need as much guidance, they could go and work upstairs in the library if they wished. This meant the
students were under the supervision of the librarian, but had the freedom to work on computers with books and with the freedom to use their time and resources as they saw fit. Matthew expressed his appreciation of this freedom in the use of resources during interviews, stating that he thought that the unit was fun because students “could use all the resources that we wanted”.

This trust and responsibility given to the case study group may have been due to the presence of the researcher and the field assistant as extra, although unofficial “supervisors”. It may also have been a result of the increase in time pressure due to the teacher’s imminent departure.

The group was also given the responsibility of working on their own during sessions five through to nine with only peripheral supervision from neighbouring classroom teachers. Four of these sessions were spent upstairs in the library, one in an empty classroom and one, in their own classroom.

The high expectations the teacher demonstrated to the class were noted from the beginning of the unit. The first class discussion observed by the researcher began with the teacher telling the class that because they had worked so well in the previous unit, the Antarctica unit would take them to an even higher level of thinking. This suggests that the class was already thinking at a high level and she expected this to improve even further.
High expectations in terms of behaviour were reinforced through the choices the teacher gave students in managing their time and resources and for the case study group and in where they chose to work. Megan liked these choices and the autonomy they gave the group, stating in her interview "we sort of got left to do our own thing more and like, we chose what we were doing more and all that, which was good."

The teacher reinforced this element of choice throughout the unit. A number of examples highlight this further. Despite the fact that the teacher allowed the groups to assign roles at the beginning of the unit, she allowed the groups to decide whether these roles remained constant throughout the unit or whether they remained flexible and changing.

This element of choice was also included in the structure of the unit. Students were able to choose an area for study while their class was in Antarctica. During a class discussion of these aspects, the teacher reinforced the diversity and creativity that can be shown through making individual choices. It appeared that the area of transport that the case study group chose was quite different to the predominant choice of wildlife chosen by other groups in the class. The teacher showed respect for the diversity of student ideas through praising the group for their creativity.

The class teacher demonstrated a consistently positive and enthusiastic approach and attitude to the unit, the class and to the case study group.
At the beginning of the introductory session, in order to attain quiet in the class, the teacher said, “OK everyone, just get your books ready quietly, I know you are all excited, but quietly now.” The instruction included an expectation that they were and should have been excited about what was to come.

Throughout observations, the teacher constantly smiled at the children when talking to them as a class, in their small groups and individually. During observations it was noted that the teacher always made time for the students questions and queries. This was done respectfully, always with a smile and taking time to answer the students’ questions fully.
5 Analysis of Results

There are two sections, Managing Information and Managing the Task.

‘Managing Information’ and ‘Managing the Task’ are themes which emerged from classroom observation, video and interview data. These sections are directly related to how the group used Inspiration and concept mapping and metacognitive outcomes of the inquiry process.

5.1 Managing Information

During the construction of the concept map, management of information was a focus for interaction between group members and with the evolving concept map. The types of information management that occurred will be discussed using the categories: Linking Information and Information Monitoring.

5.1.1 Linking Information

Linking information is necessary in the construction of concept maps.

Due to the inclusion of concept mapping from the initial brainstorming stage of the inquiry through to the eventual presentations, additions and adjustments to information and information links were an ongoing part of the concept mapping process. Observations showed that these additions and adjustments were negotiated. The awareness group members had of the negotiated linking process; it’s difficulties and value was highlighted in interview data.
A Negotiated Process

All group members provided input into the creation and alteration of links during the inquiry process and construction of the group’s concept maps.

Negotiating links with other members of the group often meant the students had to justify their suggestions either with facts or using other elements of the task. The following examples have been selected to illustrate this.

While Matthew was constructing the brainstorm in session two, with the three other group members observing, Megan commented, “...huskies, that goes under wildlife”. Matthew placed huskies under wildlife. In this example, no justification for the placement was provided, however there was also no disagreement with this suggestion from the other members of the group (see a, Appendix L2).

In a discussion between Megan and Kate during session five, Megan used the structure of the task itself to justify a suggestion for organising the concept map. Kate asked Megan whether they should make the main idea Antarctica or transport. Megan replied “Antarctica, and then we can put branches out to transport and survival and we’re answering those questions”. The resulting concept maps provide evidence that the group accepted this idea (see b, Appendix L4).

Another linking suggestion that Megan made during session five was that “Huskies” “...could go under history cos they used to travel by husky and now they don’t”. She
suggested the placement and linkage of the concept, and gave factual reasoning for her suggestion. Figure 3 below provides evidence from the concept map and shows that the group accepted this suggestion and reasoning (see c, Appendix L4).

**Figure 3**
Matthew discussed linking during his interview with reference to the difficulties with concept mapping. He highlighted differences in opinion as integral to the difficulties in creating links that the whole group agreed with:

“...different people had different ways of doing it so they clashed a bit... but only a bit, there wasn’t too much of a problem.”

“...we’d spend half the time reorganizing the way they [the concepts] went, like the way it [the concept map] looked because we had so much more information every time. We had to, sort of re-group it every time because it got so much bigger, yeah. So one person would want to do that and one person would want to do that and then, but mostly when that happened it wasn’t too big a deal, we’d sort of ask the other two who weren’t doing it, you know they were researching, what they thought and then we’d decide from that.”

Matthew was aware that integrating concept mapping into the inquiry throughout the process facilitated

During session nine, while Megan, Matthew and Tom were focusing on linking new information to the existing concept map, Matthew commented:

“I don’t know why we don’t just move on from the links”.

This supports his interview comment and the feeling that a great deal of time was spent on linking and re-linking information within the maps. It also highlights the fact that because the computer generated map was adaptable, it was possible to accept the map as it was, continue to move on and return to the linking at a later stage. Megan reminded Matthew of the need to have a final map including careful linking with her response:

“No, cos we have to do more than just add on for our proper, like, end one.”
However, her reference to the final concept map as a “proper” one also highlights the evolving map as temporary and changeable.

These comments highlight the negotiation process that was necessary due to the concept map being an ongoing, shared product of the inquiry. Because there was so much more information to manage in each consecutive session, not only did the map have to be reorganised in terms of linking and grouping, but this had to be done with negotiation and input from other group members. An extended example of this occurred during session four when Matthew translated changes suggested by Kate and Megan onto the concept map:

M: (Crossing concepts out on a hard copy of the brainstorm) We don’t need penguins or birds or anything like that. We need, no, no, no. Food chains, no.
K: We sort of need the huskies but we don’t need the dog part.
S: Do we need tourism by air? Oh, yeah, cos that has, like, the flying thing.
(See d, Appendix L3)

The girls critically analysed the map, identifying the necessary changes through reference to the group’s choice topic and research questions.

Interview evidence supports this claim. Kate stated that the group “started off with, like, um, everything about, like, Antarctica” that they had and then “just broke bits off”. They deleted everything they “didn’t need, like everything about the wildlife, like penguins and stuff like that.”
The resulting decisions they made were communicated to Matthew who was working on the concept map at the time. He then translated these changes onto the evolving concept map. He followed their recommendations and the food chain and birds sections of the brainstorm map were deleted and the link between transport, tourism and air transport formed. The link with huskies was moved from wildlife to transport history. Extra information was then added (see figure 4 below).
Figure 4

Appendix L2: Partial Map

Appendix L3: Partial Map
The Thinking Behind Linking

As highlighted through the group’s negotiation of concept map links, reasoning and justification for changes and additions to the map were necessary. Megan, Matthew and Kate made comments in their interviews that demonstrated an awareness of the need to think more deeply and apply well-developed reasoning when considering links. They provide a view of the concept map as a useful method for stimulating and demonstrating thinking and reasoning.

The examples used in this section also highlight the students’ abilities to verbalise the thinking processes they were using during concept mapping.

Matthew demonstrated awareness of the need to have well-developed reasoning in creating links when he said, “…it [the linking] sort of explains your reasons for thinking things, not just that you think something. You’ve sort of got to give reasons because the links are the reasons.”

Megan thought that concept mapping “makes you think more about stuff, cos, like you have to think about linking it all together” She also mentioned the way forming the propositions in concept mapping encourages deeper thinking about the concepts: “You have to think about what you’ll write to link it and how it links together. Which makes you think more about like, what you want to link together and makes you look at the…information more closely.”
Megan viewed *Inspiration* and concept mapping as useful in the inquiry. This was highlighted when discussing ways the Antarctica unit could be improved. She suggested one improvement to the unit could be letting students choose whether to use *Inspiration* and concept mapping instead of making it a compulsory element of the unit. She thought that given this choice “most people would have used them either way” and that then groups could just use the mapping “as a way to like enhance your information.”

Matthew’s comments on linking made repeated reference to the creation of links requiring reasoning. He also mentioned consideration of the importance of links:

“The way you could link stuff to other stuff, if, like, you looked at it and saw a link, then you could link it and think about why you made that link and if it was important or not.”

Kate referred to the usefulness of the concept map in creating cross-links:

“...if you had wildlife and, um, transport, then you could, then under wildlife there was like huskies, and um, under there was like, under transport there was like, sledges and stuff...you could link huskies with sledges because they sort of helped pull them…”

Despite this awareness, none of the maps contain any cross-links.

Kate mentioned the difficulties of reasoning in creating links and cross-links on the concept maps:

“...sometimes there would be more than one place that the piece of information could go under and sometimes there wouldn’t be anywhere it would fit in.”
Figure 3 highlights another aspect of information organisation and linking that occurred during the evolution of the group’s concept map. The example from concept map three shows that Matthew began changing the shapes of the concept “bubbles” at different levels in the map’s hierarchy. This was not discussed with the rest of the group until session nine of the inquiry when Matthew explained to Megan and Tom that he had a “theory”. In the resulting discussion, Matthew justified and clarified his “theory” and illustrated Matthew, Megan and Tom’s understanding of concept map hierarchy:

Matthew: That, if you, say, the first ones would be a circle and the next ones down from that should be a box, is that right? And then the next one should be a ...

Megan: Triangle

Tom: The main ideas are ovals, then the sub-ideas are squares and then all the ideas from the subs are

Megan: Triangles

Tom: Little roundy-type bubbles. Then the ideas coming off the ideas are diamonds.  
(See Appendix L4-7)

The example above discussing Matthew’s theory behind the shapes used in the concept map provides the only example, in observed sessions or during interviews, of Tom discussing linking.

During observations, Matthew was the only group member to verbalise an awareness of the importance of relationships in the concept map. This was evidenced during a class discussion in which the teacher asked what the class needed to take care with when
presenting their work as a concept map. Matthew volunteered his answer by raising his hand and suggested that the information has to be well related.

5.1.2 Information Monitoring

Concept mapping facilitated the summarising of information and therefore the ability to cope with increasing amounts of information generated during the inquiry.

Summarising

When new information was being added to the concept map, there was often one person reading out facts while another recorded them on the map. Sometimes the person reading out the information from books or other printed material summarized the information. For example, during the brainstorming in session two, Megan read aloud,

“Warm clothing can be worn inside the base…” and immediately rephrased this in her own words to read, “Inside, warm clothing can be worn.”

In this case, Matthew then summarized the phrase further as he recorded it on the brainstorm concept map. The phrase then became “Normal clothing can be worn” with “inside” as the propositional link (see e, Appendix L1).

Figure 5

Concept Map 1 (Appendix L1: Partial Map)
At other times the translation was made directly by the person constructing the map. For example, in session nine, Megan read aloud from a printed information sheet, “…you need to keep your energy up so you need lots of nutrients and vitamins.” Matthew translated this into the following summarised form on the map: “nutrients and vitamins to keep energy up”. He then checked this with Megan.

In response to questions on usefulness during his interview, Tom referred to this ability to use the practicality in using a concept map to summarise a lot of information:

“…if you have like a massive pile of relevant information you have to file through it to see what you want and it might be right at the bottom, but if you have like the concept map, then, um you can just get the main subject that you want and then get all the information quickly and easily.”
5.2 Managing the Task

During the inquiry the group used a variety of references and strategies for planning, delegating and monitoring the completion of tasks in their achievement of success.

The group used the Activities and Assessment Sheet (Appendix K), research questions and concept maps, as references.

Group meetings, utilising the strengths of each person and reliance on the cooperative dynamic of the group were strategies identified.

5.2.1 Activities and Assessment Sheet

The researcher observed the group referring to the Activities and Assessment sheet (Appendix K) to help them plan what to do next and to ensure they understood requirements. The group referred to the sheet in discussion during the selection of an area for study in Antarctica and the development of related research questions. The sheet was not referred to in discussion at any other time during the inquiry. None of the group members mentioned the Activities and assessment sheet as helping them in planning and monitoring their work during interviews.

