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Student learning and cognition in cooperative small groups : towards a fourth metaphor of human learning

Scott C. Zehnder
Edith Cowan University

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Student Learning and Cognition in Cooperative Small Groups:

Towards a Fourth Metaphor of Human Learning

by

Scott C. Zehnder Dip.Teach., B.Ed., M.Ed.

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ABSTRACT

Research into the benefits of cooperative learning has focussed most attention onto a social psychological perspective with the result that the putative cognitive benefits of these strategies have not been thoroughly researched and clearly delineated. One consequence of this research focus has been that cooperative learning strategies are not always adopted by teachers and included permanently into their regular classroom practice, thereby possibly denying some students the potential for cognitive gain. This study was conceived originally as an investigation into the claimed cognitive benefits of small-group cooperative learning from a cognitive perspective but the investigation of the cooperative learning literature also led to an investigation of the general learning literature base.

Recent research suggested that human learning might not have been described adequately by the earlier perspectives. Some authors contended that a fourth metaphor of human learning may be emerging from the socio-cultural perspectives. Investigating how students learn in cooperative situations was seen as a potential vehicle for the wider investigation of a fourth metaphor. It was against this background that the present study was undertaken.

Learning was not seen in terms of a dichotomy between the main cognitivist and socially based perspectives so a pluralist approach was adopted in this study in an attempt to reconcile some of the differences between the main perspectives. Process-product research has been criticised for providing a narrow view of the classroom lives of students. Additionally, critics of laboratory-based research have argued for research to regain its connection with real classroom settings. Given the contentions of several authors, this study was conceived as non-positivist, naturalistic and pluralist within the post-modernist era

Five groups of students at two schools were recruited for this qualitative case study. The students' learning from five purpose-designed lessons was tracked through their transcribed discussions and their recall in "learning journals". Journal data were collected as much as twelve months after the last lesson was completed, enabling the longitudinal tracking of student learning.

A major finding of the research was the strong mediational effects on student learning of the classroom context and the group within the classroom. The nature of student talk also impacted strongly upon student learning. Evidence was found of both individual and social construction of knowledge. Knowledge sometimes seemed to appear initially as a group construct but was later modified significantly by the students' individual minds. Although all knowledge originated in socio-cultural contexts, usually through the ultimate human social semiotic of language, the final form of the knowledge appeared highly individual and idiosyncratic. The idiosyncratic nature of the students' learning led the researcher to posit that knowledge resided in the individual neural structures of the brain. This "mind-as-brain" proposition was advanced as a contribution towards a fourth metaphor of human learning. The findings suggested several implications for teachers about the recommended procedures for small-group cooperative learning. Implications for research included further neuroscience investigations into human learning because of the potential for this kind of research to inform practice.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;

(ii) contain any material previously published or written by another person except where due reference is made in the text; or

(iii) contain any defamatory material.

Signature

Date 26/8/02

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In memory of Kevin Barry and Andrew King who were sadly lost to us during the preparation of this research.

I acknowledge and thank my wife Sue for her support, patience and love over several years of long absences. It is to her and our two children, Samuel and Hayley that I dedicate this thesis.

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CHAPTER ONE

INTRODUCTION

1.1. Background to the study

Collaborative learning has been supported increasingly by research in the study of teaching since the late nineteen seventies. These strategies can provide moments in the classroom when multiple variables combine to produce cognitive and social benefits for students. Acceptance and application of collaborative learning among educators has spread widely because of the potential to improve prosocial behaviour, to increase participation rates among low achievers and to produce learning gains, including gains in students' higher order cognitive achievement (Cohen, 1994; Good & Brophy, 2000). These types of *complex instruction* have also been credited with improving inter-racial tolerance (Cohen, 1991). The various *cooperative learning* methods, as genre of collaborative learning, have appealed to educators because they provide opportunities for students to become more engaged in a group task and to actively construct knowledge in a social setting. In the complex classroom setting, cooperative learning involves students more actively in learning opportunities than the passive recipients of knowledge in more traditional modes of instruction (Cohen, 1994; Nuthall, 1996; Good & Brophy, 1997).

Research on cooperative learning has until recently focussed most attention on a social psychological perspective, in particular on the relative merits of the various cooperative learning models (Slavin, 1991) or on competitive versus cooperative efforts and student helping behaviours (Slavin, 1991; Kohn, 1991; Webb & Favivar, 1994; Nattiv, 1994; Ross, 1994). This focus may have deflected attention onto social issues to the detriment of research on the potential cognitive benefits of the strategies. Several authors have argued for a re-focussing of the research effort onto a cognitive psychological perspective. This research effort would seek to describe the cognitive benefits of cooperative learning more precisely and attempt to establish clearer relationships between the teachers' cognitive intent, cooperative learning conditions (including tasks), cooperative discussion and student cognitive outcomes (Meloth, Deering & Sanders, 1993; King, Barry & Zehnder, 1996; Barry, King, Maloney & Burke, 2000).

Implementation of cooperative learning has resulted in a number of difficulties, particularly in the role of the teacher and teacher beliefs. According to Meloth (1991) the apparent potential of cooperative learning has not ensured the long-term survival of the strategies as legitimate, alternative means of instruction. Cooperative learning does not always become well established in the belief systems of teachers (Palincsar, Stevens & Gavelek, 1989; Rich, 1990) and if these strategies are to be accepted as genuine alternatives in some learning situations, research needs to focus on the potential for cognitive gains. The demonstration of teaching and learning benefits and how these benefits can be achieved, together with descriptions of which instructional models are best suited for various learning contexts, may encourage teachers to persist with cooperative learning despite the difficulties of implementation. Research focused on a cognitive perspective appears more likely to be translated into effective teacher professional development and bring about changes in teacher beliefs (Meloth & Deering, 1999).

The present study was conceived originally as an investigation into the cognitive benefits claimed for cooperative learning. As the literature was examined, it became apparent that an investigation of cooperative learning also required an investigation of learning theories. New directions in the research into human learning were found during this review. Although almost a century of research has been conducted into learning, debate has continued within the educational psychology community over a guiding metaphor for the discipline (Mayer, 1996; Derry, 1996; Vosniadou, 1996). New theories have emerged which challenge the previous metaphors and some authors have argued that the emergence of a *fourth metaphor* may be imminent. This metaphor would evolve from research which encompassed a more naturalistic research paradigm, where human learning is investigated in its full social, emotional, cultural, intellectual, physical context (Mayer, 1996; Nuthall, 1996; Vosniadou, 1996; Prawat, 1996). Social constructivist and socio-cultural theories (Cobb & Yackel, 1996; John-Steiner & Mahn, 1996), representing the broader spectrum of the classroom learning experiences, may be leading a trend towards a more holistic view of human learning. These theories reveal a classroom setting which is far more "complex, multi-layered, and context dependent" (Nuthall, 1996, p.209) than may have been previously imagined by teachers and considered by researchers.

According to Nuthall and Church (1973), research into student thinking and learning should have proceeded through certain phases, beginning with an observational and descriptive phase, and proceeding through to correlational and experimental designs. Nuthall (1997) argued that research had moved through these phases too rapidly and had become too narrow in its focus. In order to re-establish connections with the complex, real world of the classroom, Nuthall argued for a return to the first phase of observational/descriptive research.

Conducting descriptive, naturalistic research into the cognitive benefits of cooperative learning was seen as an ideal medium for the wider investigation of a possible fourth metaphor of human learning. The search for contributions to this metaphor provided a unifying core for the present study. Against this background, the study was conceived and undertaken.

1.2. Significance of the study

Although this study draws a measure of its significance from the search for a fourth metaphor of learning, lines of inquiry needed to be established that had more obvious potential to inform teaching practice. For this reason the collaborative learning/cooperative learning literature was consulted and an attempt was made in the research design to address some of the deficiencies identified in the existing research base. A first phase in the design was a narrowing of the research focus onto *small-group cooperative learning* methods.

Despite the putative benefits of these strategies the research base has a number of limitations and the application of cooperative learning involves many unresolved problems. Good and Brophy (1997) argued that insufficient observational data had been gathered into how students interacted in groups and how the student cognitive and affective gains claimed for cooperative learning actually occurred. According to Good & Brophy (1997, 2000), a limited band of variables had been investigated and more research was needed into how small group interactions affect higher-order cognitive skills. Bossert (1988-1989) contended that researchers had not demonstrated satisfactorily whether students were actually interacting cooperatively and that results had not always supported cooperative learning theory.

Meloth and Deering (1999) called for collaborative learning research focussed on the kinds of discussion which produce cognitive and metacognitive benefits and for research into the teacher's role in monitoring and facilitating these kinds of discussion.

Bennett & Dunne (1991) provided the impetus for several studies into the nature of talk in small group settings (King, Barry, Maloney & Tayler, 1994; Barry, King, Pitts-Hill & Zehnder, 1998; Barry et al, 2000). This research noted that implied links between higher level cognitive talk and improved thinking could be demonstrated but research that related these kinds of talk directly to student outcomes, over extended time frames had yet to be undertaken.

Good and Brophy (1997) also noted deficiencies in the study of group processes. Although research has identified problems of student passivity (Mulryan, 1992, 1995; King, 1993) and recent research has described the idiosyncrasies of group dynamics (King, Luberda, Barry & Zehnder, 1997), further research was required that describes the life of cooperative groups and provides understandings about group effects on cognitive gains.

Focussing cooperative learning research onto a cognitive psychological perspective may have other benefits in the study of teaching and learning. Some researchers have called for an educational learning theory that helps explain the teaching-learning process rather than theory that prescribes teacher behaviours (Bereiter, 1990; Nuthall & Alton-Lee, 1993). Attempts to develop learning theory should investigate student learning in its full context and complexity and track the life histories of students (Nuthall, 1997). Nuthall (1996) noted that almost no studies had attempted to establish the stability or permanence of student learning and behaviour over time. Attention to the tracking of student learning over time and context has the potential to provide richer understandings about the true nature of learning and the effects of student mediations and teaching (Nuthall, 1996).

Several authors have argued for research in real classroom settings. Mayer (2001) supported naturalistic research when he argued that earlier research in cognitive psychology had become irrelevant because an essentially human issue had been studied using animals in artificial environments. What was needed was a shift in emphasis to studying learning and cognition in realistic situations (Mayer, 2001). In arguing that education and psychology could each offer something to the other, Mayer (2001) contended that psychology needed something "real" to study and education needed well researched and validated theory in order to improve student learning. In this study, the classroom was seen as the logical place to study student knowledge construction. A focus on the social context of the classroom was regarded as crucial and the study's naturalistic research design provided it with additional significance.

Billett (1996) argued that the effects of the classroom situation on knowledge construction were still unclear. Franklin (1985) also argued for models of thinking and learning developed from real populations in real contexts instead of trying to fit populations into theoretically derived general models. Nuthall (1996) contended that if simplistic versions of classroom life persist, "we will be satisfied with naive theories of classroom learning and will carry out narrowly conceived research studies" (p.208).

The kinds of research alluded to above have the potential to contribute to the development of a fourth metaphor but of what significance is metaphor in attempting to understand human learning? The researcher saw metaphor as a valid point of discussion because it is often through metaphor that teachers conceptualize student learning and cognition and subsequently shape their approaches to teaching. For example, learning metaphors derived from animals in artificial environments may produce simplistic conceptions of learning like those described by Nuthall (1996), and lead to teaching methods that over-emphasize drills and rote learning. Therefore, ostensibly theoretical, esoteric discussion can become practical and relevant as a means of informing and improving practice.

1.3. Purpose of the study

The purpose of this study was to apply naturalistic research methods to investigate a possible fourth metaphor of human learning. The investigation was undertaken by examining student knowledge construction and the mediational effects of social context under conditions of small-group cooperative learning. The study took account of the complexities of the classroom and attempted to capture and track the long-term effects of the moments in the students' classroom experience when cognitive change occurred.

1.4. Research questions

A study which examines student learning and cognition during cooperative learning and which tracks individual learning over time, has the potential to contribute to a fourth metaphor and to possibly extend understandings of the learning process and conceptions of "mind". Are the reported cognitive benefits of cooperative learning due in part to the interaction of several "minds" in the co-construction of knowledge? To what extent is knowledge socially constructed or does knowledge comprise unique meanings constructed by the individual? How do these forms of interaction mediate the teachers' cognitive intent and produce academic gains?

The research questions were based upon two general avenues of inquiry: (a) the processes whereby student learning and cognition occurred under cooperative learning conditions and (b) the role of the group setting in influencing individual and social construction of knowledge. Each broad question involved subsidiary questions.

<u>Question1: What processes produce knowledge construction under cooperative conditions?</u>

1.1. What evidence of co-construction of knowledge can be discerned?

1.2. To what extent do specific types of discussion lead to co-construction of knowledge?

These questions were central to the study because of their potential to contribute to learning theory and the development of the fourth metaphor. Question 1.1 represents an hypothesis that knowledge would be mainly socially constructed. Question 1.2 represented an intention to investigate whether long-term learning outcomes were produced by specific kinds of student talk.

<u>Question 2: What conditions or factors mediate student learning and cognition in small groups?</u>

2.1. What is the role of prior knowledge during group discussion and knowledge co-construction?

2.2. What classroom contextual factors influence discussion and knowledge co-construction?

Previous experience of cooperative learning (King, Barry & Zehnder, 1996; King, Luberda, Barry & Zehnder, 1998; Barry, King, Pitts-Hill, & Zehnder, 1998) and student class work in general had led the researcher to conjectures about the importance of student prior knowledge as a mediating factor. Prior knowledge was seen as a contextual factor in cooperative learning and the researcher decided to investigate other significant contextual factors.

Question 3: What connection can be discerned between teacher cognitive intent, cooperative conditions, student discussion and student outcomes?

3.1. How do group processes mediate teacher cognitive intent?

3.2. How does student discussion mediate teacher cognitive intent?

3.3. What individual and group student characteristics influence teacher cognitive intent?

This question stemmed from the Meloth, Deering and Sanders (1993) research framework and previous research by King, Barry and Zehnder (1996). These questions were designed to test the teacher cognitive intent-conditions-discussion-outcomes connection. It was hypothesized that individual students and groups would mediate teacher cognitive intent. Question 3.2 was related to question 1.2.

1.5. Definitions and assumptions

The following definitions and assumptions apply in this study. Other definitions are specified within the text of the thesis.

1. Collaborative Learning is seen as an overarching term that includes all forms of peer collaboration including small group work, dyads and any combination of students working towards common goals as opposed to students working on assigned tasks individually.

2. Cooperative Learning is seen as a genre of collaborative learning. Several specific strategies and learning programs have been labelled cooperative learning. For the purposes of this study, a groups of four model was applied (Burns, 1981). Cooperative learning is seen as students working together in a group small enough so that everyone can participate on a collective task that has been clearly defined (adapted from Cohen, 1994). Students work and interact together on a task. Tasks and duties are shared.

Students work, learn with and gain feedback from other group members (adapted from Barry & King, 1993).

3. Student Passivity is behaviour which "indicates failure and unwillingness on the part of the student to engage in on-task activity and/or interaction with fellow group members during cooperative small-group work, including failure to ask questions, contribute to explanations, comments or suggestions, or respond to other students' questions or initiations". (Mulryan, 1989, p.31).

4. Cooperative Conditions are the classroom management and academic conditions under which cooperative learning is conducted. These include the roles for group members, the rules for group work, group goals, group and individual accountability processes and the training in giving and asking for explanations. For the purposes of this study, practices in cooperative conditions, recommended in the literature, were applied.

5. Cognition is the processes by which we receive, transform and use information from the environment, or the social and physical world in which we live (Partington & McCudden, 1992). It is assumed that when cognition occurs the individual operates mentally on these inputs from the external world. Cognition is a series of mental processes (Mayer, 1996, p.154).

6. Learning is defined as the acquisition of mental representations, "an enduring change in behaviour, or in the capacity to behave in a given fashion, which results from practice or other forms of experience" (Shuell, cited in Schunk, 1991, p.2). Learning is "doing something differently as a result of experience and not because of physical growth, or of other changes in the 'hard wiring'" (Biggs & Moore, 1993).