The researcher observed the group’s use of the Activities and Assessment sheet during session four. Matthew read the task aloud to the group:

😊 Identify one area for class investigation while in Antarctica.

😊 Develop 3 fat and 3 skinny research questions for your chosen area.
Provide answers to your questions using research and explain how and why the class would investigate this area further while actually in Antarctica.

S: And we think of that [one area for class investigation while in Antarctica] and then we do our three, ahh, six questions on that.

The criteria above were then used to identify increasingly more specific elements of the task:

Matthew pointed to the Activities and Assessment Sheet and said, “But look, you’ve got to be able to investigate while in Antarctica. You’ve got to be able to do it there.”

The group then chose transport as their topic and began discussing possible aspects of transport that they could cover. Once the group was ready to begin writing their research questions, Matthew asked Megan how many skinny questions they needed to write. In response, Megan read the criteria aloud to the group again.

5.2.2 Research Questions

Once developed the research questions became a reference for planning, monitoring group progress and delegating tasks. Examples to illustrate this are given in the following sections:
5.2.2.1 Planning

During construction of the concept map in session nine, Megan referred to the questions in planning what to add to the map next:

“We’re going to answer our fat questions”

Matthew’s response is a suggestion that the concept map actually be structured around the questions:

“Can’t we just put all the information under the question headings”

Tom supported this idea and suggested that the map be structured using the skinny questions and the fat questions. Upon rejection of the complete restructuring of the map from Megan, the new ideas for structure were eventually refined and the map was split into two maps, one for the compulsory element of survival, including answers to the related questions and the other comprised of answers to the group’s transport questions.

5.2.2.2 Monitoring Group Progress

In session seven the group focused on finding information, some of which was used and recorded in various ways by the group members. During this session, Megan explained to Matthew a way of using the research questions to monitor what had been completed:

Megan: Um, what we have done, like number one, we just tick them.

Kate discussed this use of the questions in monitoring progress during her interview. When asked what the group did to ensure they were on track with the task, Kate replied, “...well, we focused it on the questions so, um, we, so we were sort of on track quite well because we um, the questions were about the topic and we didn’t really do anything but the questions.”
5.2.2.3 Delegation of Tasks

Also during session seven, the researcher overheard Megan asking Tom and Matthew to spend some time researching the “fat question” about what they would need and why they would need it in terms of transport as scientists in Antarctica.

5.2.3 Group Meetings

In interviews, Tom, Kate and Megan all referred to meetings at the beginning of each inquiry session, in which planning and task delegation for the session were discussed. In these, “everyone would say what they wanted to do and whether that fitted in with everyone else” (Tom). They would discuss what they were “gonna do” (Megan) and “who was going to be doing what” (Kate).

The researcher observed only one of these meetings referred to by Tom, Megan and Kate. This was during the exploration session at the beginning of the unit, where it was decided that Matthew and Tom would look at the CD ROM and Megan and Kate would go to the library. On checking this information with the students, it was discovered that these agreements on who would do what occurred at other times of the day, in class, prior to the inquiry session. The class teacher had the seating arranged so that each inquiry group was sitting together at all times, for the duration of the Antarctica unit. The students felt that this meant they could discuss their inquiry easily at any time of the day.
5.2.4 The Cooperative Group

Data collected illustrate that the case study group demonstrated many of the characteristics of a cooperative learning group as described by Johnson & Johnson (1999, p. 72). Characteristics of the cooperative learning group are listed below. Results have been analysed in response to these characteristics.

High positive interdependence. Members are responsible for own and each other’s learning. Focus is on joint performance. Both group and individual accountability. Members hold self and others accountable for high quality work.

Members promote each other’s success. They do real work together and help and support each other’s efforts to learn

Members promote each other’s success. They do real work together and help and support each other’s efforts to learn

Group processes quality of work and how effectively members are working together. Continuous improvement is emphasized.

A combination of interview and observation data illustrated that the group viewed the tasks within the inquiry and their roles in completing these as interdependent.
The group used individual strengths as a way of completing elements of the task more effectively and more efficiently but maintained a shared approach through providing input and mutual support.

Interview data shows that Megan saw Matthew’s role as using the computer, therefore using *Inspiration* and entering data into the concept map. She saw this role allocation as a way of utilising each person’s skills as effectively as possible and part of achieving a “good” end product:

“...I think we like, used all our skills really well, like Matthew with the computers and I’m good at researching from books and stuff... and our mind maps looked really good.”

During session nine, a comment made by Megan supports the claim that she saw Matthew’s role in creating the concept map as the most efficient way to complete this element of the cooperative task. During this session Megan took over the mapping from Matthew when he had trouble keeping up with the information she was dictating. Her initial response to his question of “Why don’t you type it in?” was “No, I’m reading, unless *you* want to read it out”. Matthew agreed to do this, to which Megan replied, “OK. I warn you, I’m a slow typist.” With Megan at the keyboard, the mapping process would slow down; a feature of the change that Megan felt was worth warning Matthew about.

Tom also commented on Matthew’s computer skills, describing him as a “computer expert” during his interview. He considered that he learnt more about computers having
Matthew in the group. Matthew’s own confidence at using computers was demonstrated by his interview comment that *Inspiration* was “on the computer so it’s easy”.

Analysis of observational data revealed Matthew as playing the central role in the construction of the group’s evolving concept map. Construction is taken to mean that he was physically seated at the computer, manipulating the keyboard and mouse, using *Inspiration* to enter information into the group’s concept map. Matthew took on the key responsibility of translating the group’s information and learning onto the concept map.

Megan saw her role as a researcher from books and other resources because that was what she considered her strength. Translation of this use of individual strengths into group organisation and task management was highlighted when Megan discussed how the group made sure each person did their share of the work:

“…we all did sort of our own thing, that was like, our specialty.”

During the sessions where Megan did take over the construction of the map, she expressed concern about her ability to use *Inspiration* and some of its features well. During session eight when she took over the mapping after Matthew left for band, she unknowingly magnified the view of the map. She reacted to this with slight panic in her voice, thinking that she had lost the map entirely, even after Kate had reassured her of otherwise:

K: I think you just zoomed in.
M: I don’t know what I just did. No, I didn’t zoom in I lost all the stuff. I don’t know!
After another response from Kate, Megan repeated the phrase “I don’t know” again, but this time said, “I don’t know what I’m doing”.

This example exemplifies Megan’s feeling that she was not the best person for the concept-mapping job as she was unsure of what she was doing.

Matthew and Megan were the creators of the concept map in terms of its physical construction using the computer. Megan worked on the concept map three times, compared to Matthew’s six. In the first inquiry session, Megan delegated him to this role. In later sessions his placement in this role was self-initiated.

Megan took over the role of concept map creator when the group did not complete part of the task to her satisfaction (between sessions two and three), when Matthew had to leave and when asked to specifically by Matthew. In this last case, during session nine, her reluctance was shown with the excuse and warning she gave Matthew regarding her slow typing.

Tom was present as an observer four out of nine times during concept map construction and Kate was present as an observer three out of these nine times. However, Tom’s absence during session five and Kate’s absence from sessions nine and ten may have affected these numbers. Neither Tom nor Kate acted as the creator of the concept map at any time during the inquiry.
An interview comment made by Matthew further illustrates the interdependence and that he felt existed within the group:

“...we had about three places, three things you could do at a time, there’d be two on one thing, so then if one person was going slowly then two people would go to that place...”.

Although there were tasks that group members could carry out individually, they would be supported in these if they were having trouble.

The interdependence demonstrated between group members could have been influenced by the very nature of the inquiry task. The steps in the inquiry process are interdependent. Each stage needs to be completed effectively in order to achieve success.

The group demonstrated an awareness of the interdependence within the inquiry process through the nature of the tasks that were undertaken and the time spent on each. The group focused on the concept map as an important part and product of the inquiry, but in the way they divided their time between this and other related activities, they showed recognition of the related importance of other aspects of the task. In four out of seven instances of working on the concept map, all group members present for the session were involved in concept mapping at the same time. In the remaining three sessions, at least one member of the group was involved in another aspect of the inquiry task. This demonstrates recognition by the group that a variety of activities and elements of the task needed to be completed concurrently.
Both Tom and Kate made comments during their interviews revealing that they viewed each group member as having had a role in the creation of the concept map. Tom referred to Kate and Megan as usually “going to the library or helping us with the mind maps”. Despite the fact that he was never actively engaged in creating the map, Tom still felt that he and in fact the whole group had a role in their creation. Kate felt that the whole group had “helped out with the mind mapping”. As two of the group purely observed during concept mapping, Kate viewed observation as part of the concept mapping process.

Despite their allocation of individual roles and tasks, the group helped each other and had input into what each other was doing. Through participating in these supporting roles and in interviews, the group members demonstrated an awareness of the interdependence of their roles and the tasks within the inquiry.

During interviews, Matthew, Kate and Megan discussed teamwork as important in the group’s success.

Matthew’s comments on the division of labour within the group focused on the cooperative nature and dynamic of the group. He felt that they “all sort of did each bit without arguing over who was going to do what”.

Kate also focused more on the cooperative nature of the group:

“…we just talked about what we were going to be doing and who was going to be doing what, like the mind map or the research. And then we just went off and did it…”
“...it was usually me and Megan um, doing the research and Tom and um, Matthew doing the mind mapping bit”.

Megan discussed the way the group talked about what they were going to do and then went and did what they had said they would. She explained that they would then come back and talk about what they had done. This suggests that the group trusted that each person would do as they said they would, demonstrating both a shared commitment to the task and a monitoring of individual accountability.

A common interest in learning was discussed by Megan in a later interview comment when she said that “most of the time we just worked well cos we like learning”. The group used talking as a strategy for checking that what each person said they would do actually happened. As mentioned previously, observation data did not illustrate this existence of meetings, however each group member confirmed later that these meetings occurred at other times of the school day. Throughout the Antarctica unit, the desks in the classroom were organised with the students in the Antarctica groups also sitting together. This made these meetings easier to organise and conduct.

Megan also discussed mutual questioning as a strategy the group used to check on what was being done and to ensure everyone knew what to do:

“Um, like we asked questions about like, what everyone else was doing and what needed to be done and all those sorts of things.”
Data highlighted Megan as the only group member who was observed using questioning with other group members to check what they were doing or what needed to be done. Matthew said that “cooperate” and working together were things the group did well and, like Megan discussed the fact that the group members would accomplish what they set out to. His comment below also illustrates the view that trust in each other achieving what they said they would without disagreements, contributed to the efficient achievement of the task:

Matthew "We’d just do it [each part of the task] without arguing over who was going to do what. We’d just do it, which is, yeah, good cos otherwise you have arguments and you slow down and don’t do the stuff so much”.

The evidence presented supports the fact that the group viewed the tasks and roles within the inquiry as interdependent. This interdependence was dealt with through delegating roles according to the strengths of group members and providing support to each other when needed. Group accountability was based on trust and a shared interest in learning. Group and individual accountability were maintained through strategies such as meetings and questioning. Three group members attributed teamwork and cooperation as factors in the group’s success.

5.2.5 Concept Maps

The researcher found no evidence of the group using concept maps in delegating or monitoring the completion of the inquiry. However the group did use concept maps in planning for the task.
At the beginning of session four in which the group was developing their research questions, the researcher became involved in a discussion about the use of the concept map in the group’s planning. Matthew and Megan began the discussion by telling the researcher that the group had decided to create a PowerPoint slideshow as part of their final presentation. Matthew agreed that they had used the concept map in considering what this slideshow might look like; he directed the researcher’s attention to the concept map in providing an explanation of this process:

“See, the bits around the main one, they’ll be our slides and then we’ll work off them.”

During session four, Megan and Kate used the group’s chosen topic of ‘transport’ and the resulting research questions to physically reduce the amount of information included in concept map two. Megan illustrated her understanding of the importance of this process in planning through a conversation with the researcher during the same session. Megan said that the concept map was “good” for seeing “what we still need”, “to see what we still need to do and what information we need.” Kate discussed using the concept map in a similar way during her interview, but her comments referred to the use of the concept map in narrowing down information, in identifying the information they didn’t need in the deciding stage of the inquiry.

5.2.6 Success

The reported success of the group’s inquiry provides evidence that the group members all felt that the ways they managed the task were effective.
Although Tom felt that spending less time “getting all the information” would be something the group would do differently next time, he had no other suggestions for improvements the group could make on their performance. He felt that the group “achieved what we wanted to achieve, got a little bit extra in”.