1.6. Outline of the thesis

The introductory chapter is followed by a review of related literature. The review examines principally two research bases, learning theory and research into cooperative learning. The first part of the chapter reviews the major theories of learning and tracks the development of the first three metaphors of learning including reference to two key developmental theorists, Piaget and Vygotsky. The second part of the chapter reviews the research into cooperative learning and includes discussion of some of the strengths and shortcomings of these strategies identified in the literature. Chapter Three continues to develop the theoretical basis of this research by explaining the philosophical underpinnings of the study. Contributions to a fourth metaphor of human learning are related to "world hypotheses" and their root metaphors. This discussion leads to a perspective of learning and a conceptual framework that guided the research.

Chapter Four details the research methods applied in the study. The main sections deal with research design, procedures and data analysis. This chapter allows the reader to interpret Chapter Five, where the learning of five groups of student participants is reported as case studies. This chapter includes substantial samples of individual student data in the form of concept maps and vignettes from the data corpus. The results are reported further in Chapter Six in the form of a cross-case analysis of the five groups. This chapter generates findings across all groups. The findings are discussed and explained in theoretical terms in Chapter Seven. The final chapter summarizes the research questions and includes implications for theory, implications for teachers and possible directions for further research. A fourth metaphor of human learning is posited to conclude the thesis.

CHAPTER TWO

REVIEW OF LITERATURE

2.1. Overview

The chapter reviews the literature that has informed the present study. Two main streams of discussion are pursued in this review; research into learning theory and research into cooperative learning methods. As a consequence, the chapter is divided broadly into two parts. The first part examines research into learning from an educational psychological perspective, including historical aspects of the discipline, in order to provide the background for a discussion about learning metaphors. The second part concerns research into cooperative learning. This chapter provides the basis for the theoretical framework described in chapter three. A summary is provided for each of the two main parts of the chapter and a chapter summary is also included.

2.2. Part One-Theories of learning

Introduction

Educational psychology has yet to provide a co-ordinated basis for a learning theory that would permit the development of theory of teaching (Bereiter, 1990; Vosniadou, 1996; Nuthall, 1996). A number of perspectives on learning exist but as yet a definitive basis for a theory of learning has not been advanced. After almost a century of research and theoretical discussion, educational psychology remains a field in a state of flux (Good & Levin, 2001) with questions about the future directions of educational psychology continuing to arise (Vosniadou, 1996; O'Donnell & Levin, 2001; Mayer, 2001). O'Donnell and Levin (2001) argued that the on-going debate about methods, purpose and directions in educational psychology suggested a field in a generally healthy state. Despite this healthy debate, educational psychology needs to strive for relevance in the 21st century (Mayer, 2001). Directions for research in educational psychology, specifically cognitive psychology, have particular relevance when examining the development of a cogent learning theory that can explain teaching effects on learning. The quest for a general theory of learning has resulted in the development of at least three major perspectives that can be represented in terms of metaphors. Educational psychology has produced rich descriptions of mental structures and a language for discussing learning and cognition but a drive for a more context embedded metaphor may be required in order for educators to better understand how students learn (Brophy & Good, 1986; Mayer, 2001).

Debates about directions for research have been conducted since the beginnings of educational psychology. The differences between the approaches of the influential educators, Edward Thorndike and John Dewey was the source of one such debate (Hilgard, 1996). Whereas Dewey was mainly concerned with the politics and social context of education, Thorndike was principally an experimenter (O'Donnell & Levin, 2001). These views were not mutually exclusive but they reflected differing ends of the education-psychology elements of educational psychology. In their historical outline of the development of educational psychology, O'Donnell & Levin (2001) described how the earliest directions taken by educational psychology were influenced strongly by Thorndike (pp. 74). These early directions featured attempts to examine and explain human behaviour, including learning, in classical scientific terms. The (behaviourist) *first metaphor* of human learning resulted from the subsequent laboratory experiments.

The emphasis on laboratory research diverted attention from the real context in which learning takes place. Early theories proved unable to account for learning beyond the limits of behaviourist methods (Vosniadou, 1996; Mayer, 2001). Mayer (2001) argued that cognitive psychology, responsible for the second (information processing) and third (knowledge construction) metaphors, had become increasingly irrelevant. The question of the relevance of research into learning has been criticised as relying too heavily upon a process-product research paradigm and naturalistic, interpretive, reflective approaches have been advocated (Erickson, 1986). Brophy & Good (1986) called for research to be conducted in real situations, a call echoed more recently by Vosniadou (1996), Nuthall (1997) and Mayer (2001). These authors saw a return to these contexts as critical in the progress towards a better understanding of the effects of teaching on learning (Nuthall, 1996; Vosniadou, 1996, Mayer, 2001).

Mayer (2001) contended that in the future development of educational psychology, the fields of education and psychology could offer something to each other. Mayer argued that in order to develop relevant theories of learning and cognition "psychologists need to examine realistic learning situations" (2001, p.84) and that educational settings could provide the vehicle for these kinds of study. Psychology could in return provide well researched, scientifically valid methods of instruction which could assist educators to improve outcomes for students. Examples in specific subject matter learning (reading, mathematics and history) and learning cognitive strategies (comprehension and problem solving) were cited to illustrate how psychology could provide this kind of support to educators (pp.84-87).

Several authors have argued that early theories were conceptualised within a narrow band and did not take sufficient account of the total context of student learning (Vosniadou, 1996; Nuthall, 1996, 1997). This review will explore the notion that the early research focus into learning theory may have been too narrow in its conception and consequently focussed research attention onto artificial, laboratory contexts. Had attempts to explain human learning, particularly learning in schools, been conducted in the actual context under study with particular attention to socio-cultural contexts, knowledge about learning might have taken different directions.

The following sections describe the major theories of learning, beginning with summaries of behavioural theories, proceeding through cognitive perspectives and finally examining more recent developments including situative theories. These discussions are set against the context of developing metaphors of learning.

2.3. Behavioural perspectives-learning as response strengthening

Early learning theories developed by Pavlov (1849-1936), Watson (1878-1958) and Thorndike (1874-1949) were based on investigation of the observable behaviours associated with learning (McInerney & McInerney, 1994). These theories were termed *behaviourist* and they dominated thought about teaching and learning for several decades, giving rise to the first metaphor.

Classical conditioning

Under behaviourist theories, the interaction of the individual with the environment was described in terms of the relationship between stimulus and response. Learning was seen as *conditioning*. In his *respondent* or *classical conditioning* experiments, Pavlov demonstrated that behaviour modification (conditioning) was related to stimulus and response. Students of educational psychology are familiar with Pavlov's experiments whereby dogs' salivation was manipulated using associations between ringing bells and food aromas so that the conditioned stimulus became the bell, causing the dogs to salivate.

Watson further defined classical conditioning and first coined the term, *behaviourism*. According to Bigge (1971), Watson's definition of human learning was couched in purely mechanistic, behavioural terms and refuted cognitive ideas.

Thorndike's contribution to behavioural theory was to propose that if pleasurable experiences followed stimuli, responses were strengthened. This he termed the *law of effect* (McInerney & McInerney, 1994).

While Watson and Thorndike's theories may have provided some basis for discussion and further research, they failed to take account of the complexities of *human learning*. To reduce complex functions like learning in complex, rational organisms like humans seems to be an over-simplification.

Operant conditioning

An influential development of classical conditioning was the work of B.F. Skinner (1904-1990). Skinner was renowned for his, sometimes radical, views on education and society. His impact on behavioural learning theory was profound. Skinner's theories influenced thinking about learning and motivation for generations. Learning programs designed step by step where each step depends upon mastery of the previous step owe much to Skinner's theories. Skinner's *operant conditioning*, introduced the concepts of the *operant, shaping, reinforcement* and *punishment* to educational thinking (McInerney & McInerney, 1994; Maltby, Gage & Berliner, 1995).

Teachers who might claim allegiance to more modern ideals may sometimes find themselves applying aspects of Skinner's theories. Skinner conducted his own experiments with animals, such as in the famous Skinner Box, which involved shaping the behaviour of an animal, such as a rat or a pigeon, so that it responded to stimuli and performed desired behaviours.

Some contemporary instructional programs and philosophies, such as *Direct Instruction*, have been heavily influenced by Skinner's theories (McInerney & McInerney, 1994). The success of these programs can be explained in cognitive terms but they owe their origins to behaviourism. They are at the core of perspectives of teaching and learning that argue the benefits or shortcomings of direct teaching as opposed to indirect teaching.

Observational learning

Bandura's (1969) investigation into learning based upon observation was related to behavourist approaches. His research differed principally from behaviourist studies in his use of human participants when he studied childrens' reaction to aggressive behaviour modelling directed towards toys. Bandura found that when we learn though observation, *behaviour models* guide our behaviour. Our observation of behaviour models changes our behaviour so that it comes to resemble the modelled behaviour.

Behaviourism in the present study's context

Questions of whether teaching and learning in humans is about strengthening responses or something more complex are central to the present study. Much behaviourist research studied the learning of animals so that the focus was on behaviour and not thoughts and feelings. The learner's environment was depicted as a set of stimuli (Biggs & Moore, 1993). Hence, the complexities of human cognition could not be explained in behaviourist terms. Behaviourists typically see learners as being simply reactive to their environment. According to these theories, students in classrooms are driven by the stimulus-response connection and learn in order to avoid unpleasant consequences or to receive rewards. While elements of these theories may credibly explain some student learning and behaviour, such as rote learning or routine behaviours, cognitivists would argue that the learner is a much more active participant in the process of learning. Additionally, behaviourism does not represent a credible learning model when attempting to explain more complex learning, particularly language acquisition (Maltby, Gage & Berliner, 1995).

2.4. Cognitive-developmental theories of learning

Theorists such as Piaget (1954), Vygotsky (1978, 1981) and Bruner (1966) have explored human learning from a predominantly developmental perspective. The theories of Piaget and Vygotsky are outlined in this review as the most applicable to the present study.

Piaget and Vygotsky both attempted to explain behaviour and child development in terms of mental processes and provided many of the fundamental tenets for later research that developed into modern constructivisms and socio-cultural theories. The work of Piaget and Vygotsky was directed towards child cognitive development and their perspectives on learning were a consequence of this developmental focus.

Piaget's theories

Piaget saw humans as active participants in their learning. His view of *mind* versus *world* appeared *organismic* (Pepper, 1942) possibly due to his original training in biology. Hence, Piaget saw humans as functioning biological organisms. Piaget developed his version of cognitive functioning over a period of approximately sixty years (De Lisi & Golbeck, 1999). His work has been criticised, expanded and modified over that time but many of the hallmarks of his theories have remained credible in the face of scrutiny.

Piaget proposed that children's cognitive capability progressed through the development of two main cognitive systems, the *sensory-motor* and the *operational* systems (Piaget, 1954). The sensory motor system developed soon after birth and the operational system in the child's second year. The two major systems were divided further into four broad stages of development; *sensory motor, pre-operational/intuitive, concrete operational* and *formal operational* (Maltby et al 1995).

According to Piaget, cognitive development occurs when people are confronted with experiences or *objects* which are beyond their existing mental representations of their environment. In these situations, children make meaning of experience by reflecting on, re-organising or adapting their existing cognitive systems or *schema* (De Lisi & Golbeck, 1999). Individuals interpret the same experience differently because they are at differing stages of adapting or re-constructing their cognitive structures. Cognitive development for Piaget was driven by the child's need to achieve a state of *equilibrium* between existing schema and new experiences. If a state of *dis-equilibrium* exists, some form of mental processing is necessary to return to equilibrium and this leads to cognitive development. *Adaptation* of schema involved *assimilation and accommodation*. Assimilation occurs when new objects or perceptions are fitted into existing schema. Accommodation occurs when schema themselves are altered in order to include the new objects or perceptions.

Piaget expanded his theories in his later work to include a focus on how cognitive systems are modified (Piaget, 1985). He posited that a process of *equilibration* leads to the modification of cognitive systems. According to Piaget equilibration existed in three forms. The first, involving assimilation and accommodation, was centred around current intellectual activity. A second form of equilibration was a horizontal re-organisation, relating to re-constructions within schemes or re-constructing relationships between two or more schemes. The third equilibration was a vertical re-structuring of whole sets of schemes within the total cognitive system (De Lisi & Golbeck, 1999).

Although many of Piaget's ideas have provided important constructs for the understanding of cognitive development, some of his methodology and findings have been criticised. Donaldson (1978) criticised Piaget's experimental methods because they were not embedded in a relevant context. She provided evidence of levels of children's thinking not thought possible under Piaget's ideas in situations of relevance to children. Davis (1991, cited in Maltby et al, 1995, p.105) contended that the dis-embedded nature of Piaget's tasks lacked "human sense" to children. According to Gelman (1985) and Nagy & Griffith (1982) tasks, instructions and social settings comprise highly influential contextual factors, which must be accounted for when studying children's thinking.

Other researchers have questioned Piaget's assertions about staged development in children (Maltby et al, 1995). Researchers have claimed that children are more capable of complex behaviour than was thought possible by Piaget. Some very young children have displayed complex knowledge in certain subject areas (Chi, 1985). Carey (1985) concluded that children were capable of thinking like adults but because adults knew much more than children, children's thinking often appeared less sophisticated.

Piaget's claim that development was universal has also been criticised by Partington & McCudden (1992) when they contended that schools cause difficulties for students enculturated differently to the limited, Western European ethnic base which produced Piaget's theories. Since Piaget's theories have been the dominant developmental theories in Western schools, students from different cultures may become alienated while attempting to operate in what is effectively, a foreign culture. Partington and McCudden (1992) contended that Piagetian theories might be of limited use in understanding the learning and cognition of more diverse ethnic groups. Claims of universality were speculative because they had not been tested across cultures (p.59). Other researchers have identified differences in cultural groups as a potentially powerful mediation on classroom experience.

Crawford (1996) found that Australian Aboriginal children experienced conflict between the values promoted between home and school, specifically in the teaching of mathematics. John-Steiner & Mahn (1996) have also described how approaches to teaching, which may be appropriate for one ethnic group may be inappropriate for another. Tharp & Gallimore (1988, cited in John-Steiner & Mahn, 1996, pp 197-198) worked with Hawaiian children grouped in fours and fives. The same success of this program was not achieved with Navajo children in the same sized small groups until the researchers found that these children preferred to work in same sex dyads (Jordan, Tharp & Vogt, 1985, cited in John-Steiner & Mahn, 1996, pp 197-198).

The criticisms and the limits of Piaget's theories do not diminish his contribution to our conceptualization of cognition in children. Although details have been tested, the broad concepts of Piaget's theories have provided a language with which educators can discuss child development. Other researchers have provided further insights that include more recognition of the role of social influences and culture in childrens' cognitive development. These socially based theories, which have become the foundation of several contemporary theories, are discussed below.

Vygotsky's theories

The theories of Russian psychologist, Lev Vygotsky have gained attention since becoming more widely available to the Western world in the nineteen seventies (Vygotsky, 1978). These theories provide an alternative to Piaget and have been influential in the development of more recent research. Vygotsky attempted to explain the human mind by examining its development and maturation in the child within its social and cultural context. Piaget argued that cognitive function occurred first in the mind of the child. In contrast, Vygotsky contended that cognitive function resided first in the socio-cultural setting and then in the child's mind. Even cognitive activity, which seemed private (reading, solving puzzles, reflecting on personal experiences) originated in collaborative activity (Berk & Winsler, 1995). He expressed this in his *genetic law of psychological development*, outlined in the following quote.

> Any function in the child's development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an inter-psychological category, and then within the child as an intra-psychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition. (1981, p.163).

Much of the focus of Vygotsky's writings was on the differences between human mental functions and that of other animals. According to Vygotsky, lower mental functions were common to humans and other species of mammals but higher mental functions using language and other cultural tools were uniquely human (Berk & Winsler, 1995). He theorised that one distinguishing feature of human learning was the convergence of practical activity and speech (Vygotsky, 1978, p.25), noting a connection between thinking, doing and speaking. Early cognitive development occurred in children when verbalized thoughts were internalized. Speech not only accompanied activity but also helped to carry it out. According to Vygotsky, the ability to verbalize thoughts allowed humans to plan ahead when solving problems.

Like Piaget, Vygotsky also allowed for the active involvement of the learner but he adopted a more socio-cultural stance and attempted to account for the impact of culture on cognitive development. Vygotsky accepted that the culture in which children grew up was crucial in shaping meanings from their environment. According to

Vygotsky, each culture reacts differently to the same situation and shapes unique socio-cultural meanings. Cognitive development is embedded in the social-cultural context.