Matthew felt that they would be a “bit more organised” to avoid “losing information and stuff”.

Kate and Megan both thought they might choose a different topic.

It is the absence of evidence demonstrating a need for the group to change the way they worked which supports a general acceptance of success in the task. It is important to note that the class teacher did not mark presentations before students were interviewed. Success was not indicated from an external source at that stage.
6 Discussion

Discussion of research findings is structured around the research questions.

6.1 Year Seven and Eight students’ use of *Inspiration* and concept mapping when working in cooperative groups during the process of inquiry

In answering the first research question, the facilitation and engagement of critical thinking through the use of concept mapping, using *Inspiration* will be discussed. The case study group used the concept map as a Mindtool in negotiating meanings and information links.

In making this claim, it is important to return to the definition of a Mindtool and align the results of this study with that definition.

Jonassen (2000, p. 9) describes Mindtools as “computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning.”

Creation of the concept map was a focus for the case study group throughout the inquiry process, from initial brainstorming through to presentation of the group’s research. This was due to the deliberate structuring of the unit by the classroom teacher and the researcher.
The concept mapping process facilitated opportunities for the group to summarise information, negotiate information linkages, cope with increasing amounts of information and reorganise concepts. This was evidenced through dialogue and resulting changes exhibited in concept maps. Integration of concept mapping throughout the inquiry meant that this was an ongoing process (See sections 5.1.1, 5.1.2).

Integration of the concept mapping throughout the inquiry meant that this was an ongoing process. For example, the group adjusted their initial brainstorming concept map once research questions had been formulated. The students deemed some brainstormed information unnecessary for the following stage of the inquiry, as it did not apply to the research questions they had formulated. This information was deleted from the map.

Although Matthew discussed the difficulties in dealing with differences in opinion during this negotiation, no evidence of disagreements or conflict was found in observation data. In a study of the social construction of scientific concepts with high school students, Roth and Roychoudhury (1992) propose that similar acceptance of individual solutions may have been provisional due to the ongoing possibility of returning to the same issue at a later point. Evidence that members of the group saw the group’s concept map as temporary, adaptable and evolving towards a final “proper” map was highlighted in the analysis of results (section 5.1.1).
This context was definitely facilitated by the Antarctica unit design. The independence given to the case study students in terms of managing time and resources made the ongoing review and changing of concept maps possible (see section 4.4).

In order to negotiate these linkages and the organisation of maps, students were required to provide reasoning and evidence for their suggestions and interpretations. They achieved this through dialogue and discussion (See section 5.1.1). Reasoning and evidence was either topic-related and factual or related to the structure and requirements of the inquiry task.

The cooperative nature of the inquiry task, combined with the concept mapping process facilitated the need to think critically about individual interpretations and verbalise this thinking. This finding reflects the view of Jonassen (2000, p. 12) who states, “In constructivist environments such as Mindtools, learners are actively engaged in interpreting the external world and reflecting on their interpretations.”

The linkages and organisation of the concept map represent structures of meaning (Novak & Gowin, 1984). Through negotiating these, group members were actually negotiating their individual interpretations of topic-related meaning. The degree to which these meanings then became shared would require further research. Such research would need to overcome “group attribution error” (Allison & Messick, 1987, cited in Stoyanova & Kommers, 2002, p. 117). This refers to the tendency to assume complete correspondence between group decisions, choices or evaluation with the visions and performance of
individual members of the group. This may take the form of creating and assessing individual concept maps at the conclusion of a similar cooperative inquiry task.

Integrating concept mapping into the inquiry process facilitated the ongoing adjustment of the map. Despite this ongoing opportunity for involvement, evidence from the study highlighted two members of the group as the creators of the concept map in terms of working at the computer and physically manipulating the keyboard and mouse (see section 5.2.4). Matthew played the major role in this construction process. Rather than domination, group members considered this as maximizing the strengths within the group and an efficient and cooperative way to delegate responsibility and achieve success.

Although not actively creating the map, group members took part in concept mapping through observation and discussion. The student constructing the concept map then translated agreed changes onto the computer screen (see sections 5.1.1, 5.2.4). The map therefore acted as a visual representation of information gathered to answer the research questions and of the negotiation process during concept mapping. It was important to have someone creating the concept map that had sufficient computer/Inspiration skills to present the translation of negotiated information links, effectively and efficiently (see section 5.2.4). The computer skills were a means to an end, they were necessary in the use of concept mapping as a tool in constructing and representing the group's information and meanings.
The case study group effectively used concept mapping with *Inspiration* as a Mindtool when working as a high-performance cooperative group during the process of inquiry. The high performing group must possess all elements of the cooperative learning group with the differentiating factor of a high level of commitment of members to each other and the group's success (Johnson & Johnson, 1999).

Strategies the group used in managing the inquiry task illustrated these elements (see section 5.2.4). The group used meetings to plan delegation and completion of tasks. They recognised and utilised the interdependence of their individual skills and contributions through completing some tasks individually, according to strengths and others as collaborative products. Evidence was collected of the group actively monitoring their progress towards success (see section 5.2.2.2), demonstrating a shared commitment to the group's achievement. Megan, in particular promoted the success of other group members using questioning as a strategy to ensure understanding and to check on progress (see section 5.2.4). Interviews provided evidence that the group processed the quality of their work and how effectively they worked together on the project (see section 5.2.4). Mutual support and interdependence of the group in working towards and achieving their shared goal was illustrated through negotiation, helping, checking for understanding and group meetings (see section 5.2.3, 5.2.4).

High performing cooperative groups often perform far above expectations (Johnson & Johnson, 1999). The high-performing nature of the case study group probably affected the amount and quality of critical thinking that was facilitated through cooperative
concept mapping and evidenced through interaction and discussion. Previous research (e.g., Okebukola, 1992) has shown that flavoring concept-mapping strategies with cooperative learning enhances achievement in assessment tasks. Further research would be required to investigate variance in cooperative dynamics and skills and the impact of these on learning.

It would be rare for all cooperative groups within a class to behave as high-performance groups. A multi-case study investigating how groups with differing levels of cooperative skills use concept mapping and Inspiration in inquiry would provide more insight into how such Mindtools could be integrated into mixed ability classroom programmes effectively.

**6.2 Inspiration, concept-mapping and higher order thinking**

The case study group Year Seven and Eight students demonstrated higher order, metacognitive thinking processes when using concept mapping the inquiry and in interviews. This claim was illustrated through:

- Verbalisation of thinking processes
- Verbalisation of the effectiveness and possibilities of concept mapping as a tool

Further discussion of how the research evidence supports this claim is based on the ladder of metacognition presented by Perkins and Swartz (1990, cited in Perkins & Swartz, 1992). This ladder presents four rungs with the most powerful level of thinking at the top of the ladder. The bottom rung of the ladder represents tacit use, the second rung, aware
use, the third rung, strategic use and the top rung, reflective use of thinking practices. The descriptions below provide indicators for each of these levels:

Tacit Use: Making use of different kinds of thinking without any awareness.

Aware Use: Aware use of a variety of thinking practices and being able to label and categorise those practices. This represents thinking about one’s own thinking to only a limited degree.

Strategic Use: Deliberately deploying thinking organisers to guide thinking. Giving deliberate, strategic self-instructions that go beyond labeling and categorizing. This use involves thinking about one’s own thinking in order to direct it.

Reflective Use: Thinking about one’s own thinking and the thinking organisers one uses to critically and creatively revise practices. Examining and reinventing how one thinks.

Evidence from observations showed that the students in the case study group used the concept map to plan aspects of the inquiry, including presentation and the recognition of information gaps and needs. Three members of the group were able to verbalise the thinking processes and strategies they were using. This demonstrated aware rather than simply tacit use of the concept map as a thinking organiser (see section 5.2.5).
The supportive and interdependent way the group organised themselves for the inquiry task meant that negotiation of map structure became an integral part of map construction (see section 5.1.1). The concept map was a group product that required ongoing adjustment and the continual addition of new information in a way that was collaboratively structured to represent meaning. All group members had the opportunity to contribute to the way the concept represented the information collected during the inquiry. This was evident in dialogue used in discussion about the appearance of maps.

Group members justified suggestions verbally, with evidence. This evidence included topic-related facts and task-related statements (see section 5.1.1).

Jonassen (2000, p. 10) claims “Students cannot use Mindtools without thinking deeply about the content they are learning.” Although this verbal justification suggests deeper thinking about the topic, the students were still demonstrating only a tacit level of thinking. When individuals simply use different kinds of thinking, such as seeking evidence and imagining options, without any awareness of what they are doing, they are deemed to be resting on the bottom rung of the ladder of metacognition or making tacit use of thinking processes (Perkins & Swartz, 1990, cited in Perkins & Swartz, 1992).

Interviewing the students about the process of concept mapping in the inquiry required the use of questioning by the researcher. It was this questioning that generated data showing that three of the students were actually aware of the thinking processes they were using, rather than these simply existing as tacit elements of the concept mapping.
process (see section 5.1.1). It may have been the act of questioning that stimulated the reflection necessary for this awareness.

Three students in the case study group demonstrated aware use of thinking practices when responding to the following interview questions:

What did you find useful about concept mapping?

What difficulties did you have when you were concept mapping?

Among the uses and difficulties, the students identified:

- Creating concepts and prioritizing/estimating hierarchies of concepts
- The linking process in concept mapping as a reasoning process
- The deeper thought processes facilitated by the linking process
- The ability to summarise a great deal of information as one visual representation
- Concept mapping as a useful tool for enhancing information
- Reassessing links allowing reflection on the importance of the information conveyed
- The ability to create cross links to show more complex relationships between information

(See section 5.1.1)

The first four features mentioned by the students demonstrate an awareness of the thinking processes facilitated by the concept mapping process. The latter three identify awareness of the possibilities for thinking and representation that concept mapping created.
This was the students’ first experience of concept mapping and it resulted in aware use of
the tool in three students’ thinking. It would be interesting to revisit the students in order
to study ongoing developments in thinking with the continued use of concept mapping,
especially if this became one of a set of cognitive or Mindtools available to the students
to use at their own discrepancy. Perhaps an ongoing commitment to developing a set of
thinking tools for students from which they could choose would help foster the strategic
use and possibly even the reflective use (Perkins & Swartz, 1990, cited in Perkins &
Swartz, 1992, p.64) of such tools and thinking practices. The comment from Megan
suggesting that without it being compulsory and given the choice, many students would
have used Inspiration and concept mapping in the inquiry to enhance their information,
provides hope for such predictions.

6.3 Implications for Teaching and Learning

Due to the nature of the case study, discussion of the implications of this study for
teaching and learning need to be made with care. Findings that have been generated by
this research are specific to the case study group.

This study has demonstrated that initial use of concept mapping using Inspiration as a
context for cooperative inquiry resulted in the engagement and facilitation of
collaborative critical thinking for the students in the high-performance, cooperative, case
study group.
Integrating concept mapping as an ongoing and compulsory element of the inquiry task resulted in the cooperative group continually negotiating information organisation and linkages in positive ways. In order to participate in this process, the students had to justify their suggestions and provide reasoning for their ideas. Thus the process facilitated and engaged critical thinking for the case study group.

Integration of Mindtools into the process of cooperative inquiry can generate a limited degree of metacognition. The definition of cognitive tools includes that they are “devices that support, guide and extend the thinking processes of their users” (Derry, 1990, cited in Jonassen, 2000, p. 10). This description implies that such tools must, through definition, generate tacit use of such thinking processes. In the study this was illustrated through ongoing information reorganisation and negotiation facilitated by the concept mapping process. Three members of the case study group demonstrated an aware use (Perkins & Swartz, 1990, cited in Perkins & Swartz, 1992) of thinking practices during the inquiry and interviews of each student in the case study group. These students were able to explain the role concept mapping played in their thinking.

Much of the evidence supporting an aware use of thinking practices was collected during interviews, when the students were asked specifically about their concept maps and the concept mapping procedure. It may have been the act of questioning itself that generated an aware level of metacognition.
Teacher questioning also generated a limited degree of metacognitive thinking. Evaluative teacher questioning was included throughout the planned lesson conclusions where it was suggested that "Evaluation of progress through questioning and discussion" should take place (see Appendix I). The development of this questioning was left to the classroom teacher's discretion.

After news of the teacher's departure at the end of the term was received scheduling of group inquiry sessions became flexible and changing. Because study groups were working at different times of the day, the teacher conducted evaluative questioning at times with the whole class and at times with the case study group on their own, before they began working and sometimes before the researcher arrived to observe (see section 4.4).