Under these theories, children are seen as *novices* in interpreting their environment. More knowledgeable parents, teachers or peers are seen as *mediators* or *experts.* Vygotsky's basic social model for the cognitive growth of the child is a dyad between novice and expert. The expert provides the guidance, instruction or scaffolding (Wood, Bruner & Ross, 1976) required to take the novice to a higher level of cognitive development. Mediators, particularly teachers, need to assess the cognitive level of students. This is represented by what the child can do independently. Next the mediator assesses what the child can do with assistance from a more competent individual. The gap between actual and potential development was termed the *zone of proximal development* (Vygotsky, 1986). The notion of a zone of proximal development was one of Vygotsky's major contributions to understandings about cognitive development.

A summary of the process of learning, described in Vygotskyian terms, sees the expert and novice working together in a culturally embedded setting, using cultural tools such as language and semiotic meanings, to socially construct knowledge. The socially constructed knowledge is then transformed into individual knowledge which then becomes more complex (Vygotsky, 1986; Maltby et al, 1995). It is through this process that the child develops a sense of the shared knowledge of their culture and becomes increasingly expert in interpreting events as a member of that culture.

2.5. Cognitive perspectives-learning as information processing or knowledge construction

A number of cognitive theories of learning have been generated which have provided the second and third metaphors of educational psychology. Mayer (1996) summarised the progress of learning metaphors as parallelling the methods of investigation. Laboratory experiments on animals produced the first (behaviourist, stimulus-response) metaphor which was followed by laboratory experiments on humans (information processing) and the second metaphor (mind as computer). Research expanded into more realistic situations to investigate human learning and produced the third metaphor (knowledge as cognitive construction). This section reviews the *information processing* model of learning and describes the major forms of *constructivism.*

General principles of constructivism

The basic tenets of constructivism developed from the work of theorists such as Piaget and Vygotsky. All versions of constructivism argue that the role of the learner is critical. The learner actively interprets or constructs meanings from their environment in an attempt to make sense of it. This attempt at interpretation leads to the development of knowledge or cognitive growth. The basis for meaning making is a process where an individual's past experience is related to new experience. It is in this active cognitive involvement of learners that constructivism differs from earlier perspectives on learning such as behaviourism. A variety of constructivist theories exist that fall basically into two groups; those inspired by Piaget which contend that knowledge is fundamentally an individual construct and the social constructivists, inspired by researchers such as Vygotsky, who describe the social basis of knowledge.

Information processing models of learning

Information processing (IP) models of learning have been interpreted *literally* or from a more *constructivist* stance (Mayer, 1996). The literal model is discussed in this section and the constructivist version is described in the following section. The main difference between these interpretations is that the literal version of information processing theory contends that although the learner is an involved party, knowledge can be transmitted direct to the learner.

The literal IP theory model depicts learning in mechanistic terms (Pepper, 1942; pp 186-231). These views of learning diverged from behaviourist views in that learning was seen as knowledge acquisition instead of response strengthening. The mind was seen as an information processing system and cognition was a series of mental processes (Mayer, 1996). The increasingly widespread use of electronic computers in the 1950s and 60s had led to this conception of the human mind as a self-programming computer (Mayer, 1996). To proponents of information processing, computers and the human mind seemed to perform similar functions such as acquiring knowledge, retrieving information, coding information and others. Learning was located in three memory systems; the sensory register, working memory and long-term memory (Biggs & Moore, 1993; Figure 1).

Tulving (1985) described three kinds of memory; *procedural, episodic* and *semantic*. Procedural memory is procedural knowledge or the memory of how to carry out actions. Episodic memory is memory of personal events, stored as iconic images (Biggs & Moore, 1993, p.221). Semantic memory represents knowledge of information, concepts, principles and so on (Maltby et al, 1995, p.262).

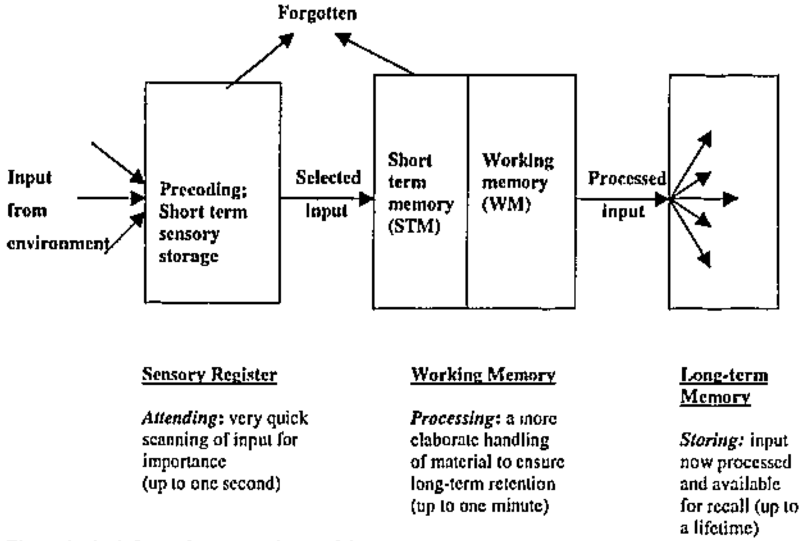


Figure 1. An information processing model of memory.

Source: Biggs, J., & Moore, P. (1993). *The process of learning* (3rd ed.). (p. 207). Sydney: Prentice Hall.

According to Biggs & Moore (1993) this model of learning proved "useful for construing some important aspects of cognitive functioning" (p.206). Some researchers have attempted to build upon IP models. Most IP research was laboratory based but classroom research by Nuthall & Alton-Lee (1993) and Nuthall (1999) was underpinned by some of the major IP concepts such as short term memory and working memory. Nuthall & Alton-Lee (1993) developed a model of learning based upon the amount of time students engaged with the content. Nuthall (1999) expanded the model, applying constructs from Piaget, IP and constructivism to further investigate knowledge acquisition.

Knowledge acquisition has also been related to the kinds of operations the learner performs on the material. This collection of information processing-based research has been described as *cognitive-elaborative* by Slavin (1990, 1995). In order for information to be retained, cognitive re-structuring or elaboration must occur (Wittrock, 1978, 1990) such as when an individual summarizes a lecture instead of simply taking notes (Brown, Bransford, Ferrara & Campione, 1983). One very effective means of elaborating on material is for the learner to attempt to explain it to another individual (Slavin, 1990, 1995). Peer tutoring has received support from researchers who have shown that peer collaboration can lead to academic gains (Dansereau, 1985). Research by Palincsar & Brown (1984) falls within the cognitive-elaborative perspective. These researchers developed a *reciprocal teaching model* of reading instruction where students worked in small groups and adopted the teacher's perspective. Students analyse reading material and lead the group in discussion, asking and answering questions about the text.

Despite providing useful constructs for further research, the limits of IP theories are significant. Mayer (1996) argued that the most literal interpretations of an information processing metaphor were close to behaviourism, "with the view of learning as a passive, atomistic, and mechanical process." (p.158). According to Mayer (1996), this model of learning was incomplete because it failed to account for the active nature of learning and ignored the "emotional, affective, and motivational aspects; social, cultural, and epistemological aspects; and biological, physiological, and evolutionary aspects" (p.158).

Mayer (1996) described other limits to IP theory. Research has raised doubts about the division of the human mind into sensory memory, short-term memory and so on. These divisions assume the mind has a bounded capacity for storing disconnected information. IP models diminish the role of the learner as an active processor and do not account for the construction and reconstruction of knowledge involved in meaningful learning. IP models also assume that cognition can be reduced to a series of processes analogous to sub-routines in a computer. Research has shown that cognitive processing does not occur on its own but is embedded in a context (Posner, 1978, cited in Mayer, 1996).

In sum, classical information processing theory fails to consider the total individual within a total context. The implications of this perspective on teaching and learning are discussed later in this review.

Constructivist models of learning

A further criticism of information processing theory, particularly relevant for the present study, is that the research was based largely upon laboratory experiments. Behaviourists based their research on animal laboratory experiments. IP researchers also examined human beings principally in laboratory experiments. This research produced an incomplete picture of human learning. As research expanded beyond contrived laboratory tasks (Mayer, 1996), the constructive nature of learning became more apparent and researchers became increasingly aware of the complexities of the classroom (Nuthall, 1996). As many as six forms of constructivism have been described (Steffe & Gale, 1995). This section summarises the key concepts of the various versions of constructivism. In Prawat's (1996) review, two perspectives of constructivism were designated *modernist* and the other four *post-modernist*. Some of these perspectives represent positions or stances rather than coherent, thoroughly researched theories. The post-modernist perspectives include several socio-cultural and language-based theories which challenge traditional views of cognition and learning and may be the early developments of a fourth metaphor of learning (Nuthall, 1996).

Modernist perspectives

Radical or schema-based constructivism draws heavily upon Piagetian theory. This model of constructivism adopts a modernist epistemological stance which assumes that knowledge resides with the individual (Prawat, 1996). Radical constructivists argue that schema are constructed in the head and mediate between mind and world, subject and object (Prawat, 1996; Derry, 1996).

Literal interpretations of information processing theory are described above. A more recent development, with a constructivist interpretation, is termed *cognitive schema theory* (Derry, 1996). This version of IP theory sees memory as knowledge rather than information, allowing for a more schematic, mediated, coherent conception. In cognitive schema theory (CST) three different classes of schema are identified (Derry, 1996). *Memory objects* are the stored results of previous experience or the prior knowledge that can be used to interpret new events. *Cognitive fields* are the pre-conceptions activated in particular situations in order for mental modelling to occur. *Mental models* occur when memory objects are re-organised into a representation of an event. CST represents some progress towards the third metaphor with the introduction of ideas about knowledge embedded in context in the learning process as opposed to knowledge in isolation.

Post-modernist perspectives: Social and language-based interpretations

Social constructivisms differ from the radical (schema based) and IP versions in their acceptance of the Vygotskian assumption that knowledge is primarily located in the social context and not in the individual (Prawat, 1996). Prawat (1996) identified four forms of social constructivism and labelled them *post-modernist* because of their epistemological stance.

Socio-cultural constructivism draws heavily upon Vygotsky's theories on the locus of knowledge. According to Prawat (1996) present day versions of socio-cultural theory include the notion of distributed cognition, where knowledge and cognition are part of a "complex construct that might be described as individual with artefact" (p.218). In this view, language is considered a social artefact. Individuals and artefacts lie embedded in culturally relevant activities as the individual attempts to make meaning from experience (objects and events) around them. Lave (1988) and Rogoff, (1990) have acknowledged the significant role of the socio-cultural context. According to Lave (1988) individuals and social activity cannot be distinguished from each other and cognition is located "in the experiencing of the world, and the world experienced, through activity, in context." (p.178).

The *symbolic interactionalist* or *emergent* perspective (Blumer, 1969; Cobb & Yackel, 1996; Prawat, 1996) examines the interplay between individuals and socially shared activity. Local community practices, such as the established learning community of the classroom, are the focus of research based upon symbolic interactionalism (Cobb & Yackel, 1996). According to Prawat (1996), it is this local community focus as opposed to a focus on broader socio-cultural practices which makes symbolic interactionalism "ideally suited to a fine-grained examination of classroom learning-one that takes into consideration, in equal measure, individual learning and social dynamics." (p.219). This perspective assigns equal weighting to individual knowledge construction and its social context. It helps account for how groups of individuals contribute their uniqueness to learning situations, combine with others to make meanings from classroom experiences and interpret the socially shared meanings in unique ways (Prawat, 1996). Symbolic interactionalism differs from socio-cultural approaches in that the individual makes more autonomous meanings from social interactions.

In *social psychological constructionism* (Gergen, 1994, cited in Prawat, 1996) individuals are part of a *discourse community* which overarches all interaction between individuals, artefacts, objects and events. According to this post-modernist perspective, all truth, behaviour and experience are linguistically based. Rorty (1989, p.7, cited in Prawat, 1996) contended that " truth is a property of linguistic entities, of sentences". This perspective has been criticised because it dos not account for private cognitive processes not involving language (Prawat, 1996).

Socio-linguistic theories were developed that acknowledged that the prime medium of learning in the classroom is language (Nuthall, 1996). Language was seen as the principle social semiotic (Halliday, 1978). Although based upon linguistic concepts and methodologies, these theories drew heavily upon socio-cultural perspectives. Halliday (1978) took an outside-in view of the relationship between the individual and the group. The individual was seen as a derivation of the group rather than the group as defined by the individual. Halliday (1978) posited that the individual human organism was destined to become a member of a group and that this enculturation was achieved "not wholly, but critically-through language" (p.14). Closely related to Halliday's view were the theories sometimes referred to as *language and learning* theories (Barnes, Britton & Rosen, 1969; Britton, 1970; Barnes, 1976). Britton's work was developmentally focussed and highlighted the axiom that children learn by using language and learn language by using it. Britton (1970) saw the use of language in the *expressive* function as the personal base for learning.

Further language-based theories, closely related to the socio-cultural perspectives of Vygotsky and Leont'ev (1981), view language as a cultural artefact.

According to these researchers, various curriculum areas are defined by the specific kinds of discourse used as students and teachers engage with them (Nuthall, 1997, pp.712). A third language-based perspective argues that language is a specific linguistic genre with a central role in cognition (Nuthall, 1997, p.712). Narrative was seen by these researchers as the principle means whereby children come to know and understand experience.

A final post-modernist perspective presented in Prawat's (1996) review is the Deweyan, *idea-based social constructivism.* Dewey assigned prominence to both social context and the individual in the making of meaning (Glassman, 2001). Exposure to and interaction with ideas were seen as the driving force for knowledge construction in individuals (Prawat, 1996; Glassman, 2001). According to Dewey, ideas mediate between private and public domains. In the Deweyan perspective, ideas provide the seeds for wider cognitive growth. Education should provide students with opportunities for "acquiring and testing ideas and information in active pursuits typifying important ideas social situations," so they could make connections between academic learning and daily life (Dewey, 1916, p.191, cited in Greene, 1986). Dewey's concern with students connecting educational experience to everyday life is salient when considering recent notions of situated cognition.

2.6. Situated cognition theories

The above perspectives have acknowledged that the classroom experiences of children are more complex and multi-facetted than was understood by behaviourists and literal interpretations of information processing theory. Versions of constructivism which place more emphasis on the social-cultural context of learning may be progressing towards a more context driven fourth metaphor of learning including developments in *situated cognition* theories.

Situated learning is learning though goal-directed activity situated in authentic contexts, which relate to the application of the learning (Lave, 1988; Brown, Collins & Duguid, 1989; Lave & Wenger, 1991; Billet, 1996). Rogoff (1984) argued that cognitive psychologists had been too concerned with describing how mental representations occur, independent of the effects of context. Cognitive skills or stages did not seem transferable from one situation to another. Lave and Wenger (1991) contended that agent, activity and world were not mutually exclusive and that most perspectives on learning ignored its fundamentally social nature. Brown et al (1989) contended that the effectiveness of teaching and learning in schools is limited because knowledge is often treated by teachers as an abstract, decontextualized "commodity". Learning and cognition were socially negotiated and located "in activity, context and culture" (Brown et al, 1989, p.32). Collins, Brown and Newman (1989) proposed a *cognitive apprenticeship* model as an alternative to conventional schooling. This model argues for a greater recognition of the role of activity and enculturation in the acquisition of knowledge. A part of this recognition might include conceiving the classroom and other learning situations in terms of Bereiter's (1990) *contextual modules*, which comprised the "entire complex of knowledge, skills, goals and feelings" (p.613). Under Bereiter's conception, the learning situation was seen as a complex unit rather than its disconnected components.

Billett (1996) argued for greater attention to the learning situation, contending that knowledge acquired out of context may not be transferred to other contexts. Lave's (1988) research into everyday uses of mathematics took cognitive psychological research from the laboratory, showing how cognition is shaped by interactions between culturally rich individuals and their total context. This interaction leads to changes both in the mind of the individual and their situation.