Most evidence collected during these discussions with the classroom teacher illustrated a "tacit use" (Swartz & Perkins, 1990, cited in Swartz & Perkins, 1992, p. 64) of thinking strategies, where the group members described where they were up to and what they planned to do next (see section 4.4).

One group member demonstrated an aware use (Swartz & Perkins, 1990, cited in Swartz & Perkins, 1992, p. 64) of thinking strategies during these observed interactions (see section 0)
The study concluded at the presenting stage of the inquiry, and did not include a final evaluative component as indicated in the Action Learning Process (Gawith, 2000), (Appendix J). Effective inclusion of this component may have stimulated further metacognitive thinking processes.

Evidence suggests that the relationships, interdependence and skills of the cooperative group (Johnson & Johnson, 1999) may have contributed positively to interactions, task management and success during the study (see section 5.2.4). The qualities of the group probably affected the amount and quality of critical thinking facilitated through concept mapping and evidenced through interactions and discussion. The case study group relied on their cooperative dynamic as a strategy for managing the inquiry task. Although they used concept maps, along with the research questions and the “Activities and Assessment” Sheet, as resources in planning, they used individual strengths, supportive behaviour and group meetings as strategies to manage and monitor contributions to the task and task completion. During interviews, both Megan and Kate discussed teamwork as an important factor in the group’s success.

In this study the role of the teacher in setting the scene for the inquiry, managing it and relating to students has not been examined in detail (see section 4.5). Such factors may have had a significant impact on the students and their experience of aspects of the task.

Evidence highlighted responsibility, choice, high expectations and a positive attitude as key features of the classroom teacher’s style and role in the delivery of the Antarctica
unit (see section 4.5). Interview evidence highlighted two of the students' appreciation of the choices they were given as a result of their teacher's instructional style and decisions (see section 4.5).

These elements of instructional style may have had a significant impact on the students' learning, motivation, behaviour and learning during the unit. For example, the case study group's behaviour as a "cooperative learning group" (Johnson & Johnson, 1999) may have been influenced by the enthusiasm and high expectations the teacher showed. Alternatively, or possibly additionally, this behaviour may have been affected by the responsibility and choices the teacher gave them.

Such predictions are supported by Choice theory (Glasser, 1998). Glasser (1998) claims, that while many students choose not to do school work, this does not mean they lack motivation. However, students are not always motivated to do what someone else (the teacher!) thinks they should. If what we are being asked to do "also satisfies one or more of our basic needs", Glasser (1998, p. 44) claims, "a great deal of work gets done." These basic needs include survival, love, power, fun and freedom. (Glasser, 1998).

Glasser (1998) claims that if teachers behave as "lead-teachers" rather than "boss-teachers" students will work harder. This role includes a variety of aspects, including; keeping the needs of students in mind, learning in cooperative groups, continually looking for better ways to teach, emphasising success, examining processes rather than purely outcomes of learning, using assessment and grades to empower students,
establishing a mood of enjoyment, asking the class to set their own rewards and 
recognising that the real power comes from students’ perceptions of the teacher’s 
competence.

6.4 Recommendations for Future Teaching and Learning

This section presents possibilities for translating the research findings into classroom 
practice.

Teachers can facilitate the use of *Inspiration* and concept mapping as a Mindtool through

- The use of cooperative groups; stimulating critical thinking in the production of
  maps
- The process of inquiry; facilitating critical thinking in the ongoing revision and
  organization of maps and the use of maps as a resource in managing the inquiry
  task.

If teachers are prepared to work on integrating and fostering a cooperative approach and
cooperative skills into their programmes, the prevalence of cooperative groups and
possibly high performance cooperative groups within their class could be expected to
increase. Thus the benefits of integrating the use of Mindtools for critical thinking in
cooperative groups would also be greater. The students in the case study group used their
cooperative skills as a strategy to manage the inquiry task. It is therefore recommended
that teachers wishing to stimulate independence and success in cooperative inquiry teach
and nurture cooperative skills. Part of task management included delegation according to
individual strengths within the case study group (see section 5.2.4). This resulted in the “expert”, Matthew completing most of the concept mapping in its physical sense. Teachers could address computer confidence when integrating Mindtools into cooperative learning environments. Inspiration was the vehicle in thinking and computer skills were not a vital part of the inquiry process, but such a non-threatening and supportive environment may provide an effective way of building confidence and skills in students other than the recognised “experts”.

Along with their cooperative skills the case study group relied on the research questions, the “Activities and Assessment” sheet (Appendix K) and the concept map as resources in managing the inquiry task. These resources gave the students references with which to plan, delegate and monitor task completion. The group appreciated the choices they were given within the unit but relied on the boundaries and guidelines these resources gave them. It is recommended that teachers include; developing good research questions, providing choice within boundaries and providing clear expectations for students as elements of cooperative inquiry tasks such as this one.

Results of this study indicate that if teachers use effective questioning techniques higher levels of thinking and metacognition are stimulated. It is therefore recommended that teachers wishing to integrate teaching and learning methods fostering metacognition use questioning as a supporting strategy. Rhodes and McCabe (1992) and McTighe and Lyman (1992) suggest such strategies, each using Bloom’s Taxonomy (1956, cited in

Encouraging students to use such questioning techniques when working in cooperative groups and using cognitive or Mindtools may in turn facilitate more useful, autonomous and higher level thinking and discussion. Providing some tools or strategies to encourage the students to develop these skills rather than telling students how to approach inquiry would allow students to tailor questioning to the specific needs of their group and context in which they were working. This would also support the constructivist learning environment, through providing students with a supporting tool to aid in individual knowledge construction and enhance meaningful learning.

6.5 Future Research Possibilities

A variety of future research possibilities have been identified as a result of this study.

The use of the Inspiration as a Mindtool with a cooperative group allowed all group members to participate in its use despite varying degrees of computer confidence and skills. Further study would be required to investigate the long-term effects of using Mindtools in cooperative groups on the computer confidence and skills of students.

Such an ongoing approach to study may also demonstrate the metacognitive benefits (if any) of integrating Mindtools as a permanent element of a classroom programme and integrated across a range of curriculum areas.
Although this study was not designed to investigate the benefits of using Inspiration for concept mapping rather than pen and paper methods, this comparison would be interesting with this age group in the cooperative inquiry context. Additionally, it would be interesting to study levels of motivation when using the two different methods. There may be novelty value associated with the use of computer-based concept mapping methods. Conversely, a lack of computer or programme knowledge may result in reduced motivation.

A multi-case study based on the same or similar design as this research would be a way of investigating the effects of using concept mapping as a Mindtool with cooperative groups with varying levels of cooperative skills.

The effects of questioning, especially during post-unit interviews leads to the suggestion of exploring the metacognitive effects of combining theory-based evaluative questioning and strategies and concept mapping using Inspiration as interventions in inquiry. It may well be in combination with such strategies that computer-based concept mapping gains strength in generating metacognitive outcomes for students working in cooperative groups.

The classroom teacher may have had a significant impact on how the students in this study worked during the cooperative inquiry process. Future investigation into the effects of the teacher’s role in creating the environment for integrating Mindtools and specifically concept mapping using Inspiration into cooperative inquiry is encouraged.
7 Conclusion

In an age where skills to manage and manipulate information are critical, cognitive tools represent concrete examples of facilitating such skills in constructivist learning environments.

This research was undertaken in order to investigate the complex process of concept map construction and to reveal some of the complexities of learning with computer-based concept mapping as a Mindtool (Jonassen, 1996, cited in Jonassen et al., 1997). Findings demonstrated that while concept mapping, the case study students used the concept map as a Mindtool in the inquiry process.

The *Inspiration* concept map provided an adaptable and evolving representation of the group’s progress through the inquiry. The students in the case study group were involved in an ongoing process negotiating the organisation and linking of information throughout the concept mapping and inquiry processes. Participation in this negotiation required students to provide justification and reasoning for their opinions, thus facilitating and engaging critical thinking.

Students demonstrated a limited degree of metacognition during the concept mapping process.

The four-rung ladder of metacognition devised by Perkins and Swartz (1990, cited in Swartz & Perkins, 1992) was used in discussion of this thinking. Perkins and Swartz
(1990, p. 64) describe four rungs on a ladder of metacognition, climbing from least to most powerful. These levels include: Tacit, Aware, Strategic and Reflective use of different types of thinking. Evidence showed that three out of four of the group members exhibited “aware” thinking at the second rung of this ladder. Evidence collected during observations and interviews supported this claim. The fourth group member demonstrated thinking at a first rung or tacit level of awareness.

It is proposed that further exposure to and experience using concept mapping as a Mindtool may result in the achievement of higher degrees of awareness of thinking for these students.

Evidence of higher order thinking was stimulated through questioning during interviews. This questioning required students to reflect on concept mapping as a tool and a process.

The researcher recommends further investigation into the use of teacher questioning and intervention in combination with concept mapping for stimulating metacognitive thinking in the cooperative process of inquiry.

The case study students worked as a cooperative group (Johnson & Johnson, 1999), demonstrating high levels of commitment to each other and the inquiry task. This may have increased the amount of negotiation and therefore critical thinking that was facilitated during the concept mapping process.
Cooperative skills were a key strategy used by the case study group in managing the successful completion of the inquiry task.

In order to provide optimum conditions for the integration of Mindtools such as concept mapping using *Inspiration* into cooperative learning environments such as inquiry, teachers should also foster the development of cooperative skills in their classrooms.
8 References


Kinchin, I.M. (2001). If concept mapping is so helpful to learning biology, why aren’t we


MasterFILE Elite database.

Stoyanova, N. & Kommers, P. (2002). Concept mapping as a medium of shared cognition
in computer-supported collaborative problem solving. *Journal of Interactive Learning
Research, 13*(1/2), 111-133.

mapping: Provoking and supporting meaningful discourse. *Theory Into Practice, 41*(1),

Publications.

Appendices
20 June 2003

To Whom It May Concern

This is to confirm that I have been fully informed of Kathryn Walrond’s intentions as far as her research is concerned.

I have been briefed as to the nature of the project Kathryn is to carry out and give my consent for our school to partake in the research project. I have seen the information sheets and consent forms being sent home to parents and to students and support Kathryn carrying out this research.

Diane Leggett
Principal
20 June 2003

To Whom It May Concern

This is to confirm that I have been fully informed of Kathryn Walrond’s intentions as far as her research is concerned.

I have been briefed as to the nature of the project Kathryn is to carry out and give my consent for my class to partake in the research project. I have seen the information sheets and consent forms being sent home to parents and to students and support Kathryn carrying out this research.

Shireen Appana
Explanatory Statement for Year 7 and 8 Students

June 17, 2003

Project Title: **Inspiration, Concept Mapping an Inquiry**

My name is Kathryn Walrond and I am studying at Christchurch College of Education.

This term, Mrs Appana is testing a new way of teaching social studies. She hopes that it will make social studies more meaningful and fun for students. I would like to test how well this new method works as part of my Masters degree.

Students who agree to take part in the research would need to be willing to

- Be observed by me and videoed by my research assistant during topic time in class,
- Take part in an interview at the end of the topic.

Mrs Appana has suggested the names of the four children I have asked to be part of this research because they work very well in groups.

The observation videos that I make will only be viewed by me and I will use them to check that what I observe in class is what actually happens. The interview at the end of the topic will be recorded using a tape recorder.

When I write up the results of my research, no student’s names will be included. The College rules say that I must keep all the research information, including videos, for at least five years. None of the information I collect will be used for any type of assessment. It will just be used for my research.

If you agree to take part, you can withdraw at any time by telling Mrs Appana or asking your parent or guardian to write to her for you.

If you have any questions, you can ask your parent or guardian to contact me on the number on their information sheet, or you can ask me when I am at school.

I will share feedback from my research with you at the end of the project.

Because it is important that no one is forced to take part in research when they don’t want to, no student can take part in this research unless both they and their parent or guardian has said they want this to happen.
The Christchurch College of Education Ethics Committee has reviewed and approved this study.

Should you have any complaint concerning the manner in which this research project is conducted, please do not hesitate to contact the Ethical Clearance Committee.

The Chair
Ethical Clearance Committee
Christchurch College of Education
P O Box 31-065
Christchurch 8030

Telephone: (03) 348 2059

Thankyou.