Billett (1996) also argued that reconciling differences between cognitive psychological and socio-cultural perspectives was necessary in order to understand and explain the situated nature of cognition, calling a "bridging of socio-cultural and cognitive theories" (p.277). Billett's analysis of cognitive psychological literature produced a delineation of sources of knowledge into *proximal* guidance (novice performing tasks under expert guidance), *distal* guidance (guidance derived from authentic activities in the situation) and the individuals' interpretations based on their personal histories. According to Billett (1996), contextualizing learning allowed for this bridging of cognitive psychological and socio-cultural perspectives but further research was needed to investigate how different social situations influence the co-construction of knowledge.

2.7. Perspectives of learning and their relationship to teaching practice

The perspectives on learning reviewed above have been very influential upon teaching practice for decades. In particular, the broad spectrum of constructivism, including socio-cultural and language-based perspectives, have shaped modern educational practice. A recent example is the outcomes-based movement in education, which can trace its origins to constructivist perspectives on learning. The importance of understandings about constructivism is the relationship of these theories to teachers' views about teaching and learning. For all their potential, constructivisms are *versions* of learning theory not theories of teaching. The application of these theories is a matter for the practices and beliefs of educators. The central understanding for teachers, from all forms of research into learning, is whether learners are passive recipients of knowledge or whether they are active participants in the learning process.

TABLE 1. Teaching and learning as transmission of information versus social construction of knowledge

Transmission View	*Social Construction View*
Knowledge as a fixed body of information transmitted from teacher or text to students	Knowledge as developing interpretations co-constructed through discussion
Texts, teacher as authoritative sources of expert knowledge to which students defer	Authority for constructed knowledge resides in the arguments and evidence cited in its support by students as well as by texts or teacher; everyone has expertise to contribute
Teacher is responsible for managing students' learning by providing information and leading students through activities and assignments	Teacher and students share responsibility for initiating and guiding learning efforts
Teacher explains, checks for understanding, and judges correctness of students' responses	Teacher acts as discussion leader who poses questions, seeks clarifications, promotes dialogue, helps group recognize areas of consensus and of continuing disagreement
Students memorize or replicate what has been explained or modelled	Students strive to make sense of new input by relating it to their prior knowledge and by collaborating in dialogue with others to co-construct shared understandings
Discourse emphasizes drill and recitation in response to convergent questions; focus is on eliciting correct answers	Discourse emphasizes reflective discussion of networks of connected knowledge; questions are more divergent but designed to develop understanding of the powerful ideas that anchor these networks; focus is on eliciting students' thinking
Activities emphasize replication of models or applications that require following step-by-step algorithms	Activities emphasize applications to authentic issues and problems that require higher-order thinking
Students work mostly alone, practising what has been transmitted to them in order to prepare themselves to compete for rewards by reproducing it on demand	Students collaborate by acting as a learning community that constructs shared understandings through sustained dialogue

Source: Good, T.L., & Brophy, J.E. (2000). *Looking in classrooms.* (8th ed.).(pp.420-421). New York: Addison Wesley Longman.

Teachers who see knowledge in traditional terms (see Table 1) will be influenced to teach in ways where knowledge is treated as a fixed, bounded "commodity", whereas teachers with constructivist views will be more likely to teach as though knowledge were a developing system of constructs.

Orientations to teaching and learning have moved from *transmission* models to *interpretation* models since the nineteen seventies (Barnes, 1976). Table 1 represents some of the alternate views on teaching and learning inspired by the information versus social construction debate.

2.8. Part One Summary

Part one of this review has outlined the development of the major strands of learning theory and attempted to place these in the context of the present study. Table 2 depicts the major features of the first three metaphors of learning. The first metaphor of learning was based upon animal responses to stimuli. Researchers realised that this metaphor was incomplete. Human learning appeared more complex than that of animals. The second metaphor was mechanistic, developing its conceptions from the advent of electronic computers. This metaphor was also incomplete because of its failure to account for the role of individuals in actively constructing meaning from experience. The knowledge as construction metaphor followed the computer metaphor. Various forms of constructivism have since evolved and focus more attention on the role of socio-cultural influences. These perspectives include several language-based views. The socio-cultural perspectives have given rise to situated learning theories that together with their social predecessors and language based perspectives, may be at the forefront of a fourth metaphor of human learning.

TABLE 2: Three metaphors of learning

Learning	*Major era*	*Research base*	*Teacher's role*	*Student's role*	*Typical instructional method*
Response strengthening	1900s-1950s	Lab animals on artificial tasks	Dispenser of rewards and punishments	Recipient of rewards and punishments	Drill and practice on basic skills
Information processing	1960s-1970s	Humans on artificial tasks	Dispenser of information	Recipient of information	Textbooks and lecturing
Knowledge constructing	1980s-1990s	Humans on realistic tasks	Guide for exploring tasks	Sense maker	Discussion, guided discovery, supervised participation in academic tasks

Source: Mayer, R.E. (1996). Learners as information processors: Legacies and limitations of educational psychology's second metaphor. *Educational Psychologist, 31*(3/4), 151-161.

2.9. Part Two-Cooperative learning: Theory and practice

Introduction

To what extent does learning occur in isolation or is it derived principally from socio-cultural contexts? This study has focussed on the specific educational context of children working in small groups. How does the construction of knowledge in these settings occur? Are the claimed cognitive benefits of cooperative learning valid?

Cooperative learning strategies are difficult to establish and manage. Teachers require strong classroom management skills before attempting these approaches. Cohen (1991) termed these kinds of strategies *complex instruction,* because of the interplay of many more variables than those involved in transmission methods. Meloth & Deering (1999) regarded the term, complex instruction, as particularly appropriate given that teachers attempting such methods are confronted with a "myriad of paradoxes" (p.253). They argued that teachers had to be prepared to hand over more control to students but they had often been offered minimal training and guidance in the use of these strategies.

The lack of assistance for teachers was likely to lead them to abandon cooperative learning strategies.

Meloth & Deering (1999) argued further that insufficient research had focussed on cognitive and metacognitive benefits of cooperative learning and how groups interact to produce putative benefits. Are the benefits of cooperative learning primarily social and affective or are cognitive gains also significant? What are the benefits and possible shortcomings of cooperative learning? A substantial body of research on cooperative learning exists and a number of review articles are available (Slavin, 1991; Cohen, 1994; Qin, Johnson & Johnson, 1995). The remainder of this chapter outlines major trends and emphases in the literature in order to provide background for the present study.

Cooperative learning models

Researchers have developed more than 80 cooperative learning strategies (Johnson, Johnson & Barlett, 1990; Nattiv, 1994), which have achieved mixed success (Kohn, 1991). The relative merits of cooperative learning systems have been the focus of much research (Sharan & Shaulov, 1990) and substantial teacher resources have been developed (Kagan, 1990; Bennett, Rolheiser-Bennett & Stevahn, 1991). Cooperative task structures as opposed to individual task structures have lead to the development of team rewards methods such as Teams Games Tournaments (De Vries & Slavin, 1978; De Vries Slavin, Fennessey, Edwards & Lombardo, 1980; Slavin, 1986), Student Teams-Achievement Divisions (STAD), Jigsaw II and Team-Assisted Individualization (TAI). These methods have been shown to produce positive achievement gains when compared to traditional methods (Good & Brophy, 1997). Other systems, Learning Together, Group Investigation (Sharan & Hertz-Lazarowitz, 1980; Sharan & Sharan, 1990) and Jigsaw (Aronson, Blaney, Stephen, Sikes, & Snapp, 1978; Johnson &

Johnson, 1994), have not produced the same positive gains (Lew, Mesch, Johnson & Johnson, 1985; Moskowitz, Malvin, Shaeffer & Schaps, 1985; Okebukola, 1985; Slavin, 1983). Slavin (1991) contended that the most consistent student achievement gains were produced under cooperative learning regimes that combined two elements; group goals and individual accountability. The major cooperative learning structures are described in more detail in Appendix A.

Social psychological perspectives in cooperative learning research

Research has provided insights into the potential benefits and shortcomings of cooperative learning. Most of the research has focussed on a social psychological perspective (Slavin, 1991; Cohen, 1994). Some researchers have viewed cooperative learning as a means of improving pro-social behaviour, including improving racial tolerance. The section below outlines the major directions in cooperative learning research with a social psychological focus.

Research on group processes and interactions

Group processes and interactions have attracted a degree of research attention (Webb, 1982; Webb & Cullian, 1983; Bennett & Cass, 1988; Battistich, Solomon & Delucchi, 1993; Nattiv, 1994; Ross, 1994). These studies have found that the nature of group interactions is a critical factor in cooperative learning. Not surprisingly, student performance was to a large degree determined by their experiences in the group (Battistich et al, 1993). Positive correlations have been found between giving and receiving explanations and achievement gains (Webb, 1982) but research has also showed that students often gave poor quality explanations (if they gave them at all), and often did not possess the communication or social skills to ask for help from their peers. Studies by Ross (1994) and Webb & Favivar (1994) found that students could be trained in help giving and help receiving behaviours, indicating that these kinds of pro-social training were related to positive achievement gains.

Another group of studies have investigated the life of groups and the various combinations of ability levels (McCaslin, Tuck, Wiard, Brown, LaPage & Pyle, 1994; Stebler & Reusser, 1996). Recent research has described the highly individual nature of group dynamics and how this can create negative outcomes for group members (King, Luberda, Barry & Zehnder, 1998).

King et al (1998) conducted a micro-analysis of one group's perceptions in problem solving lessons and found that the individual group members combined to create a dysfunctional group. Some group members did not successfully participate in cooperative interactions or become engaged actively in the task. These students were more concerned with negotiating social status within the group and engaging in off-task, socially oriented talk. The group became adept at appearing to be on-task when the teacher was in the vicinity but quickly returned to their off-task talk as soon as the teacher moved away.

Research on group processes has highlighted the importance of the group context in determining the success or otherwise of cooperative learning. Teachers attending to social issues appears essential. Achieving an optimal social setting will be more likely to lead to cooperative learning sessions becoming positive episodes in the classroom life of students.

Problems with status differentials

A lack of active engagement in the task is a particular problem for low status students. Low status students are often low achieving students or at least those who are perceived as less likely to be competent in the given task. Several studies have examined problems of passivity among low status/low achieving students (Mulryan, 1992; King, 1993) and other research has investigated treating the status of these kinds of students (Cohen, Lotan & Catanzarite; 1990).

Good's (1981) passivity model applied to whole class situations, although it has been subsequently investigated in cooperative settings. Good proposed that low achieving students became passive as a result of teacher behaviours directed towards them and because of their overall school experiences. Good noted that teachers tended to (1) provide less wait time for low achievers (2) give lows answers rather than helping them to improve their answers (3) allow fewer opportunities for lows to participate in class discussions (4) criticise lows more when they give unsatisfactory answers and (5) praise lows less when they give satisfactory answers. The nature of low achieving students' total school experience tended to re-enforce already poor student expectations of success. Students in these situations tended to resort to passivity.

Mulryan (1992) reported six different types of passive student behaviour in mathematics lessons; (1) the discouraged student (2) the unrecognized student (3) the despondent student (4) the unmotivated student (5) the bored student and (6) the intellectual snob. In addition to passive students, Mulryan (1992) also identified three categories of actively uninvolved students. These were the (1) social opportunist (2) intentional loafer and the alternatively involved. Mulryan (1992) also described causes of passive behaviour and students' perceptions on passivity and found that low achieving students were generally passive in group work. Mulryan (1992) noted that small group cooperative learning in mathematics could not be claimed as "a panacea or a means of bringing about improvements in mathematics learning in some or all students" (p.271). Mulryan found that students who gained most from other classroom contexts also appeared to gain most from small group cooperative learning and low achieving students remained generally uninvolved.

Mulryan's latter findings were echoed by King's (1993) investigation into the thought processes of two groups of four (Burns, 1981) in mathematics. King found that the small group model did not reduce greatly the status differentials. Status differentials from regular mathematics classes remained basically unchanged by the cooperative setting. In King's study, high achieving students assumed a dominant role in completing the group task, making decisions and in determining the quantity and quality of talk offered. King (1993) also found that low achieving students were passive. These students appeared unable to take command of the learning situation because they " continually seemed to be outwitted and outmaneuvered by the speed of thought and depth of mathematical knowledge and reasoning of high achievers" (p.409). The low achievers in King's study expressed their frustration at their lack of control but appeared unable to affect changes to their situation.

Research by Day (1997) examined self-accountability perceptions of passive students. The students felt accountable for their academic progress and their contribution to the group product. Several factors were identified which led the passive students to behave passively. These factors included lack of understanding of group talk, their lower achievement levels, working on difficult or meaningless tasks, lack of skills in seeking help, exclusion from the group and lack of help from other group members. Day (1997) suggested that academic and group contribution accountability perceptions were interrelated.

Problems of passivity may be addressed in part by application of student training in tutoring or helping techniques and group processes (Nattiv, 1994; Ross, 1994 & 1995) but evidence exists that systematic status treatments can also be beneficial (Cohen et al, 1990). Status could be treated by regularly acknowledging in class of individuals' capabilities and worth. According to Cohen (1994), status treatments combined with "ill-structured", true group tasks were capable of delivering the putative cognitive benefits of cooperative learning, including higher rates of participation and achievement among low status/low achieving students. "Ill structured" tasks are tasks with open-ended solutions. "True" group tasks are those which are designed so that success depends on the inputs of all group members. Structuring tasks so that low achiever/passive students are valued members of the group may reduce passivity effects (Cohen, 1994).

The above measures should receive the attention of teachers because research (Mulryan, 1992; King, 1993) has shown that at least one putative benefit of cooperative learning, that of greater involvement of low achieving/passive students, does not automatically occur. For all students to become more involved in these learning situations, teachers must attend to issues of status and attempt to reduce them or the regular status and control of the learning situation experienced by students will be simply duplicated in cooperative settings. In some circumstances, student passivity may be amplified by cooperative situations, only exacerbating the difficulties low achievers experience in accessing the curriculum.

Cognitive perspectives in cooperative learning research

Although most of the cooperative learning research has focussed on a social psychological perspective (Slavin, 1991; Cohen, 1994) there have been relatively few studies with a cognitive psychological perspective (Meloth & Deering, 1999). Meloth & Deering argued for further research into cognitive and metacognitive processes in cooperative conditions with associated student interactions (1999). Other researchers have called for studies which examine the quality of student talk in order to determine whether students are actually engaged in cooperative interactions (Bennett & Dunne, 1991; Meloth & Deering, 1994; King, Barry, Maloney & Tayler, 1994; King, Barry & Zehnder, 1996).

Examining the nature of student talk may assist in overcoming one of the main deficiencies in cooperative learning research identified by Good and Brophy (1997); that is, understanding how cooperative learning actually produces cognitive gains. Research by Bennett & Dunne (1991) investigated the nature of student talk. Other research (King, Barry, Maloney & Tayler, 1993) has examined the kinds of talk necessary to enhance cognitive gains. In order to conduct detailed analysis of small group talk, a low inference analysis system was developed. The MAKITAB instrument has been applied as a means analysing task enhancing talk (King, Barry, Maloney & Tayler 1994) and has provided an important means of analysing student talk in subsequent studies (King, Barry & Zehnder, 1996; Barry, King, Maloney & Burke, 2000; Zehnder & King, 2000). King et al (1996) produced findings about teacher cognitive intent and its effect on teacher monitoring behaviour, teacher determined conditions for group discussion and cognitive outcomes for students. An important finding of this research was the increased rates of higher order discussion produced by open-ended problem solving tasks. Barry et al (2000) found that training students in philosophical thinking and discourse processes led to significant increases in higher cognitive level talk.

Most of the early research into academic achievement under cooperative conditions focussed on lower order academic tasks (Good & Brophy, 1997) but more emphasis has been focussed recently on higher order tasks including problem solving. A number of studies have claimed academic gains for cooperative learning. A meta-analysis of 46 studies into cooperative learning found that students in cooperative teams consistently performed better than competing individuals (Qin, Johnson & Johnson, 1995).

Research has also found that combining meta-cognitive training with cooperative strategies produces academic gains. In a study on cooperative learning in mathematical problem solving, Mevarech (1996) found that meta-cognitive training correlated positively with achievement in problem solving. Students were trained to apply a system of meta-cognition to problems. The groups trained in meta-cognition outperformed the untrained students.

<u>The role of the teacher during cooperative learning</u>

The most appropriate role for the teacher during cooperative learning has been the subject of some debate. Cohen (1994) favoured an approach involving minimal teacher interference, preferring teacher statements that delegate authority for completion of the task to the students. Under Cohen's recommended approach, teachers should keep monitoring to a minimum and quickly move away to avoid interruptions to the flow of discussion.

Meloth & Deering's (1999) view was that teacher monitoring should focus on facilitating productive discussion and not be so concerned with the amount of time spent with the group. In some cases, only a few words may be needed to achieve this end but teachers should be ready to step in or out of the discussion and stay for as long as the situation demands. These kinds of approaches to monitoring further complicate the teachers' role and require the development of additional skills.

Some teachers may experience difficulty adapting to cooperative methods because of a lack of support and problems adapting to a less dominant role. Delegating more authority for learning to students may seem alien to some teachers and they could be left wondering about their role in these situations (Meloth & Deering, 1999). Meloth and Deering contended that in order to maximize the cognitive benefits of these strategies, teachers needed greater guidance in understanding their facilitative role.

Potential strengths and shortcomings of cooperative learning

Bossert (cited in Good & Brophy, 2000, p. 294) suggested four possible explanations for the benefits of cooperative strategies. These were (1) *reasoning strategies*; cooperative groups may stimulate higher order thinking (2) *constructive controversy*; heterogeneous cooperative groups may force students to accommodate others' opinions (3) *cognitive processing*; cooperative methods may increase opportunities for oral rehearsal and integration of material and (4) *peer encouragement and involvement in learning;* positive interactions increase social acceptance and cognitive information processing. Good and Brophy advanced eight additional reasons for the success of cooperative learning in enhancing student learning, together with a list of possible problems. These are summarized and presented in Table 3.

Student passivity remains a major problem in the implementation of cooperative learning strategies. Models of cooperative learning that do not attend to problems of status differentials may be unlikely to succeed and gain acceptance among teachers in the longer term. If at least some of the claimed cognitive benefits are not identifiable for all students, teachers are unlikely to persist with these strategies. If low status/low-achieving students are permitted to remain passive bystanders in cooperative sessions and are not more actively engaged with the content, traditional instructional models may be just as appropriate for these kinds of students. Therefore status treatments for low status/low achieving students, structuring of true group tasks and selection of ill-structured tasks (Cohen, 1994) would seem to be among pre-requisite conditions for cooperative learning.

TABLE 3

Potential strengths and shortcomings of cooperative learning strategies

Potential strengths	*Potential shortcomings*
1. Access to greater subject matter knowledge; sum of the group knowledge is greater than that of one individual	1. Mis-conceptions are re-enforced.
2. Students value shared academic tasks. More academic time spent on understanding concepts rather than on finishing products.	2. Dependency shifted from teachers to peers. Collaboration should lead to higher rates of independence and participation, not "expert" peers becoming the teachers.
3. Student regulation of resources and work pace.	3. Students may come to value the product more than the process. Speed of completion becomes more important than quality interactions.
4. Learning how to co-ordinate and manage time, resources and information with others.	4. In some classrooms, "how well we worked together" becomes more important than subject matter.
5. Challenging tasks become more attractive and approachable because of shared skills and knowledge.	5. High achievers also gain more from cooperative learning and may assume overly dominant positions and increase or maintain existing status differentials. Passives may be unable to engage with the lesson content.
6. Group tasks tend to be more like those done in real life, more authentic.	6. Students may believe they are unable to contribute because the academic demand appears too high.
7. Group members can serve as role models for others such as in time management skills.	7. Students may feel their contribution is not needed or valued which may lead to another form of passivity.
8. Enhanced interpersonal and intrapersonal understandings.	8. Group accountability may influence "failure - avoiding" and "success -enhancing" behaviours. Some students may not offer information in order to avoid unwelcome reputations as "know-it-alls". Information may also be withheld to allow other students to contribute more.

Source: Good, T.L., & Brophy, J.E. (2000). *Looking in classrooms*. (8th ed.). New York: Addison Wesley Longman.

Much of the research into group dynamics seems to have focussed on passive, cognitively disengaged students but additional research is needed on students such as engaged passives, who may learn well in cooperative settings and on dominant students, who are often high achievers. The latter often act as the driving force for the group and tend to dominate discussion (King, 1993). Research into peer collaboration has focussed on enlisting these kinds of students as peer tutors (Good & Brophy, 2000) but additional research on dominant students may be required to broaden understandings about the total group composition.

2.10. Summary of cooperative learning literature

The majority of the potential strengths and shortcomings of cooperative learning included on Table 3 can be viewed from a socio-cultural perspective. Students cannot be considered as individual, disconnected "brains" in classrooms. Nor are they necessarily ruled totally by the social context. Taking a strictly dichotomous cognitive versus social psychological perspective of student learning in cooperative settings may fail to appreciate the role of students' individual cognitive functions in their total socio-cultural context. The classroom is increasingly recognized by researchers as being much more multi-layered and complex than has been previously thought (Nuthall, 1996). All learning is embedded in the socio-cultural context of the classroom. Even a student working alone at computer is working in a social and culturally rich context. In this example, the student applies socio-cultural artefacts (in this case advanced electronic technology) and operates the high-tech tool using the ultimate human social tool of language. Research into classroom learning and thinking may need to take greater account of the richness and complexity of the total context.

2.11. Chapter summary

The review above has described research in educational psychology, which has produced theories of learning and cognition and the first three metaphors of learning.

The chapter has also highlighted the major cooperative learning methods and some of the major benefits and problems associated with these strategies.

The educational psychological component of the chapter sought to provide the background for a continuing discussion of a fourth metaphor that appears to be emerging from research. It is an investigation of this metaphor that underpins the present study. The literature seems to suggest a new metaphor that takes greater account of the socio-cultural context of the real classroom. A metaphor of this kind may be more beneficial and relevant to classroom practitioners, partly because it has the potential to describe more accurately the world in which they operate on a daily basis.

The cooperative learning literature has provided a research base and a language with which researchers can discuss these strategies. Despite potential benefits of cooperative learning, problems of access and equity for all students remain. These are related closely to teacher practice and preparation. Cognitive benefits still appear under-researched. Terms like "quality talk" have not been precisely defined and related to student learning and the mechanisms of cognitive gains claimed for the strategies are not clear.

Questions about individual versus social construction of knowledge are also unanswered by the literature, although a marriage of socio-cultural and cognitive theories may assist in explaining the effects of context (Billett, 1996). As was described in the first section above, early educational psychological research was dominated by the work of Thorndike (O'Donnell & Levin, 2001) rather than Dewey. Dewey was interested in the social context of schooling, including the real, daily lives of children as opposed to Thorndike's focus on experimentation. Despite the strong contribution of the early research, the reader and researcher are left to speculate where understandings about learning and cognition might be today had Dewey's ideas been the focus of the early research instead of Thorndike's.

This review has attempted to place the present study in the context of the literature on learning and specifically on the application of theory through some teaching strategies which take advantage of peer collaboration. The first part of the chapter dealt with the various major theories and perspectives of learning. The second part dealt with the application of these theories and perspectives into cooperative learning strategies. To what extent does the development of a fourth metaphor of learning and cognition relate to small group cooperative learning and peer collaboration in general? How does the development of a context-guided metaphor relate to broader questions of ontology and epistemology? The next chapter seeks to place notions of metaphor in a philosophical context and provide a theoretical framework for these questions by examining ontological and epistemological issues related to the present study and adopting a conceptual framework derived from research on learning.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1. Overview

The chapter presents the theoretical basis of the study in terms of broader philosophical and theoretical considerations than were described in the previous chapter. The theoretical perspectives presented in this chapter should be taken in context with the material presented in the first two chapters. Possible directions for research into a fourth metaphor are described. Meta-physical questions of epistemology and ontology are discussed together with the guiding root metaphors of previous research and the present study. The study's conceptual framework is illustrated and the guiding perspective on learning is outlined.

3.2. Introduction

Investigating metaphors of human learning and cognition was a core goal of the present study. The study was located within a philosophical world-view and explicates a naturalistic research paradigm. These theoretical assumptions formed the basis of the research questions, the types of data sought and the practices applied in data analysis and reporting.

Philosophers have long argued about the ontological and epistemological questions surrounding knowledge construction. Can knowledge ever be independent of the individuals' subjective perceptions of experience? How can the acquisition of knowledge be represented? In seeking to answer these questions, scientists and philosophers have often resorted to the use of metaphor. Morgan and Smircich (1980) argued that metaphor was a prime means through which scientists created knowledge about the world and that metaphors were usually derived from a foundation of assumptions about ontology and human nature. According to Morgan and Smircich the use of metaphor included questions about the nature of knowledge, arguing that "debates about epistemology hinge largely on the advocacy of different kinds of metaphoric insight as a means of capturing the nature of the social world" (1980, p.493). The use of metaphor has also been advocated for pragmatic reasons as a means for researchers to reflect upon data and conceptualize from new perspectives. Metaphor can assist the researcher to generate theory (Berg, 2001). The present study had the social context of classrooms as one of its main foci so these kinds of metaphoric questions were seen as particularly salient.

Various authors have described research in educational psychology, particularly cognitive psychology, as a search for metaphors that depict human learning. Researchers have called for a re-evaluation of existing research paradigms and the creation of a new guiding metaphor that takes greater account of the intricacies of the classroom (Vosniadou, 1996; Nuthall, 1996; Mayer, 1996). Recent research has indicated that learning can no longer be viewed in terms of response strengthening, information processing or knowledge construction. The literature suggested that the socially oriented perspectives may be leading consideration of the fourth metaphor. Previous research has provided rich descriptions of the mental structures and processes which underpin student performance but a fourth metaphor which adequately describes student learning in its full context has yet to become well established (Bereiter, 1994; Mayer, 1996; Nuthall, 1996; Vosniadou, 1996).

Social constructivist and socio-cultural theories have a number of implications for researchers and teachers because of what they may reveal about classroom complexities (Nuthall, 1996). According to Nuthall, classroom learning was more complex than was first thought. Like the socio-culturalists, Nuthall and Alton-Lee (1993) also recognized the importance of classroom context, claiming it was a mistake for researchers to "think that, within a natural environment, behavior, can be validly described, counted or, explained independently of the multiple contexts within which it occurs (p.800). Nuthall argued that research on learning in the classroom needed to account for its multi-facetted, context-embedded nature (1996).

Critics of the process-product research paradigm have called for more naturalistic, interpretive, reflective analyses of the classroom experience (Erickson, 1986; Nuthall & Alton-Lee, 1993). Nuthall (1997) argued for a return to research that seeks to observe and describe students' classroom experience in its full complexity, particularly the means whereby students apply language and social processes in order to learn. In evolving from the early observational/descriptive studies to correlational and experimental designs, research had developed a narrowness and limited conceptions of learning and teaching (Gage & Needles, 1989). In calling for a widening of the focus of educational research, Nuthall (1997) depicted the evolution of research as an upward spiral, and argued that the research cycle had returned to observational/descriptive studies, requiring the development of more sophisticated research methods.

Concerns about the lack of transfer of knowledge from one context to another have lead to recent research into "situated learning"(see chapter two) which also focuses on learning in its authentic context (Brown, Collins & Duguid, 1989; Billett, 1996). These researchers argued that differing views about knowledge as *individual construction* versus *culturally shaped* knowledge may be reconciled by considerations of where the knowledge is to be applied. In this way contributions may be made to the development of a metaphor of student learning which is generated from its socio-cultural context. Nuthall (1996) called for a re-assessment of existing research paradigms involving a "larger strategic conception of research on classroom learning that attends to the life histories of students, their individual trajectories over time and context, as much as it attends to their situated learning in school classrooms." (p. 213).

Given the calls for research described above, the researcher determined that the investigation into cooperative learning, underpinned by a search for the fourth metaphor, needed to account for the complexities of the real classroom context. Therefore this study was conceived as naturalistic, descriptive research, guided by a socio-cultural perspective of learning.

The chapter continues the discussion about the kinds of research, suggested by the literature, which may lead to a new metaphor. The existing third metaphor is discussed, focussing on the metaphors at the core of meta-physical thinking, Pepper's (1942) *root* metaphors, which provide the background for suggesting directions for a fourth metaphor. Later, the discussion turns to ontological and epistemological assumptions, the study's conceptual framework and perspective on learning.

3.3. World views and the third metaphor

A theoretical discussion about the third metaphor appears to be the logical starting point from which to explore a fourth metaphor. What kinds of philosophical thought processes form the basis of the third metaphor of cognitive psychology? Pepper (1942) advanced a theory of six *root-metaphors* to explain "world hypotheses" or meta-physical systems. He described how these hypotheses could be judged systematically by examination of evidence and by seeking corroboration. World hypotheses correspond to the traditional schools of philosophy and underpin research paradigms. Three of Pepper's hypotheses were identified as potentially relevant to the present research, with two being applicable to the third metaphor.

Prawat (1996) described two constructivisms, information processing and schema-driven (Piagetian) as modernist although they adopt differing epistemological stances (see chapter 2). Information processing (IP) is a *mechanistic* view, adopting the machine as its root metaphor (Pepper, 1942, pp.186-231). IP theory provided the second metaphor. This version of constructivism has a *realist* orientation (Prawat, 1996). According to mechanistic views, events can be interpreted in terms of mechanical relationships. Mechanical in this instance is defined also as electrical and electromagnetic, so the root metaphor can be taken as a lever or a dynamo. In the case of IP theories, the mind is metaphorized as an information processor or a computer.

Contrastingly, the schema-driven models of constructivism adopt an *organicist* world view (Pepper, 1942, pp.280-314). This view takes the living organism as its root metaphor. Organicists interpret events in the world in terms of processes within the organism. This third metaphor, mind-as-knowledge-constructor, appears particularly applicable to *rationalist* attempts to explain human learning and cognition in terms of changes within the mind as new material is assimilated into existing schema or accommodated into new ones. In this perspective, the organism attempts to make sense of objects and events in its environment.

The discussion above signals directions for a new metaphor of human learning and cognition. Assuming that the second and third metaphors adopted mechanist and organicist root metaphors respectively, and given calls for research that accounts for the learner's total context (Vosniadou, 1996, Nuthall, 1996, 1997), a fourth metaphor based upon socio-cultural perspectives would seem to be rooted in context. This notion will be explored below as one of Pepper's (1942) world-views is adopted as an orientation for this research.

3.4. The individual mind and the "fourth metaphor"

The cognitive-constructivist and the socio-cultural perspectives of learning have a number of points of difference. Packer and Goicoechea (2000) called for non-dualist conceptions in this debate. They argued that assumptions about what constitutes knowledge or knowing (epistemology) and the nature of "being" (ontology) were two key differences between the constructivist and socially oriented perspectives. They described constructivist ontology as a *dualist* ontology of two spheres between the individual and an independent world. According to Packer & Goicoechea (2000) "this dualism poses all sorts of problems for a coherent theory of human knowledge, learning and action."(p.228). Depicting the mind as a self-sufficient entity presents a quandary of how to explain the nature of knowledge itself and how it comes to exist at all. They argued that learning was central to the construction, through activity, of the whole person as part of a socio-cultural setting and motivated by a search for identity. Learning was part of a broader process of human transformation and change. According to Packer and Goicoechea (2000) individuals cannot "know" in isolation but do so as part of their "being" within their socio-cultural context and the individual mind could not be divorced from its context. Through this understanding, socio-cultural perspectives can help reconcile epistemological and ontological questions.

The notion of *situation or context* is a major point of difference between constructivist and socially oriented perspectives that stems from epistemological and ontological differences. IP and schema-driven models tend to investigate and theorize about learners and knowledge in isolation from context. Their focus is in the head of the individual. Socially oriented approaches have in common the notion that learning is connected inextricably to context. To what extent can a focus on context relate to world-views? Among his other world hypotheses, Pepper advanced a root metaphor based upon context that is of relevance to the socially oriented perspectives described in the present study. This root metaphor was termed *contextualism* (Pepper, 1942).

Contextualism's root metaphor is the historic event. This does not necessarily refer to events of the past but more to the live events of the here and now. Pepper described these as dramatic, active events or acts. They were not acts in isolation but acts "in and with its setting, an act in its context."(1942, p.232). Change and novelty are fundamental presuppositions of this world view (pp.235-236).