Kathryn Walrond

Telephone: 476 7209
Explanatory Statement for Parents

17 June, 2003

Project Title: Inspiration, Concept Mapping and Inquiry

My name is Kathryn Walrond. I will be working under the supervision of Lindsey Conner, Research Chair at Christchurch College of Education and Sue Collins, a senior lecturer in the School of Professional Development. I am studying for a Master of Teaching and Learning at Christchurch College of Education.

The aim of this research is to evaluate the effectiveness of using a new method of teaching and learning in Social Studies for Year 7 and 8 students in Room 21. We are hoping that this makes the research process more effective and meaningful for students.

I am conducting this research as a case study and Mrs Appana has suggested a group of four students who she feels would be able to work effectively in a group.

During social studies, the group would be observed by me and videoed by my research assistant. At the end of the topic of study, I would interview the group members about their experience of the project they have completed.

No findings that could identify any individual participant will be published. However, data collected must be stored for at least five years according to university regulations. Data collected by me will not be used for assessment or other school uses. Some feedback will be given to students taking part in the research at the end of the study.

If you agree for your child to take part, you can withdraw at any time by contacting Mrs Appana.

If you have any queries please contact me.
The Christchurch College of Education Ethics Committee has reviewed and approved this study.

Should you have any complaint concerning the manner in which this research project is conducted, please do not hesitate to contact the Ethical Clearance Committee.

The Chair
Ethical Clearance Committee
Christchurch College of Education
P O Box 31-065
Christchurch 8030

Telephone: (03) 348 2059

Thank you.

__________________________________________
Kathryn Walrond
476 7209
Inspiration, Concept Mapping and Inquiry

17 June 2003

Mrs Walrond has explained the research project she wants to do. I have talked to
__________ (mum, dad, guardian) about the project. I would like to be observed
during the Antarctica topic and take part in an interview.

I know that I will be videoed and taped and that these tapes will be kept at the College for
five years. My name will not be used when the research is written up.

If I have any questions I know I can talk to Mrs Appana or Mrs Walrond when she is at
school. At any stage I can tell my teacher or Mrs Walrond that I don’t want to take part in
the research any more.

Signed:

Name: _______________________

Date: ____________

Inspiration, Concept Mapping and Inquiry

17 June 2003

Mrs Walrond has explained the research project she wants to do. I have talked to
__________ (mum, dad, guardian) about the project. I would like be observed during
the Antarctica topic and take part in an interview.

I know that I will be videoed and taped and that these tapes will be kept at the College for
five years. My name will not be used when the research is written up.

If I have any questions I know I can talk to Mrs Appana or Mrs Walrond when she is at
school. At any stage I can tell my teacher or Mrs Walrond that I don’t want to take part in
the research any more.

Signed:

Name: _______________________

Date: ____________
Parental Consent Form

I have read the information provided about the research to be conducted in Room 21 of Karori Normal School by Kathryn Walrond. I understand that participation in the research is voluntary and that participants may withdraw from the research at any stage. I understand that identities of participants will be protected and will not be published.

Signature: _______________________

Name: _______________________

Date: _______________________

Learning how to learn

Table 2.3. Strategies for introducing concept mapping in grades seven through college

A. Activities to prepare for concept mapping

1. Make two lists of words on the blackboard or overhead projector using a list of familiar words for objects and another list for events. For example, object words might be car, dog, chair, tree, cloud, book; and event words could be raining, playing, washing, thinking, thunder, birthday party. Ask the students if they can describe how the two lists differ. Try to help them recognize that the first list is things or objects and the second list is happenings or events, and label the two lists.

2. Ask the students to describe what they think of when they hear the word car, dog, etc. Help them recognize that even though we use the same words, each of us may think of something a little different. These mental images we have for words are our concepts; introduce the word concept.

3. Repeat the activities in step 2, using event words. Again, point out the differences in our mental images, or concepts, of events. You may want to suggest at this point that one reason we have trouble understanding each other sometimes is that our concepts are not quite identical even though we know the same words. Words are labels for concepts, but each of us must acquire our own meanings for words.

4. Now list words such as are, where, the, is, then, with. Ask students what comes to their minds when they hear each of these words. These are not concept words; we call them linking words and we use them in speaking and writing. Linking words are used together with concept words to construct sentences that have meaning.

5. Proper nouns are not concept words but rather names of specific people, events, places, or objects. Use some examples and help students to see the distinction between labels for regularities in events or objects and those for specific events or objects (or proper nouns).

6. Using two concept words and linking word(s), construct a few short sentences on the board to illustrate how concept words plus linking words are used by humans to convey meanings. Examples would be: The dog is running. Or, There are clouds and thunder.

7. Have students construct a few short sentences of their own, identify the concept words and tell whether each is an object or event, and also identify the linking words.

8. If you have bilingual students in the class, have them present some foreign words that label the same events or objects. Help the children recognize that language does not make the concept, but only serves as the label we use for the concept.

9. Introduce some short but unfamiliar words to the class such as dire, terse, or canis. These are words that stand for concepts they already know, but have somewhat special meaning. Help students see that meanings of concepts are not rigid and fixed, but can grow and change as we learn more.

10. Choose a section of a textbook (one page is sufficient) and duplicate copies for the children. Choose a passage that conveys a definite message. As a class, ask them to read the passage and identify key concepts. (Usually 10 to 20 relevant concepts can be found in a single page of text material.) Also have the students note some linking words and concept words that are less important to the story line.

B. Concept mapping activities

1. Select a particularly meaningful paragraph or two from a text or other printed material. Have the students read the text and select the key concepts, that is, those concepts necessary for understanding the meaning of the text. List these concepts on the board (or overhead projector) as they are identified. Now discuss with the students which concept is the most important, most inclusive idea in the text.

2. Put the most inclusive concept at the head of a new list of rank-ordered concepts. List the next most general, most inclusive concepts, working through the first list until all concepts are rank ordered. There will not always be agreement among the students on the ordering, but usually only a few major differences in ranking of the concepts will arise. This is OK because it suggests that there may be more than one way to see the meaning of the text.

3. Now begin constructing a concept map, using the rank-ordered list as a guide in building the concept hierarchy. Have students help in choosing good linking words to form the propositions shown by the lines on the map. One good way to have them practice map making is to have students write concept words and linking words on paper rectangles and then rearrange these rectangles as they get new insights on the map organization. (See Figure 2.10.)
Learning how to learn

Table 2.3. (cont.)

4. Now look for cross links between concepts in one section of the map and concepts in another part of the concept “tree.” Have students help to choose linking words for the cross links.

5. Most first effort maps have poor symmetry or some concept clusters poorly located relative to other more closely related concepts or clusters of concepts. Reconstruct the map if this would be helpful. Point out to students that at least one and sometimes two or three reconstructions of a map are needed to show a good representation of propositional meanings as they understand them.

6. Discuss the concept map scoring criteria in Table 2.4 and score the concept map constructed. Point out possible structural changes that might improve the meaning, and perhaps the score, of the map.

7. Have the students select a section of text or other material and repeat steps 1–6 on their own (or in groups of two or three).

8. Student-constructed maps can be presented to the class on the blackboard or overhead projector. “Reading” the map should make clear to other students in the class what the text was about, as interpreted by the map maker.

9. Have students construct a concept map for ideas important in a hobby, sport, or special interest they have. These might be posted around the room and informal discussion encouraged.

10. Incorporate one or two concept mapping questions in your next text to illustrate that concept mapping is a valid evaluation procedure that demands hard thinking and can illustrate understanding of the subject matter.
The following steps are suggested to facilitate the integration of concept mapping software into a classroom learning environment (adapted from Jonassen, 1996, cited in Jonassen, 1997).

1. Familiarise students with computer-based concept maps by allowing them to navigate existing maps.
2. Students should begin to build maps with familiar content. A concept map of their family and friends is a good beginning.
3. When students begin mapping content domains that they are studying, help them to set an appropriate perspective for analyzing a domain of knowledge (eg. Thinking like a biologist).
4. Identify a set of important concepts by brainstorming, analyzing texts, or other means.
5. Create, define, position according to semantic distance, and elaborate nodes with text and graphics.
6. Construct and label links to represent meaningful interrelationships among concepts. Identifying clear, descriptive, and meaningful link relationships is the most difficult part of the process.
7. Evaluate the concept map with respect to the viability of the information included and the meaningfulness of the links.
# Social Studies Unit Planner

**Year:** 7/8  
**Teacher/Syndicate:** Shireen Appana  
**Duration:** 3-4 weeks

## Unit/Topic/Theme

Antarctica

## The Big Questions

- How would Room 21 survive a week in Antarctica?
- What specific area would you study or investigate while in Antarctica and why?

<table>
<thead>
<tr>
<th>Achievement Objective</th>
<th>Level</th>
<th>Processes</th>
<th>Essential Skills</th>
<th>Thinking Skills</th>
</tr>
</thead>
</table>
| Resources and economic Activities |      | Inquiry  
Collect, process and communicate information about human society | Communication  
Work and study  
Numeracy  
Information  
Problem-solving  
Self management and competitive  
Social/cooperative  
Physical | Questioning  
(Fat and Skinny)  
Planning  
Summarizing  
Comparing  
Problem solving |
| Social Organisation            |       | Values Exploration                                   |                                                       |                                           |
| Place and Environment          | 4     | Why and how people find out about places and environments |                                                       |                                           |
| Time, Continuity and Change    |       | Social Decision Making                               |                                                       |                                           |
| Culture and Heritage           |       |                                                       |                                                       |                                           |

## Learning Outcomes

The students will be able to

1. Outline key aspects of clothing, safety and behaviour necessary for a class of year 7 and 8 students to survive a week in Antarctica, giving reasons for these choices.

2. Identify one area for class investigation while in Antarctica. Develop 3 fat and 3 skinny research questions for your chosen area. Provide answers to your questions using research and explain how and why the class would investigate this area further while actually in Antarctica.

3. Present an Inspiration concept map and one other resource, which outlines the findings from outcomes 1 and 2.
Learning Experiences:

Preparatory Activities

Inquiry Review
Use Action Learning Guide to review stages and skills required using jigsaw approach or similar.

Cooperative Skills
Use drama game or similar to highlight/review necessary skills for cooperative work.

Introductory Activity
1. Classroom set up for exploration of a range of resources on Antarctica. Background music. Students encouraged to view, read, discuss and interact with the resources. Resources chosen to reflect a wide range of features and issues related to Antarctica and including:
   - Climate
   - Marine Life
   - Tourism
   - Ecosystems
   - Explorers
   - Research
   - Ozone Depletion
   - Pollution

2. Skit performed by teacher/s introducing the two problems/questions. Scenario of teachers planning a class trip to Antarctica and requiring student input and ideas.
3. Pre-formed Cooperative groups brainstorm their initial ideas using Inspiration. Save in Antarctica group files.
4. Initial ideas/brainstorms are shared with the class and discussed.

Formative Assessment Opportunities
- Emerging concept map
- Observation
- Thinking Paths completed
- Self/group assessment at different stages in Inquiry

Summative Assessment Opportunities
- Concept Map
- Other Resource Completed
- Group Evaluation

Unit Overview
- Action Learning Approach
- Exploration Activities followed by research sessions
- Research sessions structured with direct teaching of related thinking skills at the beginning of each session
- Students in control of their research with movement back and forth in the research continuum encouraged
- Display areas with supporting resources, research prompts, student work and Inspiration support- flexibility allowing students to contribute to displays
- Each research session to include formative group/individual evaluation through discussion, plan revision etc. (Inquiry timeline can be used as a reference for this).

ICT Tools
- Internet
- CD ROM
- Inspiration
- Phone
- Fax
- Email

ICT Application
- Web searches
- Finding
- Using and Recording
- Presentation
- Finding
- Finding
- Finding
Resources / Materials

- Books, visuals, CD ROM, videos for Exploration Activity
- Action Learning Time line
- Pre-made display area including areas for student generation of information, vocabulary and resulting presentation work (Concept maps etc.)