Conceptions of what constitutes the *mind* are central to this research, but investigating the mind in its total context appeared appropriate, given the literature reviewed above. Vosniadou (1996) argued for a revised epistemology of cognitive psychology in order to investigate the environmental variables which enable learning and inclusion in society. Vosniadou indicated that conceptions of the mind and its context are critical, describing the complexities of human learning as a function of a biological organism. This author called for a research paradigm that assigned greater emphasis to the biological and situational contexts of human learning and also accounted for the role of the individual mind. Vosniadou was also critical of the third metaphor because it failed to take account of a "biological, developing system that exists equally well within an individual brain and in the tools, artifacts, and symbolic systems used to facilitate social and cultural interaction" (1996, p.95).

Prawat (1996) argued that the two "modernist" constructivisms he outlined adopted differing positions in the mind-world debate. Schema-based, *radical constructivisms* take a MIND-world position. In this epistemological stance, knowledge resides primarily in the individual mind and "mind and world go their separate ways" (p. 216). In Prawat's assessment, researchers like Piaget made the dualist distinction between cognitive processes in the individual mind and the "real world 'stuff' that provides grist for the rational mill" (1996, p.216). Information processing (IP) theories adopted a mind-WORLD approach. Under this conception, "structures built up in the head are judged valid to the extent to which they map onto whatever structures are present in and extractable from the world" (Prawat, 1996, p.216). Although both "modern", these versions of constructivism adopt opposing epistemologies.

Packer and Goicoechea's (2000) contention that the distinction between epistemological and ontological aspects of human change was that "the former is always an aspect of the latter" (p.239), could lead to a further conceptualizing of the mind-world world debate. For humans, a part of "being" is "knowing". The socio-culturalist sees learning as this larger process where individuals participate in learning communities and relationships, which involve the "transformation both of the person and the social world" (p.239). The individual both acts upon and is acted upon by their socio-cultural world, thereby producing changes to both. In Prawat's (1996) terms, socio-cultural perspectives could be represented as MIND-WORLD.

Bereiter (1994) contended that the constructivist locates the mind in the individual's head and the socio-culturalist locates it in the individual-social-action chain. Bereiter (1994) argued that an additional perspective existed where knowledge was seen as an immaterial object and therefore had no location. Bereiter described Popper's (1972, cited in Bereiter, 1994) view that this kind of objective (scientific) knowledge was located in a "World 3" (World 2 is the in-head constructivist knowledge and World 1 is the physical world). Bereiter argued that education had traditionally concentrated on Popper's World 2 while researchers and scholars typically focus on World 3. Bereiter contended that education should focus more on the building of knowledge, theories, explanations and so on in World 3 as part of the process of inducting students into the various spheres of knowledge in the various academic disciplines. In order to help students direct their attention outward toward objects rather than inward toward the state of their own minds or social position, teachers need "an epistemology that helps them distinguish between efforts directed toward the construction of knowledge and efforts directed toward the changes in students' minds." (p.23). According to Bereiter (1994), neither constructivist or socio-culturalist perspectives quite fulfil the needs of this endeavour.

The sections below establish further the philosophical basis for the study generated from the literature and Pepper's (1942) meta-physical systems. The study's epistemological and ontological stances are explained and placed within a research paradigm resulting in the adoption of a guiding learning perspective.

3.5. Ontological and epistemological perspectives of this research

In view of Prawat's (1996) discussion of modernist versus post modernist orientations, an overarching post modernist approach seemed most appropriate for this study. Post modernism was coined as a term in the 1930s and has been a growing intellectual mood or form of cultural expression since the 1970s (Grenz, 1996). It is a label used to delineate an holistic approach that resists unified, all encompassing, universally valid explanations for phenomena. Set in an overarching era of post modernism, and given the literature that underpins this study, a naturalistic, non-positivist research paradigm was adopted (see Table 4). Positivism, with its roots in the work of nineteenth century philosopher, August Comte, has been criticised since the Second World War (Tashakkori & Teddlie, 1998). According to Tashakkori and Teddlie (1998), dissatisfaction with positivist axioms (Lincoln & Guba, 1985) had been growing, particularly axioms relating to ontology, epistemology and axiology (role of values in inquiry). Table 4 contrasts the positivist versus naturalist research paradigms in relation to these issues.

TABLE 4 Contrasting Positivist and Naturalist Axioms

Axioms about	*Positivist Paradigm*	*Naturalist Paradigm*
The nature of reality	Reality is single, tangible, and fragmentable.	Realities are multiple, constructed and holistic.
The relationship of knower to the known	Knower and known are independent, a dualism.	Knower and known are interactive, inseparable.
The possibility of generalization	Time and context-free generalizations (nomothetic statements) are possible.	Only time and context bound working hypotheses (idiographic statements) are possible
The possibility of causal linkages	There are real causes, temporally precedent to or simultaneous with their effects.	All entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish causes from effects.
The role of values	Inquiry is value-free.	Inquiry is value-bound.

Source: Lincoln, Y.S., & Guba, E.G. (1985). *Naturalisitic inquiry*. Beverley Hills, California: Sage Publications.

The ontological perspective adopted in naturalistic inquiry appears particularly relevant to the present study with the emphasis on constructed, holistic reality. This study examined the relationship between knowledge as an individual versus social construct supporting epistemological notions that highlight the intimate relationship between knower and known. In addition, the time and context boundedness of naturalistic research relates more closely than positivist axioms.

As a consequence of a post-modernist, naturalistic stance, this study was based upon the epistemological assumption that knowledge resides first in the socio-cultural/historical context and is the property of the group before it can be transformed by the individual. It is accepted that knowing and being are inextricably linked. Ontologically, the assumptions of Packer & Goicoechea (2000) were adopted in this research. The person is constructed through social interaction and activity, motivated by a search for identity within their socio-cultural context.

Both Packer and Goicoechea's (2000) and Bereiter's (1994) positions suggested to the researcher that a pluralist approach to epistemological and ontological questions was consistent with post modernist perspectives. A pluralist approach could potentially provide a reconciliation of the two major learning perspectives in support of Billett's (1996) claims that each had something to offer the other. The literature review highlighted the need for this research to be approached without pre-conceived hypotheses and for the researcher to be prepared to examine all possibilities. For example, knowledge might be found to exist immaterially as in Popper's World 3, rather than in the individual mind or as a social construct and learning contexts might become prominent. It seemed that attempting to reconcile the broad perspectives could contribute more to the development of the fourth metaphor. Therefore a pragmatic, pluralist approach to this study was taken and a contextualist root metaphor was adopted.

Two of Pepper's (1942) world hypotheses have been the basic philosophical approaches of the modernist learning theories. Since this research is set within a post-modernist/naturalistic paradigm, mechanistic and organicist world views were not considered appropriate, although some elements of organicism were not overlooked because of their biological elements. The world view most applicable to this research was contextualism because its root metaphor focuses on events located in context in the here and now.

These philosophical and paradigmatic positions were adopted tentatively. They only provided the guiding influences for this study and were open to revelations from the data corpus. The intention was to generate assertions and conjectures inductively from the data and not to make the data fit pre-conceived notions about learning and no pre-determined hypotheses were advanced. Hypotheses were working hypotheses and as will be seen in the next chapter, these were subjected to rigorous testing and re-testing. It should also be emphasized that this was classroom research and as such it was prone to the unpredictability of the classroom but at the same time had the advantage of providing access to rich, thick data located in an authentic context.

The previous chapter described the various constructivisms and the importance of context in the emerging socially oriented perspectives (social constructivism and socio-cultural perspectives). Although these perspectives have in common the belief that the learner is a much more active participant in constructing meaning from experience than was described in the previous metaphors, they differ in their approaches to the influence of the learners' social context. Constructivists, with their Piagetian roots, argue that the learner makes individual constructions of knowledge from experience. The socially oriented perspectives, derived from the work of Vygotsky, argue that knowledge is at first a social construct that is then modified by the individual. At the core of these differing approaches is their fundamental epistemological and ontological differences and their stance in the MIND-WORLD debate (Prawat, 1996).

Given the theoretical position described above, a Vygotskian-derived socio-cultural framework has guided this study. These assumptions seemed to allow best for investigations into cooperative learning settings and the fourth metaphor. The previous perspectives on learning (see chapter 2) have appeared too narrow in their focus, tending to produce simplified explanations for complex human behaviour. A key criticism of the previous metaphors has been this narrowness and over-simplification (Mayer, 1996; Nuthall, 1997).

A further reason for adopting a Vygotskian perspective is that Vygotsky was very concerned with the application of theories in real situations, not theories for esoteric reasons (Berk & Winsler, 1995, p.5-6). His research into education, including educating children with special needs, always emphasized practical application.

3.6. A perspective of learning

Although Vygotsky's ideas occupy a key place in this research and socio-cultural theory is the perspective on learning adopted, the idea of direct transmission of knowledge to the learner was not overlooked. Bereiter (1994) argued that research had provided evidence that young children have gained knowledge of their world before they could have been influenced by culture (Carey & Gelman, 1991, cited in Bereiter, 1994). Newborn babies may even be pre-disposed to conceptualize number and their world in certain ways (Spelke, 1982, cited in Bereiter, 1994). Although socio-cultural influences play a major role "it cannot be said that all of conceptualization originates on the social plane" (1994, p.21).

Context is a major focus of the present study because research has yet to explain its place in knowledge co-construction. Billett (1996) argued that one way to achieve a better understanding of these processes was a bridging between socio-cultural and cognitive theories of learning. Bereiter (1994) argued that the socio-cultural and cognitive perspectives were not incompatible. An advantage of the socio-cultural perspective on learning is that it assumes that human learning does not take place in a vacuum but occurs in cultural settings, is mediated by social semiotics, particularly language, and can be best understood when examined in historical context (John-Steiner & Mahn, 1996). The socio-cultural perspective provides the opportunity to investigate learning in its full complexity and context, enabling a richer examination of students' experience of classroom learning. This approach to learning determined this study's research questions, the kinds of data sought and the methods selected in collecting data.

Despite the socio-cultural orientation to learning, the researcher conjectured that the data might support aspects of *symbolic interactionalism.* Relationships between shared meanings and individual meanings are cornerstones of the present study because of the focus on learning under cooperative conditions (Cobb & Yackel, 1996). According to Prawat (1996), symbolic interactionalism has several advantages over other contemporary learning perspectives because it allows for a close, more equal examination of individual as opposed to socio-cultural knowledge construction. This approach not only accounts for how groups interact to co-construct knowledge in the classroom but also accepts that individual students may take on unique meanings from this knowledge.

3.7. Conceptual framework

The conceptual framework for this study is derived from two principal sources. Duncan and Biddle (1974) provided an early conceptual framework for the study of teaching and a vocabulary that allowed subsequent researchers to describe what they were studying (Shulman, 1986). They described four classes of variables: *presage variables* (teacher pre-dispositions such as training, gender, age etc) *context variables* (student, school and community properties), *process variables* (observable teacher and student behaviours in class) and *product variables* (effects on students of their classroom experiences).

This representation spawned process-product research programs. Bearing in mind the criticisms of process-product research described above, this research takes particular account of the context variables relating to students, the classroom events and the products of these events (Figure. 2).

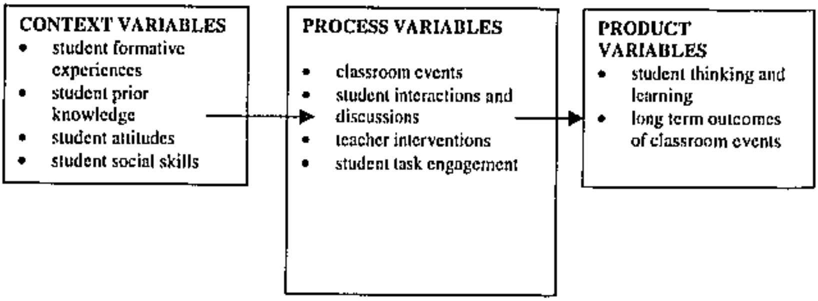


Figure 2. Part one of conceptual framework

Source: Adapted from Duncan, M.J. & Biddle, B.J. (1974). *The study of teaching.* New York: Holt, Rinehart and Winston.

The second part of the conceptual framework (Figure 3) in linked mainly to the process and product variables and highlights the relationship between individual and shared knowledge construction (Prawat, 1996). In this study, the *culturally relevant activity* is represented by the cooperative learning task and includes the interaction of artefacts, objects and events that may occur under cooperative conditions.

The framework reinforces the interdependent nature of the individual, the social setting and the elements of human culture such as artefacts. For the purposes of this study, *language* is considered a cultural artefact (Wertsch & Rupert, 1993), the social "tool of all tools" (Prawat, 1996, p.218). Real world *objects and events* are represented by the classroom events and materials provided in the lessons. The conceptual framework (Figure 3) depicts individuals interacting with artefacts (smaller circle) within the context of the culturally relevant activity (large ellipse).

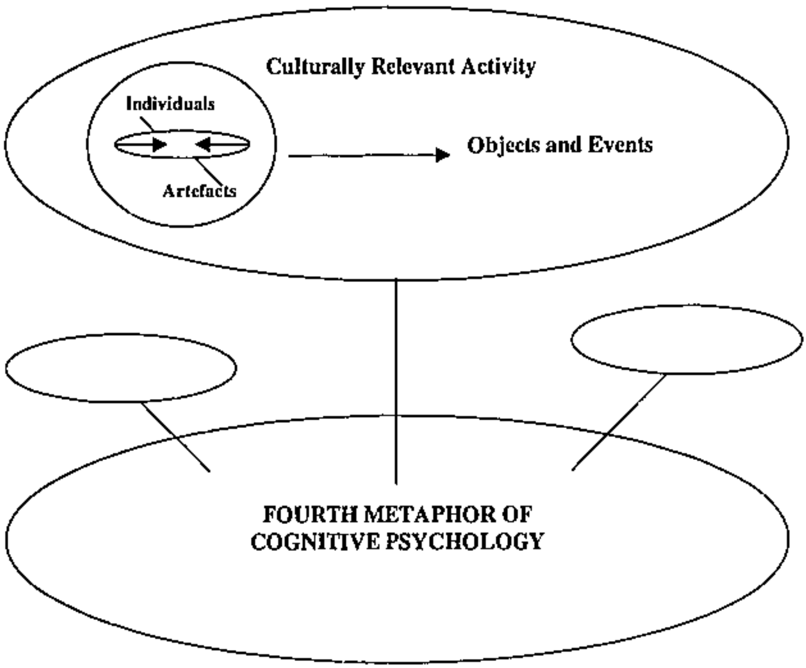


Figure 3. Part two of conceptual framework. Socio-cultural constructivism and the fourth metaphor.

Source: Adapted from Prawat, R.S. (1996). Constructivisms, modern and postmodern. *Educational Psychologist, 31* (3/4), 215-225.

The conceptual framework illustrates the drive towards a fourth metaphor (large ellipse at the base of the conceptual framework) of cognitive psychology. Other perspectives of learning such as symbolic interactionalism and language-based perspectives (represented by blank ellipses) may also contribute to the new metaphor but this study explores the individual/socially shared knowledge construction nexus through a socio-cultural perspective. It is anticipated that the conceptual framework might be modified as a result of findings generated from the data. This revision will be included in the final chapter as part of the implications for theory discussion.

3.8. Summary

The chapter has described the philosophical and theoretical foundations for this naturalistic/non-positivist, descriptive study. The study is set in a post-modernist era so holistic, pluralist approaches were taken in order to attempt to reconcile the differences between the two major perspectives on learning. The place of the mind in the third metaphor was discussed and led to a discussion of the place of the mind in a possible fourth metaphor of cognitive psychology. The ontological and epistemological assumptions were outlined and the chapter concluded with descriptions of the present study's guiding learning perspective and conceptual framework. The conceptual framework depicted a socio-cultural constructivist learning perspective but this was acknowledged as a working framework that might require adjustment as the data were analysed and interpreted. The previous two chapters have provided a foundation for the next chapter where details of the research design and methods are described.

CHAPTER FOUR

METHOD

4.1. Overview

The research methods and procedures applied during the study are detailed in this chapter. The research design, selection of methodology, selection of participants, types of data sought, data sources and data analysis methods are described. Questions of reliability and validity of the research are addressed in the methodology section of the chapter.

4.2. Introduction

The present study was informed by a base of literature that required the collection of data from real sources rather than contrived laboratory contexts. Therefore a central tenet of the research design from the study's earliest conception was the requirement to collect *naturalistic classroom data*. By regular consultation with the study's teacher participants, attempts were made to maintain the classroom authenticity of the data. Authentic classroom tasks were designed based upon the subject matter and kinds of activities normally engaged in by the student participants. All data were collected in actual classroom settings.

Consistent with the naturalistic paradigm described above, this was a *qualitative, descriptive* study using case study methods. Qualitative methods were considered most appropriate because this research focussed on individuals in their social settings and "how inhabitants of these settings make sense of their surroundings through symbols, rituals, social structures, social roles, and so forth" (Berg, 2001, p.7). Some quantitative data were collected and reported but full statistical analysis was not considered applicable to the research design. Data were collected in three classrooms in two schools located in similar middle income socio-economic urban areas. Three volunteer teachers, including the researcher as teacher/researcher, were involved in the preparation of the lessons and data collection.

Five purpose designed lessons, dealing with subject matter typical for the student participants, were the basis of data collection. Five target groups were selected for case study from among the three classrooms. The target groups' discussions for each lesson were audio-taped. Written data from all students were collected. Data collection occurred after each lesson, upon completion of the last lesson and again at three-month and twelve month intervals.

Re-statement of the study's purpose

The purpose of this study was to apply naturalistic research methods to investigate a possible fourth metaphor of human learning. The investigation was undertaken by examining student knowledge construction and the mediational effects of social context under conditions of small-group cooperative learning. The study took account of the complexities of the classroom and attempted to capture and track the long-term effects of the moments in the students' classroom experience when cognitive change occurred.

Research questions

The research questions were based upon two general avenues of inquiry; (a) the processes whereby student learning and cognition occurred under cooperative learning conditions and (b) the role of the group setting in influencing individual and social construction of knowledge. Each broad question involved subsidiary questions.

1. What processes produce knowledge construction under cooperative conditions?

    1.1. What evidence of co-construction of knowledge can be discerned?

    1.2. To what extent do specific types of discussion lead to co-construction of knowledge?

2. What conditions or factors mediate student learning in small groups?

    2.1. What is the role of prior knowledge during group discussion and knowledge co-construction?

    2.2. What classroom contextual factors influence discussion and knowledge co-construction?

3. What connection can be discerned between teacher cognitive intent, cooperative conditions, student discussion and student outcomes?

    3.1. How do group processes mediate teacher cognitive intent?

    3.2. How does student discussion mediate teacher cognitive intent?

    3.3. What individual and group student characteristics influence teacher cognitive intent?

4.3. Design of the study

Research sites

The initial research design was intended to include only two volunteer classrooms but as the researcher was a practicing classroom teacher for the duration of the study, additional data were collected from the researcher's own classroom in order to take advantage of the teacher/researcher opportunity. This provision allowed for the collection of participant observer data, closer monitoring of the data collection and collection of data from a broader range of student ages. Final data collection was in three classrooms ($N = 87$ students) in two schools (Schools A and B).

Schools A and B were located in similar middle income socio-economic, urban areas. The schools' cultural mixes were predominantly Anglo-Australian. Very small numbers of Asian and indigenous Australian students attended. The schools had total enrolments of 258 students and 217 students respectively. Student participants from both schools ranged in age from seven to ten years (year two to year five at school).

The teacher/researcher's classroom (classroom A1, School A) consisted of 19 year four and 9 year five students (overall 9 female, 19 male). Classroom B1 (Teacher B1, School B) consisted of 7 year two and 22 year three students (overall 12 female, 17 male). Classroom B2 (Teacher B2, School B) consisted of 9 year two and 21 year three students (12 female and 18 male). Teachers 1 and 2 worked as a teaching team, jointly planning and delivering their educational programs to the School B participants. Teacher 2 worked in a tandem setting with an additional teacher. Although the latter teacher was not present for any of the lessons, she was present for the collection of some written data but only as an observer.

Teacher participants

The study teachers were volunteers who made their classrooms available as research sites with approval of the School A and B principals (Appendix B). All study teachers were experienced practitioners. At the commencement of data collection, Teacher B1 had been teaching for 14 years. Teacher B2 and the teacher/researcher (Teacher A) were both into their 22nd year of teaching primary school. Teacher B2 had spent five years specialising in teaching Art but had returned recently to the regular classroom. Both teachers B1 and B2 had some experience of applying cooperative learning strategies. They had expected to develop their skills in this area by participating in the study.

Selection of student participants

Parental permission for students to participate in the study was sought by letter (Appendix B) for all students (*N=87*). Purposive sampling (Tashakkori & Teddlie, 1998) was applied to the selection of student volunteer participants from class rolls. The sampling was necessarily purposive because a major data source was to be written reports of learning by students in a *"learning journal"* and the study teachers and the researcher agreed that basic writing skills were required of the students. Basic writing skills were defined in terms of teacher *"on balance judgements"* (Appendix C) of students' writing set against the Western Australian Numeracy and Literacy Assessments (WALNA, 1998) and Education Department of Western Australia Student Outcome Statements (EDWA, 1998a; 1998b) standards and work samples. The above standards were applied as a framework to identify children with at least level one writing skills for inclusion as student participants (see Appendix D and E work samples). Random selection identified students who were, in the judgement of the study teachers, sufficiently able to express what they had learned in written form so that usable data would be produced (see Appendix F). Case study methods were to be applied to target groups consisting of students selected on this basis. Issues of informed consent, confidentiality, anonymity and rights of withdrawal were explained to all students and their co-operation was sought. These issues were also explained in the parental permission letter (Appendix B).

In consultation with the teachers, a total of eight target groups of four students each were identified for case study. The first stage of data reduction reduced the case study groups to five, two groups at School A and three groups at School B. Groups were heterogeneous in composition, based upon guidelines described by Johnson, Johnson, Holubec & Roy (1984). The study students came principally from Anglo-Australian cultural backgrounds, although one School A student was of indigenous New Zealand (Maori) origin. English was the first language of all participants.

Types of data sought

The study was concerned with providing detailed descriptions of student cognition and learning while engaged with authentic academic tasks in cooperative settings and with the tracking of the outcomes of these classroom events over an extended time. In order to address the research questions, rich, naturalistic data were required which would permit qualitative micro-analysis of student discourse and the effects of the planned classroom experiences on student knowledge construction. Data were sought which could reveal some of the complex, multi-layered nature of the classroom at a particular moment in time and then facilitate the longer term tracking of student learning. Additional data were required which would enhance understandings of group processes, the verification and monitoring of the lessons and the verification of assertions and conjectures generated. The data were not intended to permit generalizibility across populations beyond the limits described below.

Data sources

Multiple sources of data were used for this study in order to achieve triangulation. The major data sources were student *learning journals* (described below) for all students (*N=87*) and the *audio-taped* and transcribed discussions of the target groups. *Script tapes* were kept systematically for each target group in order to identify speakers and speaker-listener combinations.

Learning journals were completed prior to the first lesson, the day after each lesson, after the final lesson, three months after the last lesson and again after an interval of twelve months. The journals were in part selected as a data source in order to differentiate between students who spoke infrequently and students who were passive *and* cognitively disengaged. In addition to these data, all students completed an objective *pre-test* (Appendix G) on the topic. *Post-tests* were completed after the lessons and at three and twelve month intervals. Pre-tests and post-tests were completed after learning journal writing was complete. Observational data were recorded as *field notes*. Discussions with student participants and discussions between the teacher/researcher and the other study teachers were also recorded as field notes. An additional source of data was the *worksheets* produced by the groups during the lessons. Other student work relating to the lesson subject matter was also collected. Field notes were kept on any other observations including comments about group dynamics, results of researcher/student discussions, results of researcher/teacher discussions, group task engagement and individual enthusiasm for the task.

Methodology

This research was a study of the particular as opposed to the "search for generalizibility" (Stake, 2000, p. 439) resting upon the assumption that the peculiarity and particularity of phenomena merit the attention of research. The research focus was on the individuality and idiosyncratic nature of students' cognition and learning as they engaged in classroom experiences within a group context. The intention was to elicit individual cognitive responses to these classroom experiences and to conduct in-depth analysis of the data. Methods were preferred that provided the opportunity to collect rich, in-depth information (Berg, 2001) and to focus analysis on *instances or examples* as opposed to wider populations. Given the naturalistic, non-positivist, constructivist stance and the focus on contexts and situations adopted in this study, survey research was considered too superficial in nature (Champion, 1993). Case study was selected as the most appropriate general methodology.

A conjecture that the context of the groups may be critical in the overall impact of classroom experiences on students also supported the selection of case study methodology. The groups were investigated within the bounded system of each classroom (Stake, 1978). Within each classroom and group context, each student was also seen as a case. The case studies were focussed at several levels; individual student, student dyads, small group and cross-case groups. Therefore the basic case for analysis was the group although the individual student was considered as a "case within a case" (Stake, 2000, p.447).

According to Lincoln & Guba (2000), the nature of cases cannot be separated from the situation or settings in which they are found. The situational aspects of social phenomena can be investigated more thoroughly using case studies than with some other research methods because case study takes account of the complexities of situations and contexts by allowing for holistic examination. Case study offered the opportunity to examine the intricacies of the total classroom context and the various cases to which the students belonged. Investigating cases at various levels was considered to be one way of revealing more of the complexities of the classroom. It was assumed at the outset of this research that any investigation can only touch on some of the individuals' reactions to the changing classroom context from moment to moment.

Another advantage of case study was the need to collect data over an extended period of time. Case studies allow for easier maintenance of contact with subjects and tracking of individuals. The research design included a longitudinal element so that collecting data from larger, more widely spread samples, was likely to have meant that a number of students may have been unavailable for data collection. Despite the best efforts of the teachers and researcher, as the study progressed, some students were unavailable at the time of data collection.

A final consideration in the selection of case study methodology was that this created the opportunity to establish greater rapport with the research participants. Non-compliance or lack of co-operation was considered a threat to the validity and reliability of this study. Establishing rapport was necessary to reduce these validity and reliability threats and permit the collection of richer oral, written and participant observational data. The students were asked to produce a written report of their learning at several data collection points and their co-operation with the study teachers and the researcher was necessary in order to achieve this. Students were more likely to produce the kinds of data sought if they felt comfortable and motivated towards their learning journal tasks and felt goodwill towards the study teachers and the researcher.

Validity and reliability in qualitative research

Validity and reliability can present some problems for the qualitative researcher. Threats to validity and reliability extend beyond co-operation of participants and must be addressed so that the researcher can demonstrate the credibility of findings and conclusions generated. This section examines issues of validity and reliability and describes how these were addressed in this study. Case study is a general methodology, not a set of techniques for collecting data, so within the case study framework, data collection methods applied necessitated procedures that could improve the validity and reliability of the research. Descriptions of these procedures are also included below.

One attribute that assisted validity and reliability was the longitudinal nature of this study. Data collection over extended time frames can reduce distortions and misinformation (Lincoln & Guba, 1985). The researcher can check the validity of assertions and interpretations of data at different intervals. What was true once may no longer be true later in the study. Data for this study were collected using consistent methods over a period of eighteen months and subjected consistently to validity and reliability checks. A threat to validity and reliability was identified as the extent to which student learning journal entries constituted *all* they could recall of the unit content. If a student recalled the same or similar information in their journals and consistently scored the test items correct it was assumed that the information was well known. Collection of data at post-lesson, three-month and twelve-month intervals supported this assumption.

Validity

Validity is concerned with the accuracy of findings (LeCompte & Goetz, 1982). Validity is established when conclusions match empirical reality and theoretical assertions accurately represent human experience (Hansen, 1979). Assessing validity also involves assessing the credibility of interpretations. Do researchers observe or measure what they think they observe or measure? This is the question of *internal validity* (LeCompte & Goetz, 1982). A second question of *external validity* revolves around whether the interpretations and constructs generated are applicable across groups and settings. Since this was a case study involving cases at different levels, the extent to which assertions made about one individual or group were valid for others was particularly relevant.

Qualitative research theory has described several strategies for improving validity. A key strategy is the *triangulation* of data. Denzin defined triangulation as the "combination of methodologies in the study of the same phenomenon" (1978, p.291). Denzin (1971) argued that triangulation provides validity through the cross-checking of information from multiple sources. Multiple sources of data are used to complement each other, allowing the researcher (1) greater confidence in their results, (2) to cross-check aspects of the phenomena in question and (3) opportunities for richer, thicker interpretations (Jick, 1979).

Sources of data for triangulation need to be selected carefully so that they converge on the same set of facts or findings (Yin, 1989). In order to establish a chain of evidence, explicit links were made between research questions, data collected and conclusions drawn. Triangulation also assists the researcher to guard against bias produced by their own beliefs, mis-information or mis-perceptions. The present study achieved triangulation with multiple sources of data described above.

Validity in qualitative research can become a strength when compared to some other methods (Erickson, 1977; Reichardt & Cook, 1979), because of the data collection methods and the manner of reporting findings. Inferences drawn in this study were based upon detailed descriptions of naturalistic data. The researcher's close involvement in the collection of data and role as participant observer strengthened validity. Tentative findings generated from initial analyses of data were checked at the research sites. Observation and cross-checking included discussions conducted with student and teacher participants which assisted in the overall understanding of the data and the eventual generation of findings and conclusions. This checking procedure was facilitated more easily by the researcher's position as teacher/researcher-participant observer.

Observer effects (LeCompte & Goetz, 1982) were reduced by the teacher/researcher's role in the conduct of the lessons. The researcher led all whole class discussion in the preparatory and actual study lessons. This enabled the students to gain familiarity and assisted in gaining the students' trust and co-operation. The researcher's role as a teacher at School A further facilitated this process.

The method of reporting findings was selected in order to enable the data to tell to some degree, the story of classroom events (Coles, 1989 & Carter, 1993 cited in Stake, 2000). This was a further validity measure. The findings (chapters five & six) include substantial selections from the data in the form of analytic narrative vignettes and direct quotes (Erickson, 1986). These allow the reader to draw their own inferences and interpretations and to check assertions made by the researcher.

Threats to validity were also addressed by establishing evidentiary warrants (Erickson, 1986) by applying *interrogative hypothesis testing* (Berg, 2001,pp.256-257). In applying this process the researcher generated tentative findings, then tested and re-tested them by a systematic, rigorous examination of the data. The aim of this process was to confirm or refute assertions. As a descriptive study, no set hypotheses were being tested against established theory. At all times, objectivity was maintained as far as possible and the researcher was mindful of the need to re-frame assertions in the light of the re-examination of the data.

Further measures to improve validity included the development and consistent application of rules for handling, reducing and displaying data. These data rules are described in the data analysis section below. The data rules strengthened both internal and external validity by helping to ensure that assertions generated from one set of data were the same as assertions generated from all other sets of data. Data for this study were collected over an extended time frame so a consistent approach to handling data was considered essential.

LeCompte & Goetz (1982) argued that *external* validity presents special problems for qualitative researchers. External validity relates to questions of generalizibility (Gay, 1990). The findings of this study were not intended to be generalised beyond the limits described above in section 4.3 but several measures were undertaken to improve external validity. These measures were the selection of more than one research site (three classrooms at two schools), the inclusion of more than one group for case study and the undertaking of a cross-case analysis (chapter six).

Reliability

Reliability is concerned with the replicability of findings (Hansen, 1979; LeCompte & Goetz, 1982) and can present more of a problem in qualitative research than validity. External reliability is determined by the extent to which the same results and findings would be discovered by different researchers in the same or similar settings. Internal reliability concerns the extent to which multiple observers in a single study agree.

External reliability issues were addressed in this study by attending to the five major problems described by LeCompte and Goetz (1982). These are (1) researcher status position (2) informant choices (3) social situations and conditions (4) analytic constructs and premises and (5) methods of data collection and analysis.

The researcher was a participant observer in the role of teacher for the whole class components of the lessons but not a direct participant during the student discussions except in the group-monitoring role. The researcher attempted to establish rapport with the students in order to facilitate data collection because student willingness to "please the teacher" was seen as a possible factor that could have influenced the reliability and richness of the data. The School A students were members of the researcher's own class. These conditions would need to be replicated by other researchers in order to produce reliable results.

Student participants were chosen first at random and then selected on the basis of their writing skills, so issues of informants gravitating towards the researcher were not applicable. Threats to external reliability from informant bias were dealt with by explicit descriptions of students who provided the data (see section 4.3. above and chapter 5). Informant bias is usually more applicable to interview studies. This study used no formal interviews.