Teacher Reflection
<table>
<thead>
<tr>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thinking Focus: Questioning (Fat and skinny)</strong></td>
<td><strong>Thinking Focus: Planning</strong></td>
<td><strong>Thinking Focus: Problem Solving</strong></td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td>- Hamburger article</td>
<td>- Allow students to browse the template menu in Inspiration</td>
<td>- Groups work together to solve a maths problem</td>
</tr>
<tr>
<td>- Article shared as a class.</td>
<td>- Practice</td>
<td>- Class brainstorm steps they went through to solve the problem</td>
</tr>
<tr>
<td>- Groups develop fat and skinny questions and share.</td>
<td>Students use inspiration to design their own adaptation of the planning template to use throughout the unit or use one already available in the template menu.</td>
<td>- Discuss similarities with the maths problem and the social studies problem they have to solve.</td>
</tr>
<tr>
<td>- Discuss positives and negatives of each type of question</td>
<td>- Fill in what they are able to so far-plan working backwards from the deadline</td>
<td></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
<td>Students work on ‘finding’ stage of inquiry</td>
<td>- Practice</td>
</tr>
<tr>
<td>- Students use initial concept maps to generate their own fat and skinny research questions</td>
<td>- Discuss how the plan worked today – does it need adjusting?</td>
<td>- Complete problem solving sheets for Antarctica</td>
</tr>
<tr>
<td>- Teacher guides process and helps with question modification</td>
<td>- Plus/minus/interesting of ‘finding’ so far.</td>
<td>- To be included in folder at conclusion of inquiry.</td>
</tr>
<tr>
<td>- Students encouraged to reflect on the assessment criteria when writing questions</td>
<td></td>
<td>- Students work on finding/using and recording stage of inquiry</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
</tr>
<tr>
<td>- Possibly sharing some questions</td>
<td>- Possibly sharing some questions</td>
<td>- Discuss progress – problems, high points, low points so far</td>
</tr>
<tr>
<td>- Discuss purpose and possible audiences for research findings</td>
<td>- Discussed how the plan worked today – does it need adjusting?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesson 4</th>
<th>Lesson 5</th>
<th>Lesson 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thinking Focus: Predicting</strong></td>
<td><strong>Thinking Focus: Summarising using skimming and scanning</strong></td>
<td><strong>Thinking Focus: Comparing</strong></td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td>- Show students example of completed future timeline.</td>
<td>- Students given a stimulating piece of text and a short relevant summary</td>
<td>- Students give three different pieces of information on the same topic – one bogus</td>
</tr>
<tr>
<td>- Discuss the difference between the probable and preferred futures perspectives</td>
<td>- In groups use blue hat to devise the steps you think you would need to use to summarise the article?</td>
<td>- They must come up with a graphic organiser using inspiration or on paper (may be one they have used before, eg Venn d.) to compare the three information sources and show up any incongruence between them</td>
</tr>
<tr>
<td><strong>Practice</strong></td>
<td><strong>Practice</strong></td>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td>- Could this sort of analysis be used in your study of an Antarctic issue? How?</td>
<td>- Use skimming and scanning hints to create a brief summary.</td>
<td>- Discuss findings</td>
</tr>
<tr>
<td>- Students encouraged to use this thinking path if applicable to their topic.</td>
<td>- Why might another student’s summary differ but still be of the same standard? (different purpose for summary – different topic/question/focus)</td>
<td>- What have we learnt that could affect our research?</td>
</tr>
<tr>
<td>- Continue inquiry process in groups.</td>
<td></td>
<td>- How will you apply what you have learnt in your work today?</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
</tr>
<tr>
<td>- Evaluation of progress through questioning and discussion.</td>
<td>- Evaluation of progress through questioning and discussion.</td>
<td>- Continue inquiry process in groups.</td>
</tr>
<tr>
<td>- Share any thoughts/uses of the future timeline</td>
<td>- Share examples of ‘excellent’ topic related summaries completed during the session</td>
<td>- Evaluation of progress through questioning and discussion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- How did you apply what we learnt about either comparing in general or comparing information sources in your work today?</td>
</tr>
<tr>
<td>Lesson 7</td>
<td>Lesson 8</td>
<td>Lesson 9</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Thinking Focus:</strong> Presenting</td>
<td><strong>Thinking Focus:</strong></td>
<td><strong>Focus:</strong> Assessment</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td>- Four-five different presentation method examples are around the room.</td>
<td>- Recap presentation features through teacher questioning and discussion.</td>
<td>- Group feedback on what still needs to be done before presentations are ready. This is to be completed by the end of the session.</td>
</tr>
<tr>
<td>- In their groups, students move around the stations noting the plus, minus and interesting factors of each method for the group to use in addition to the concept map for presentation</td>
<td>- Independent Activity</td>
<td>- Groups to identify key tasks for the day, including time frames for each task.</td>
</tr>
<tr>
<td>- Share findings</td>
<td>- Groups continue work on research/presenting.</td>
<td>- Independent Activity</td>
</tr>
<tr>
<td>- Practice</td>
<td>- Conclusion</td>
<td>- Task completion</td>
</tr>
<tr>
<td>- Groups adapt plan to include the presentation phase and begin work on presentation if ready</td>
<td>- Evaluation of progress through questioning and discussion.</td>
<td>- All groups hand in folders of work and presentations, including any computer generated presentations on disk or with a reference to the student files for the teacher to follow.</td>
</tr>
<tr>
<td>- Research continues for others</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
<td><strong>Conclusion</strong></td>
</tr>
<tr>
<td>- Evaluation of progress through questioning and discussion.</td>
<td>- Discussion of methods chosen</td>
<td>- Findings from evaluation and possible solutions to any problems collated on a class list on the board. This can then be published and used in future teaching and learning or specifically in future inquiry units.</td>
</tr>
</tbody>
</table>

**Lesson 10**

**Thinking Focus:** Evaluation

<table>
<thead>
<tr>
<th>Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In their groups, students discuss and report back answers to the following questions:</td>
</tr>
<tr>
<td>- What is evaluation?</td>
</tr>
<tr>
<td>- Why do we need to evaluate?</td>
</tr>
<tr>
<td>- How have we evaluated so far?</td>
</tr>
</tbody>
</table>

**Practice**

- In their inquiry groups, students are then guided through the process of writing and responding to their own evaluative questions.
- Jigsaw approach then used to mix members from teams for sharing and further discussion of the evaluation.

**Conclusion**

- Findings from evaluation and possible solutions to any problems collated on a class list on the board. This can then be published and used in future teaching and learning or specifically in future inquiry units.
**It's easier in STAGES**

1. **DECIDING**
   - How can I go and "look it up" if I don't know what I'm looking up, and why, and if I haven't worked out what I know already?

2. **FINDING**
   - Do I know what I want?
   - Where to find it?
   - How to find it when I get there?

3. **USING**
   - Is photocopying the only way?
   - If I ask the right questions, will I find the right answers?

4. **RECORDING**
   - [Diagram of recording process]

5. **PRESENTING**

6. **EVALUATING**
   - I feel like a researcher
   - I do not feel like a researcher
‘Chill Out’ In Antarctica - Activities and Assessment

<table>
<thead>
<tr>
<th>Group Names:</th>
<th>Pass</th>
<th>Pass with Merit</th>
<th>Pass with Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>◊ Outline key aspects of clothing, safety and behaviour necessary for a class of year 7 and 8 students to survive a week in Antarctica, giving reasons for these choices.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>◊ Identify one area for class investigation while in Antarctica.  ◊ Develop 3 fat and 3 skinny research questions for your chosen area.  ◊ Provide answers to your questions using research and explain how and why the class would investigate this area further while actually in Antarctica.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>◊ Present one or more Inspiration concept maps for numbers one and two, which outline the main concepts you discover.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>◊ Present your group’s ideas and information to the class using your concept map and one other resource produced by the group.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following items need to be in your research folder at the end of the Inquiry:  ◊ Your research plan  ◊ A black and white printout of your concept map  ◊ Thinking paths used  ◊ Research notes

Overall Grade

<table>
<thead>
<tr>
<th>Comment:</th>
<th>Marking Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>All parts of the activity are completed. Limited accuracy, information needs to be more concise. Evidence of some organisation. Limited creativity.</td>
</tr>
<tr>
<td>Pass with merit</td>
<td>All parts of the activity are completed to a very good standard. Usually accurate and concise information. Good organisation and creativity.</td>
</tr>
<tr>
<td>Pass with distinction</td>
<td>All parts of the activity are completed to an impressive standard. Consistently accurate and concise information. Excellent organisation and creativity.</td>
</tr>
</tbody>
</table>
canvas long leg boots with rubber soles are worn with feltliners and warm socks.

Mukluks, originally made from seal and reindeer skin.

A shirt on top

These boots were use by the Inuits.

Topped with waterproof outer

Hats, ballaclava, gloves, undermats, sunglasses

When you exhale into cold air, you loose alot of your body heat. If you could trap the heat as you exhale, you would stay warmer.

A layer of thermal underwear

Normal Clothing can be worn

polar-tech pants

inside

Animals

Survival

Breathing

This is how the Emperor penguin's nose work

Coat themselves in a thin layer of snow to stop the wind percutating their fur

Huskies

Treaties

History

Wild life

Antarctica

Sea

Air

Tourism

Transport

Sea Life

Land Bound

Birds

Amphibious

Food chains

Marine

Food chain
This is what can happen if your feet get too cold - Frostbite!!
Most ships sail from Patagonia, South America.

Captain Ross was the first to sight Antarctica in 1840 in a boat.

Early explorers and private yachts.

Sightseeing and modern transport.

Most tourists come to Antarctica on cruise ships.

Transport on land, sea, and air.

Examples of vehicles.

Huskies, well used and famous.

Transport includes:
- Skidoos, who makes them? This site has the brands.
- Our Questions and Answers (Slide Show).
- History 150 years ago.
- About aeroplanes in Antarctica.
- Transport you would have used.
- Larger Eskimo or Greenland husky, weighs 45kg.
- Malamute, smaller than Greenland husky.
- Siberian huskies, smaller still.
- Smallest pure bred husky is the Samoyed husky.

In some ways, huskies are more economic than motorised vehicles today. They do not pollute the air with exhaust smoke and chemicals that damage the ozone layer.

However, in other ways, huskies damage the environment just as badly. In 1984, huskies were removed from Antarctica because they disturbed the environment by killing and eating the seals. They also disturbed other wild life.

Husky behaviour shows that both modes damage the environment.

Seal meal was their main diet. Now replaced by kitchen scraps and wallpaper samples.

They have spent their entire life outdoors.

They were used to pull sledges. Now used as back-up and recreational transport or for different purposes.

In 1991, led to a new disease in the Antarctic Treaty.
Avoid conflict and be more considerate and respectful.

Supportive

Your classmates, teacher, other adults, yourself

need to support

Behaviour

Try to get on with people

Our Questions and Answers (File: Shoe)

Survival

meal and fish

A balanced diet

dairy products

Healthy foods like fruit, vegetables and bread

calorie rich foods for generating heat for your body

Food

Numeral and vitamins to keep energy up

Not foods and drinks to keep warm

Construction that will stay up in the windy conditions and that will also keep you warm

This is what can happen if your feet get too cold - Frostbite!!

layers

1) thermal undies

2) polar-tech pants, a shirt on top

3) normal clothing can be worn inside

4) hats, balaclavas, gloves, underwear and sunglasses, woolen mittens

5) top with wind proof outer layer

6) shoes: canvas long-leg boots with rubber soles are worn with felt liners and warm socks: you can also wear thermal boots

shelter

7) mainkkaa, originally made from seal or reindeer skin are boots you can also wear
Extended Abstract
Management of the Inquiry Process through Concept Mapping with *Inspiration*

Due to rapid changes in society and the world the focus within education is changing. In a world where there has been an information explosion, a key focus has become managing information, not memorising facts (Speer-Cameron, 1992).

In order to manage information effectively in the inquiry process, students need to develop appropriate skills “as they collect, process and communicate information about human society” (Ministry of Education, 1997).

The purpose of this study was to investigate the results of using concept mapping through the computer tool *Inspiration* for mediating the use of these skills.

**Conceptual Framework**

Response to rapid changes in society and the world has resulted in changes to educational policy, pedagogy and practice. Many of these changes reflect a rise in the popularity of constructivist approaches to teaching and learning.

A constructivist orientation includes multiple approaches and perspectives (Daley, 2002). Within these, knowledge has taken on new definitions. Jonassen (2000) explains three types of knowledge within the constructivist paradigm: declarative, procedural and structural. A brief outline of each is provided below.
Declarative

- What you remember
- Awareness of an object, event or idea

Procedural

- Knowledge of how to use declarative knowledge
- What you know how to do

Structural

- Connects declarative and procedural knowledge
- “Knowledge of how the ideas within a domain are integrated and interrelated”
  (Diekhoff, 1983 cited in Jonassen, 2000, p. 61)

Other terms for structural knowledge include cognitive structures, conceptual knowledge and semantic networks (Jonassen, 2000).

The notion of “meaningful learning” is embedded in constructivist theory, and utilises the processes involved in structuring and integrating knowledge. Jonassen, Reeves, Hong, Harvey and Peters (1997, p. 290) align “meaningful learning” with Ausubel’s assimilation theory, which is based on the assumption that “human thinking involves understanding concepts as well as the relationships between them.” The learner is able to link new, specialised concepts to more general concepts already known, which then become the foundation for the learner’s cognitive structure (Jonassen et al., 1997).

Rhoades and McCabe (1992) claim that thinking skills or strategies are used as a basis for developing these new understandings. Through experiencing different ways of thinking,
new strategies or paths are added to a learner’s repertoire. The way we view and interpret the world around us is dependent on the network of thinking paths we have available (Rhoades and McCabe, 1992).

The notion of “cognitive modifiability” drives the thinking skills movement (Hyerle, 1996, p. 72) and is based on the premise that educators are able to “facilitate and improve students’ intellectual abilities” (Hyerle, 1996, p. 72). This idea is not a new one. Vygotsky (1978, p. 126) states, “…if one changes the tools of thinking available to a child, his mind will have a radically different structure”.

Cognitive tools are intended to engage and facilitate cognitive processing in the learner through controlled mediation (Stoyanova and Komsers, 2002). Their role in cognitive modification lies in enhancing the cognitive powers of learners during thinking, problem solving and learning (Jonassen et al., 1997).

Concept maps - also known as cognitive maps or organisers, semantic networks or visual/graphic organisers (Guastello, 2000) - act as cognitive tools, enhancing the interdependence between declarative and procedural knowledge which enhances structural knowledge (Dabbagh, 2001).

Concept mapping requires learners to link known concepts to new knowledge using a visual representation of both sets of concepts and their related, propositional links (Novak & Gowin, 1984). It has proven learning benefits for students. These include:
• Increased problem-solving abilities (e.g., Novak et al., 1983),

• Improved comprehension abilities (Guastello, 2000)

• Better meaningful learning for cooperative groups (Okebukola & Jegede, 1988)

• Increased understanding of learning processes by students (Daley, 2002)

• Also, computer-based concept mapping is beneficial as a mediating tool for group collaborative learning, both at group and individual level (Stoyanova & Kommers, 2002)
An example of a concept map for water is provided below:

Novak and Gowin, 1984, p. 16

When computer programmes act as cognitive tools, Jonassen (1996, cited in Jonassen et al., 1997) labels them “Mindtools”. Jonassen (2000, p. 9) describes Mindtools as “computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning.” The term “Mindtool” refers to this definition in the remainder of this article. Computer-based concept mapping software such as Inspiration
enables much easier and possibly enables the production of more powerful concept maps (Jonassen et al., 1997).

When learners actively create their own concept maps, the concept map acts as a tool in meaningful learning. Learners have to create their own meanings (Novak and Gowin, 1984) through the creation of a hierarchy of prepositional links and cross-links, meanwhile assimilating new knowledge into their existing knowledge structure (Jonassen et al., 1997).

The concept map is both a knowledge representation tool (Jonassen, 1993, Stoyanova & Kommers, 2002) and a knowledge construction tool (Novak and Gowin, n.d., McAleese, 1998). Some theorists question the role of the concept map as a complete externalisation and representation of knowledge structure. There is doubt about whether the dynamic nature of structural knowledge and the complexity of cognitive structure can actually be depicted in concept maps (Jonassen et al., 1997).

Changing the view of the concept map from a representation of learning to a learning environment depicting results of knowledge construction (McAleese, 1998) addresses these concerns. The map then becomes a snapshot of the results of a process rather than a snapshot of what has been learnt.

Many theorists and researchers interested in the use of concept mapping with cooperative groups support this idea. Crook (1998) highlights the importance of the concept map in
the process of cooperative learning. Crook (1998) claims that the more abstract the problem, the more useful it may be to have external representations that support the construction of shared understandings. Despite still labeling the concept map as an external representation, the focus is on the concept map as part of a process rather than as the result of that process.

Roth and Roychoudhury (1992) found that in completing concept maps as cooperative groups, the concept map became an interactive tool and a means of negotiating meaning between participants, allowing multi-dimensional communication. Roth and Roychoudhury (1992, p. 551) concluded “the process of mapping concepts as a group activity may be more important than the concept map itself”.

Whether seen as a knowledge representation tool or a knowledge construction tool, there is widespread agreement among theorists located that concept mapping is beneficial to metacognitive processes in learners.

Flavell (n.d., cited in Perkins, 1995, p. 83) coined the term “metacognition” and defined it as “meaning people’s knowledge of and management of their own cognitive functioning.”

Perkins and Swartz (1990, cited in Perkins & Swartz, 1992) present a ladder of development and use of metacognition. This ladder proposes four rungs with the most powerful level of thinking at the top of the ladder. The bottom rung of the ladder
represents tacit use, the second rung, aware use, the third rung, strategic use and the top rung, reflective use of thinking practices. The descriptions below provide indicators for each of these levels:

Tacit Use: Making use of different kinds of thinking without any awareness.

Aware Use: Aware use of a variety of thinking practices and being able to label and categorise those practices. This represents thinking about one’s own thinking to only a limited degree.

Strategic Use: Deliberately deploying thinking organisers to guide thinking. Giving deliberate, strategic self-instructions that go beyond labeling and categorizing. This use involves thinking about one’s own thinking in order to direct it.

Reflective Use: Thinking about one’s own thinking and the thinking organisers one uses to critically and creatively revise practices. Examining and reinventing how one thinks.

Jonassen et al. (1997) claim that concept mapping is predictive of higher order (metacognitive) thinking. Dabbagh (2001) notes the dependence of structural knowledge on cognitive and metacognitive strategies the learner uses while acquiring knowledge. Hence the use of a tool like concept mapping, which aids in the development of structural knowledge, relies on the cognitive and metacognitive strategies of the learner.
More than simply relying on metacognitive strategies the learner already possesses, McAleese (1998, p. 260) explains that when learners use computer-based concept mapping software such as Inspiration over a period of time, the programme allows learners to engage in metacognitive thinking through ongoing “reflection in action and reflection on action” in regard to a particular topic.

In order to study a cooperative group of Year Seven and Eight students using Inspiration in the process of concept map construction, a case study group of four students was observed during an inquiry unit on Antarctica. The intention was not to analyse the effectiveness of Inspiration as concept mapping software, but to examine how the students used concept mapping and Inspiration and the higher order learning outcomes of this process.

**Research Questions**

In this study a class of Year Seven and Eight students learned to create concept maps using Inspiration 7. Concept mapping was then integrated into an inquiry unit on Antarctica in which the students worked in cooperative groups. One cooperative group of four students became the focus for this case study. Participant observation, concept maps and semi-structured interviews generated data for the analysis of concept mapping within this context. The following research questions guided the research:

- How do Year Seven and Eight students use concept mapping and Inspiration when working in cooperative groups during the process of inquiry?
• In the group studied, how does students’ use of *Inspiration* as a concept mapping tool affect higher order thinking?

• What are the implications for teaching and learning?

Before the inquiry unit began the class teacher taught the class how to create *Inspiration* concept maps as an integrated part of a variety of units of class work.

Four students were selected by the class teacher to participate in the case study group. Selection of the case study students was based on each student exhibiting a high level of “social and cooperative skills” as outlined in the New Zealand Curriculum Framework (Ministry of Education, 1993, p. 19). Students and their parents were provided with information about the research and completed consent forms before research began.

Two of the students were in Year Seven and two were in Year Eight. A boy and a girl from each age group were selected, however sex was not a criterion for selection. The students were given pseudonyms to protect their identities. These and the age group of each student are listed below:

Megan       Year 8
Matthew     Year 8
Kate        Year 7
Tom         Year 7
The inquiry unit took place over five weeks and included ten sessions. Data from these sessions was collected using participant observation. Each session was filmed and tapes transcribed for later analysis. Concept maps were collected at the end of the six sessions in which the students worked on them.

At the end of the unit, each student was interviewed individually using the following prompts and questions:

Tell me about your experience of the Antarctica unit.
What do you think your group did well?
How did you organize your group?
How did you ensure that everyone knew what to do?
What did you do to make sure the group was on track?
Tell me about the ways you organized the information that you found.
Tell me about your concept maps.
What did you find useful about concept mapping?
What difficulties did you have when you were concept mapping?
What did you like about using Inspiration?
What didn’t you like about using Inspiration?
How do you think the Antarctica unit could be improved?

Concept map data was used in triangulation with observation and interview data.
The Antarctica Unit

The classroom teacher and the researcher planned the Antarctica unit collaboratively. The key features of the Antarctica unit for the purposes of this research were that it contained the progressive construction of a concept map by the case study group and that the task was structured cooperatively.

The Action Learning Process (Gawith, 2000) was used as a basis for the progression and stages within the inquiry.

The inquiry groups were provided with coloured manila folders at the beginning of the unit. These were for storing all group resources gathered during the inquiry. An “Activities and Assessment Sheet” was glued to the front of each of these and the groups designed and wrote a group name on the back of their folder. The “Activities and Assessment Sheet” contained a detailed outline of the assessment criteria for the unit including the individual components of the inquiry that needed to be completed by each group.

The class teacher used her professional discretion when delivering the structure and content of lessons as outlined in the unit plan. One example of this divergence was evaluative questioning used by the teacher. Although this was mentioned in the conclusions to the planned lessons, feedback about progress was requested and guidance from the class teacher was given at a variety of times and in a variety of ways during the unit and the final, evaluative lesson of the unit was not completed.
The teacher gave the students feedback on progress both to the whole class and to members of the case study group individually. However discussion of planning and next steps for groups was usually undertaken with individual groups and through instructions rather than questioning. This was consistently the case once time became restricted after the announcement of the class teacher’s imminent departure at the end of the term. Both of these processes were illustrated during session eight of the inquiry. The teacher addressed the whole class to guage progress for each group. In this process, each group was asked to share their chosen issue for study, one of their “fat questions” and information they had found to answer that question so far. This class sharing was followed by a discussion with the case study group where the teacher asked them to use the session to spend time researching their question about what transport they would need as scientists in Antarctica and to find some information on flying in Antarctica.

The announcement of the class teacher’s departure at the end of the term meant that the unit had to end by that time. Time pressure was increased. The news of the classroom teacher’s imminent departure had the following consequences for the unit:

- Students were allowed to choose sections of the day when they would like to work on the inquiry and when other work was up to date. (These had to be checked with the teacher)
• The case study group had to make these decisions at least one hour before they intended to work on the unit so that the researcher and field assistant had time to get to the school

• Resources actually became more easily accessible to students through this flexible timetabling as there were fewer students requiring the resources at any one time

• Sometimes the case study group missed out on class discussions on progress or planning through being allowed to work in other areas of the school

• The teacher spent time with individual groups reflecting on progress and planning their next steps

When the teacher was working with the whole class and alone with the case study group a number of features of the teacher’s manner and approach became evident.

The teacher demonstrated trust in the students and high expectations in standards of work and behaviour.

For example, trust was demonstrated in session four when the teacher told the case study group that, as they did not need as much guidance, they could go and work upstairs in the library if they wished. This meant the students were under the supervision of the librarian, but had the freedom to work on computers with books and with the freedom to use their time and resources as they saw fit. Matthew expressed his appreciation of this
freedom in the use of resources during interviews, stating that he thought that the unit was fun because students “could use all the resources that we wanted”.

The group was also given the responsibility of working on their own during sessions five through to nine with only peripheral supervision from neighboring classroom teachers.

The high expectations the teacher demonstrated to the class were noted from the beginning of the unit. The first class discussion observed by the researcher began with the teacher telling the class that because they had worked so well in the previous unit, the Antarctica unit would take them to an even higher level of thinking. This suggests that the class was already thinking at a high level and she expected this to improve even further.

High expectations in terms of behaviour were reinforced through the choices the teacher gave students in managing their time and resources and, in terms of the case study group, in where they chose to work. Megan liked these choices and the autonomy they gave the group, stating in her interview that “we sort of got left to do our own thing more and like, we chose what we were doing more and all that, which was good.”

This element of choice was also included in the structure of the unit. Students were able to choose an area for study while their class was on their imaginary camp in Antarctica.
The class teacher demonstrated a consistently positive and enthusiastic approach and attitude to the unit, the class and to the case study group. This was evident through verbal and body language and interactions at both a class and individual level. An example of this approach through speech occurred at the beginning of the introductory session. In order to attain quiet in the class, the teacher said, “OK everyone, just get your books ready quietly, I know you are all excited, but quietly now.” The instruction included an expectation that they were and should have been excited about what was to come.

Findings

Findings from this study indicate that concept mapping served as a mindtool for the case study students during the process of inquiry. Higher order thinking was stimulated to a limited degree and the case study students worked as a cooperative group as demonstrated by their abilities to link and summarise information. Through these processes the group demonstrated their behaviour as a cooperative group as defined by Johnson and Johnson (1999). Johnson and Johnson (p.73) define the cooperative learning group as having the following characteristics:

- High positive interdependence. Members are responsible for own and each other’s learning. Focus is on joint performance. Both group and individual accountability. Members hold self and others accountable for high quality work.
- Members promote each other’s success. They do real work together and help and support each other’s efforts to learn.
- Teamwork skills are emphasized. Members are taught and expected to use social skills. All members share leadership responsibilities.
• Group processes quality of work and how effectively members are working together. Continuous improvement is emphasized.

The “Mindtool”, as well as other artifacts, helped the students to manage the inquiry process.

**Linking Information**

All group members provided input into the creation and alteration of concepts and links during the construction of concept maps.

This input was labeled “negotiation” as providing input usually involved students in justifying their suggestions with either content or task-related facts.

The following examples illustrate this:

In a discussion between Megan and Kate during session five, Megan used the structure of the task itself to justify a suggestion for organising the concept map. Kate asked Megan whether they should make the main idea Antarctica or transport. Megan replied “Antarctica, and then we can put branches out to transport and survival and we’re answering those questions”. The resulting concept maps provide evidence that the group accepted this idea. The first two levels of the concept map worked on during this discussion are provided below:
Another linking suggestion that Megan made during session five was that "Huskies" "...could go under history cos they used to travel by husky and now they don’t". She suggested the placement and linkage of the concept, and gave factual reasoning for her suggestion. The group accepted this suggestion and reasoning. This is shown in the resulting concept map:
The students were aware of the process of negotiation. This awareness was illustrated during interviews. For example, Matthew said that "...we'd spend half the time reorganizing the way they [the concepts] went, like the way it [the concept map] looked because we had so much more information every time. We had to, sort of re-group it
every time because it got so much bigger, yeah. So one person would want to do that and one person would want to do that and then, but mostly when that happened it wasn’t too big a deal, we’d sort of ask the other two who weren’t doing it, you know they were researching, what they thought and then we’d decide from that.”

Megan was also aware that negotiation of the concept map’s organisation and linkages was an ongoing process throughout the unit. Megan referred to the final map as the “proper one”. Initial maps were temporary, changeable and negotiable.

During interviews, three of the students discussed the need to think deeply and apply good reasoning when considering concept map organisation and information links. The examples below illustrate this.

Matthew demonstrated awareness of the need to have well-developed reasoning in creating concept map links when he said, “…it [the linking] sort of explains your reasons for thinking things, not just that you think something. You’ve sort of got to give reasons because the links are the reasons.”

Similarly, Megan commented, “You have to think about what you’ll write to link it and how it links together. Which makes you think more about like, what you want to link together and makes you look at the information…more closely.”
Kate referred to the usefulness of the concept map in creating cross-links, commenting
“...if you had wildlife and, um, transport, then you could, then under wildlife there was
like huskies, and um, under there was like, under transport there was like, sledges and
stuff...you could link huskies with sledges because they sort of helped pull them...”
Despite this awareness, none of the maps contain any cross-links.

**Summarising Information**

Concept mapping facilitated the summarising of information and therefore the ability to
cope with increasing amounts of information generated during the inquiry. When new
information was being added to the concept map, there was often one person reading out
facts while another recorded them on the map. Sometimes the person reading out the
information from books or other printed material, summarized the information. For
example, during the brainstorming in session two, Megan read aloud,

“Warm clothing can be worn inside the base...” and immediately rephrased this in her
own words to read, “Inside, warm clothing can be worn.”

In this case, Matthew then summarized the phrase further as he recorded it on the
brainstorm concept map. The phrase then became “Normal clothing can be worn” with
“inside” as the propositional link.
Task Management

The case study group used a variety of resources to manage the inquiry task. These included the “Activities and Assessment” sheet and the group’s research questions and the concept maps. The group used meetings and reliance on cooperation as strategies.

The group only used concept maps in planning for the task, whereas they used the activities and assessment sheet for planning and monitoring of the task and research questions for planning, monitoring of the task and delegation.

The following example shows how concept maps were used in one aspect of planning. During an informal discussion, Matthew and Megan told the researcher that the group had decided to create a Powerpoint slideshow as part of their final presentation, Matthew explained how they had used the concept map to begin planning this slideshow, commenting, “see the bits around the main one, they’ll be our slides and then we’ll work off them.”

The cooperative nature of the case study group emerged as a strong factor that the group relied on when managing the inquiry task.

The group was interdependent. They used individual strengths as a way of completing elements of the task effectively and efficiently but maintained a shared approach through providing input and mutual support. An example highlighting this interdependence and support was revealed in analysis of observational and interview data. Although Matthew
and Megan were the only two group members to actively construct or alter the concept maps using the computer, both Tom and Kate made comments during interviews indicating that they viewed each group member as having contributed to the process. Tom referred to Kate and Megan as usually “going to the library or helping us with the mind maps”. Kate felt that the whole group had “helped out with the mind mapping”.

During interviews, Kate and Megan discussed teamwork as important in the group’s success. Megan discussed the way the group talked about what they were going to do and then went and did what they said they would. She explained that they would then come back and talk about what they had done. The group trusted that each person would do as they said they would. They took on individual responsibility but maintained a shared commitment to the task through this strategy of checking each person’s contribution to the task as a whole.

**Discussion**

Results of this study indicate that the case study group used concept mapping as a Mindtool during the cooperative process of inquiry.

Jonassen (2000, p. 9) describes Mindtools as “computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning.”
Critical Thinking

When the case study group used the computer-based concept-mapping tool *Inspiration*, critical thinking was engaged and facilitated.

The concept mapping process facilitated opportunities for the group to summarise information, negotiate information linkages, cope with increasing amounts of information and reorganise concepts. This was evidenced through dialogue and resulting changes exhibited in concept maps. Integration of concept mapping throughout the inquiry meant that this was an ongoing process.

The use of *Inspiration* meant that early versions of maps were temporary and changeable. This may have been a factor in allowing negotiations and interpretations between group members to remain positive during the concept mapping process. There was no evidence in the data of disagreements or conflict during concept mapping, despite the need, recognised by three of the group members, to address differences of opinion when mapping. Roth and Roychoudhury (1992) propose that such acceptance of individual solutions may be provisional due to the ongoing possibility of returning to the same issue at a later point.

Evidence from observation data showed that during interactions between group members when manipulating information on the concept map, the students provided reasoning and evidence for their suggestions and interpretations. This was either topic-related or related to the task and task structure.
The Cooperative Group

The cooperative nature of the task, combined with the concept mapping process facilitated the need, not only to think critically about information, but also to verbalise this thinking to other group members.

Observation and interview data indicated that the case study group behaved as a cooperative group (Johnson and Johnson, 1999). This probably affected the amount and quality of critical thinking facilitated through concept mapping and evidenced through interactions and discussion.

The case study group relied on their cooperative dynamic as a strategy for managing the inquiry task. Although they used concept maps, along with the research questions and the “Activities and Assessment” Sheet, as resources in planning, they used individual strengths, supportive behaviour and group meetings as strategies to manage and monitor contributions to the task and task completion. During interviews, both Megan and Kate discussed teamwork as an important factor in the group’s success.

Higher Order Thinking

The case study group demonstrated higher order (metacognitive) thinking processes when concept mapping during the inquiry and in interviews. This was illustrated through:

- Verbalisation of thinking processes
- Verbalisation of the effectiveness and possibilities of concept mapping as a tool
Further discussion of how the research evidence supports this claim is based on the ladder of metacognition presented by Perkins and Swartz (1990, cited in Perkins & Swartz, 1992).

When the group used the concept map for organising information they demonstrated a tacit use of the map as a thinking tool. They were using the tool for thinking, but without demonstrating an awareness of what they were doing.

Interviews generated data that showed three of the case study students were aware of the thinking processes they used when concept mapping. Interviewer questioning generated this data and may also have stimulated the reflection that created this awareness of thinking processes.

Three students demonstrated aware use of thinking strategies when responding to the following interview questions:

- What did you find useful about concept mapping?
- What difficulties did you have when you were concept mapping?

Among the uses and difficulties, the students identified:

- Creating concepts and prioritizing/establishing hierarchies of concepts
- The linking process in concept mapping as a reasoning process
- The deeper thought processes facilitated by the linking process
• The ability to summarise a great deal of information in one visual representation
• Concept mapping as a useful tool for sorting information
• Reassessing links allowing reflection on the importance of the information conveyed
• The ability to create cross links to show more complex relationships between information

The first four features mentioned by the students demonstrate awareness of the thinking processes facilitated by the concept mapping process. The latter three identify awareness of the possibilities for thinking and representation that concept mapping created.

Implications for Teaching and Learning
This study has demonstrated that initial use of concept mapping using Inspiration as a context for cooperative inquiry resulted in the engagement and facilitation of collaborative critical thinking for the students in the high-performance, cooperative, case study group.

Integrating concept mapping as an ongoing and compulsory element of the inquiry task resulted in the cooperative group continually negotiating information organisation and linkages. In order to participate in this process, the students had to justify their suggestions and provide reasoning for their ideas. Thus the process facilitated and engaged critical thinking for the case study group.
Integration of Mindtools into the process of cooperative inquiry can generate a limited degree of metacognition. Much of the evidence supporting an aware use of thinking practices was collected during interviews, when the students were asked specifically about their concept maps and the concept mapping procedure. It may have been the act of questioning itself that generated an aware level of metacognition.

Evidence suggests that the relationships, interdependence and skills of the cooperative group (Johnson & Johnson, 1999) may have contributed positively to interactions, task management and success during the study.

In this study the role of the teacher in setting the scene for the inquiry, managing the inquiry and relating to students has not been examined in detail. Such factors may have had a significant impact on the students and their experience of aspects of the task.

**Recommendations for Teaching and Learning**

Teachers can integrate concept mapping using Inspiration as a Mindtool to stimulate critical thinking into units of work that use inquiry as a process. Students can use concept maps as a resource in managing the inquiry task.

When inspiration is used by students who behave as a cooperative group (Johnson & Johnson, 1999), interdependence, mutual support, and teamwork can facilitate and engage critical thinking for members of the group other than the person working directly at the computer.
If teachers are prepared to work on integrating and fostering a cooperative approach and cooperative skills into their programmes, the prevalence of cooperative groups as defined by Johnson and Johnson (1999) within their classes could be expected to increase. Thus the benefits of integrating the use of Mindtools for critical thinking in cooperative groups would also be greater.

Along with their cooperative skills the case study group relied on the research questions, the “Activities and Assessment” sheet (provided by the teacher) and the concept map as resources in managing the inquiry task. These resources gave the students concrete references with which to plan, delegate and monitor task completion. The group appreciated the choices they were given within the unit but relied on the boundaries and guidelines these resources gave them. It is recommended that teachers include the development of good research questions, provide choice within boundaries and provide clear expectations for students as elements of cooperative inquiry tasks such as this one.

Results of this study indicate that developing effective questioning techniques further stimulates higher levels of thinking and metacognition. It is therefore recommended that teachers wishing to integrate teaching and learning methods fostering metacognition use questioning as a supporting strategy.

**Future Research Possibilities**

A variety of future research possibilities have been identified as a result of this study:
The *Inspiration* concept map provided an adaptable and evolving representation of the group’s progress through the inquiry. The students in the case study group were involved in an ongoing process negotiating the organisation and linking of information throughout the concept mapping and inquiry processes. Participation in this negotiation required students to provide justification and reasoning for their opinions, thus facilitating and engaging critical thinking.

Students demonstrated a limited degree of metacognition during the concept mapping process.

It is proposed that further experience using concept mapping as a Mindtool and combining concept mapping with evaluative questioning techniques may result in the achievement of higher degrees of awareness of thinking for these students.

The case study students worked as a cooperative group (Johnson & Johnson, 1999), demonstrating interdependence, mutual support and a focus on producing quality work. This may have increased the amount of negotiation and therefore critical thinking that was facilitated during the concept mapping process.

Cooperative skills were a key strategy used by the case study group in managing the successful completion of the inquiry task.
In order to provide optimum conditions for the integration of Mindtools such as concept mapping using *Inspiration* into cooperative learning environments such as inquiry, teachers should also foster the development of cooperative skills in their classrooms.
References