The social situation was acknowledged by this research as critical to the kinds of data gathered. In fact, it is the social context itself that was one of the main foci of the research. Therefore, the social setting in which the data were gathered was clearly delineated for the purposes of replicability.

Replication is further aided by the delineation of the analytic constructs and premises underpinning this study. Chapter two reviews the literature base that has informed the study and chapter three describes the theoretical framework and assumptions.

Finally, replicability is influenced by the clear delineation of the methods and procedures applied. LeCompte and Goetz (1982) argued that other researchers should be able to "use the original report as an operating manual by which they can replicate the study (p.40).

Issues of internal reliability were carefully addressed in this research. The nature of the project meant that issues of inter-coder reliability tests were not widely applicable. However, several procedures were implemented in order to improve reliability. First, significant data such as transcribed small-group discussions were analysed using a low inference instrument, the MAKITAB Small Group Interaction Analysis System (King, Barry, Maloney & Tayler, 1993). The MAKITAB instrument has been cross-validated in Missouri (USA) and Perth (Western Australia). The data analysis section below describes how the researcher improved the reliability of coding with the MAKITAB instrument using reliability checks over an extended time.

All transcribing of discussions were carried out verbatim with annotations added. Random samples of group discussion transcriptions, particularly of the School B discussions, were checked by one of the study teachers (teacher B2). Voice recognition was not a problem for the School A students because of the teacher/researcher relationship but the researcher also checked random samples of transcript to check for accuracy. Audio-taped discussions allowed a permanent, ready reference for the transcripts. The concern with these checks was for accurate transcription and voice recognition. Script-taping during discussion was also applied as a reliability measure.

Multiple researchers were not feasible in this study but the comments and discussions with the study teachers at School B were recorded as field notes and used to check the reliability of the researcher's observations. These comments were particularly important when the School B teachers collected journal data because the researcher was not present at these times.

4.4. Procedure

Preparation for data collection

A formal pilot study was not conducted but students received familiarization with cooperative learning strategies, learning journal writing and recording equipment in preparation for data collection.

The familiarization with cooperative learning methods comprised a series of three mathematics, problem solving lessons (see Appendix K). These lessons provided the students with training in group and individual accountability processes, group roles, group rules, helping and asking for help procedures (Burns, 1981; Webb, 1982; Johnson, D., Johnson, R., Holubec & Roy, 1984; Ross & Cousins; 1993; Ross, 1994; Webb & Farivar, 1994; Nattiv, 1994). The "groups of four" model of cooperative learning (Burns, 1981) was applied in the familiarization phase and throughout the main phase lessons. The Burns (1981) model involves (1) students working in groups of four, (2) randomly assigned group composition, (3) group members assigned a specific role (4) groups working on the same problem, the same group product and towards the same group reward.

Two large charts depicting rules and roles for cooperative learning (see Appendix L) were prepared and displayed in the classrooms. These charts were reviewed and discussed at the commencement of each of the lessons in the preparatory phase and again during each of the main data collection lessons. Lesson conclusions also included discussion about the effectiveness of the groups' cooperative learning skills. The basis for this evaluation was the five essential elements of cooperative learning (Johnson, Johnson & Holubec, 1990), positive interdependence, individual accountability, face-to-face interaction, social skills and processing. All groups of four remained the same throughout data collection although one student left School A soon after completion of the lessons.

Student training in the use of *learning journals* during the preparatory phase of the study consisted of the students writing immediately after the whole class wrap-up. Learning Journals were used normally by the researcher as a means of student review and assessment and were already a part of the researcher's class routine. The other study teachers also adopted journals. The journals took the form of student reports of their learning during the lessons. The students were asked to describe what they *knew* now, *could do* now and *felt or believed* now as a result of the lesson. In the early stages of the preparatory lessons, students often seemed to confuse what they had done in the lesson (activities) with what they had learned in the lesson. Initial analysis of the learning journals in this phase allowed for this point to be clarified with the students so that subsequent entries focussed more explicitly on learning as opposed to activities.

During the preparatory lessons students were exposed to microphones and tape recording equipment in preparation for tape recording. Recording equipment was rotated among each of the groups and placed on desks in order to provide familiarization for all students.

The researcher conducted all training in cooperative learning and the preparatory lessons in each of the three classrooms in order to reduce possible researcher effects, particularly in the School B classrooms where the researcher was initially unknown to the students. This improved reliability in the presentation of the training and lessons across the three classes and assisted the development of rapport with the participants.

The objective test (Appendix G) was validated in an additional volunteer classroom at School A. Validation exposed some possible confusion with question 2 (Appendix G). This is described further in chapter five.

Role of the teachers and teacher/researcher during the lessons

As was described above, the teacher/researcher conducted whole class introductions, interventions and wrap-ups (Appendices H & I), constituting a participant observer role. In the actual progress of the lesson activities and discussion, the teacher/researcher, and the teacher participants monitored the groups' progress according to procedures recommended by Meloth, Deering & Sanders (1993) and Meloth & Deering (1999). The researcher also read aloud to the classes all relevant material from the lesson worksheets so that reading difficulties were reduced. Students were informed that any reading problems should be referred to one of the study teachers for clarification. At times it became necessary to focus teacher/researcher monitoring on maintaining the quality of discussion (Meloth & Deering, 1999) or clarifying details of content to the whole class. In these instances, the teacher/researcher or study teachers conducted small-group or whole class interventions as the need arose.

Main phase of the study

The study was centred around five purpose designed lessons on the social science topic *Antarctica* (see Appendix J). A premise of this study was that data should be collected as naturalistically as possible from the kinds of learning experiences normally engaged in by students. Antarctica was selected as the topic for the study in consultation with the study teachers because of the need to achieve this kind of authenticity and because of its high interest value to the students. Antarctica is commonly studied in Western Australian Primary Schools as a component of the Social Studies K-10 Syllabus (Education Department of Western Australia, 1981) under the theme of *Living in a Harsh Environment*. It was conjectured that although the students had probably all heard of Antarctica (two School A students had studied the topic the year before) they may have had limited prior knowledge of the topic and student learning would have been more likely due to the lesson experiences.

Careful selection of the subject matter to be presented allowed the researcher to determine possible sources of students' learning. Four broad themes were chosen for the lesson content; *geography, history, living and working in Antarctica and natural history*. The objective test was structured so that five items from each of the content themes were included. Subject matter was presented mainly in the lesson text and the students discussed and completed worksheet questions (Appendix J) designed principally as *true group/ill structured tasks* (Cohen, 1994). The first three lessons involved some reading (to gain information) followed by discussion questions which required the students to use higher order processes in order to answer the questions. This research investigated possible social construction of knowledge or whether students individually obtained knowledge through transmission (reading or teacher statements), so much of the information presented in the lesson texts was not referred to in the discussion questions. The latter two lessons involved a relatively small amount of reading for information and sets of questions which required students to apply knowledge gained from the previous lessons (see Appendix J) so that possible cognitive processes could be investigated. As was described above, the lessons involved a group product with built-in individual accountability procedures.

Data collection

In order to determine prior knowledge, the students were asked to write all they knew about Antarctica in their learning journal (termed the *pre-lesson* journal) and then given a multiple-choice pre-test prior to the commencement of the lessons. On this occasion and at all subsequent data collection points, learning journal writing occurred *before* the administration of the objective tests in order to avoid the test items acting as a memory stimulus for the learning journals.

The same multiple-choice test was used for the pre-test as well as the subsequent post-tests at the conclusion of the lessons and at three and twelve-month intervals. To reduce the possibility of the students learning the material from these tests, the test results and correct responses were not made public.

Students wrote in their learning journals the day after each lesson. Experience had shown that students seemed to require time to process large amounts of new information. Therefore learning journal writing after a time interval (next day) produced more useable data. Learning journals were also completed the day after the final lesson (termed the *post-lesson* journal), and again at intervals of three months and twelve months (termed the *three-month* and *twelve-month* journal respectively).

Only the target groups' cooperative discussions were tape-recorded. Speaker-listener combinations and voice recognition were verified using script-tapes and in consultation with the study teachers as was described above.

The two case study groups at School A were also asked to discuss an additional question prior to commencing the task; "What did we learn in the last lesson?". One of these groups was also asked to discuss "How are these problems like those we've done before?". These questions were intended to engage student prior knowledge using metacognitive processes (Mevarech, 1996). They were not intended as an experimental component to the study but were included in order to explore the effects of deliberately engaging prior knowledge in these groups.

During the lessons, observations about the progress of the lessons, particularly the group dynamics, were kept as field notes. Target groups' on-task behaviour was systematically observed and timed. The accuracy of these observations were cross-checked with transcripts. Cross-checking also involved "mini-interviews" with some students after initial analysis. These interviews were recorded as notes as were all discussions with the study teachers about the progress of the lessons and any other relevant details. After the long-term data had been collected (three-month and twelve-month) the students were asked to what extent they had heard about or studied Antarctica in the intervening period. Comments by the students were noted and added to their individual data files. Most students reported very little contact with information relating to the topic. This meant the researcher could be more confident about the longitudinal findings.

4.5. Data analysis

Introduction

This section describes the micro-analysis of the data and particularly how different procedures were applied as the analysis and findings became progressively more detailed. An interactive method of data analysis (The Flow Model; Miles & Huberman, 1984; Figure 4) was selected for this research.

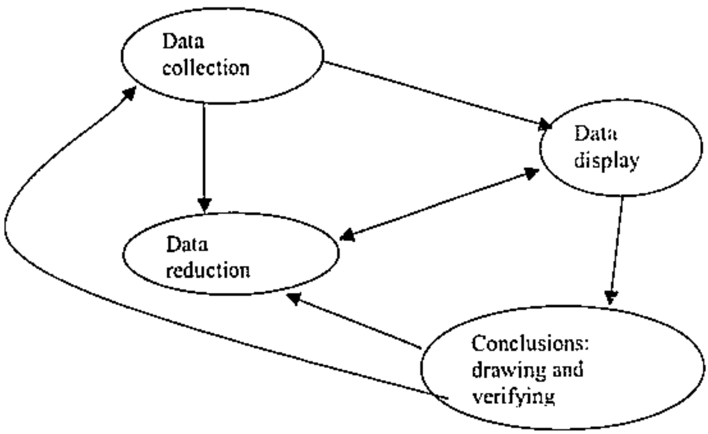


Figure 4: Flow model of data analysis.

Source: Miles, M., & Huberman, M. (1984). Drawing valid meaning from qualitative data: towards a shared craft. Educational Researcher, 84, 20-28.

Through this approach the researcher was able to interact with the data through several phases of data reduction and display, each phase becoming more "fine-grained".

These interactions generated tentative findings that were tested and re-tested against the data. Initial analysis involved the development of general trends and categories and the identification of units of analysis (Berg, 2001). More detailed findings were generated using analytic induction methods (Erickson, 1986; Berg, 2001).

Testing evidentiary warrants and interrogative hypothesis testing

A synthesis of two similar processes was used to test the credibility of tentative assertions. Erickson (1986) recommended testing the evidentiary warrant of assertions by "a systematic search of the entire data corpus, looking for dis-confirming and confirming evidence, keeping in mind the need to reframe the assertions as the analysis proceeds" (p.146). Berg (2001) described *interrogative hypothesis testing*. This process investigates the *negative* case in seeking verification of findings (Robinson, 1951; Lindesmith, 1952; Manheim & Simon, 1977 & Denzin, 1978; cited in Berg, 2001, p.257) and proceeds through the following steps:

1. Rough hypothesizing based on an observation from the data.
2. Conducting a thorough search of all cases to locate negative cases (that is, cases that do not fit the hypothesized relationship).
3. If a negative case is located, either discard or reformulate the hypothesis to account for the negative case or exclude the negative case.
4. Examine all relevant cases from the sample before determining whether "practical certainty" (Denzin, 1978) in this recommended analysis style is attained.

Data handling rules for learning journals and tests

The longitudinal component of this study necessitated the creation of consistent rules for the processing of all data. Group A2 was selected as a reference group for the creation of these rules.

Data files were created for each target student and contained within a group file. These files included learning journals, test papers and group worksheets. Learning journal data for the target groups were coded under the categories described in chapter five (p.95). The codes were not related to grammatical structure. Each fact or concept recalled in journal statements became the unit of analysis and was treated as a discreet entity. If a student wrote two or more pieces of information in one sentence, each piece of information was coded separately. Specific codes were tabulated and the originating student identified. The tables were used as a reference for coding of subsequent students' journal writings.

Tests were scored and items scored correct were recorded in the students' data files. Raw scores were converted to a percentage. The qualitative nature of the study meant that full statistical analysis of the test scores was not undertaken.

Analysis of learning journals

Initial analysis of all student learning journal data *(N=87)* produced seven broad categories from learning journal responses. These protocols provided the basis for more detailed coding and analysis of the target students' learning journals. Reliability measures involved reserving and copying of randomly selected journal writings from non-target groups. At two separate, three-month intervals, the reliability scripts were coded and checked against the initial coding. All target students' journals were then individually coded and cross-referenced. Tentative findings were recorded as notes. When all target students' journals had been coded, journal and test data were entered onto tables in order to track students' acquisition of knowledge. Notes were kept for each student and group trends were noted. Journal and test data were then displayed for analysis on *concept maps* (see chapter five). Statements were recorded verbatim unless meaning was not affected by abbreviation. Concept maps for all group members were placed onto large charts and arranged according to data collection points. The concept maps enabled individual and cross-case analysis within and between groups. The concept mapping exercise allowed for the generation, testing and re-testing of findings described above.

The major data sources described above were the transcripts and journal data. The extent to which journal data could be regarded as representing student "learning" was a possible threat to validity but this threat was reduced by the availability of student test results collected on four occasions after the students had written their journals. The cross-referencing of journal data and test results was an important means of generating and checking findings. Assertions based upon journal data were also checked against evidence provided by the transcripts. This process also worked in reverse. Triangulation included the use of close observational data (see section 4.3.).

Data handling rules for tape transcripts

Accuracy of transcription and voice recognition was considered essential as a validity and reliability measure. The first (raw) transcriptions were free from any researcher notes (see below). In common with the learning journals, each discreet statement was taken as the unit of analysis of the students' discussion. Therefore, if a student made more than one separate statement in an utterance, all statements were counted. Both raw and annotated copies of transcripts were included in the group data files. Raw copies of transcripts were reserved for reliability checks.

Analysis of student discussions

The initial analysis of target group discussions occurred as audio tapes were reviewed immediately after taping. This was when initial voice recognition was carried out, particularly for the School A students. Five target groups were selected as a first stage of data reduction.

Student discussions were initially reviewed in their entirety in order to gain an overview of the nature of the discussions. The tapes were then transcribed and trends or tentative findings were recorded as narrative notes in the transcripts. The MAKITAB instrument was used as a framework for this analysis. Some statements were MAKITAB coded and noted in the transcripts. These initial findings became the basis for further investigation.

The next stage of transcript analysis was the counting of all utterances and their sub-division into statements. Each student contribution was enumerated and expressed as a percentage compared to the other group members (see chapter five). Enumeration then involved separating on-task and off-task talk on a lesson by lesson basis.

Before MAKITAB coding of all transcripts was commenced, reliability trials were conducted using the raw transcripts. Randomly selected sections of transcript from each target group were copied. These were checked for accuracy by one of the study teachers and the researcher. The selected transcripts were MAKITAB coded and left for six months. This was possible because of the study's longitudinal design. At two further intervals of six months, the reliability scripts were coded again with average agreement of 93%. All transcripts were then MAKITAB coded. The display of MAKITAB data allowed for the micro-analysis of student discussion. With the MAKITAB instrument the researcher was able to analyse in detail the kinds of student talk in small group settings. These kinds of talk were then matched to the individual and group concept maps in order to generate findings.

4.6. Generalizibility

Due to the small sample of participants, the findings of this research should not be generalised beyond the bounds of the study. In particular, note the limits imposed by the narrow socio-cultural range of the student participants. Findings about student cognition and learning should be considered with these limits in mind. The findings in the following chapter highlight the idiosyncrasies of the participants and the question arises that these idiosyncrasies could be the result of the small sample and/or the research design. Would these idiosyncrasies even out over a larger population?

The research was not intended to provide a definitive answer to the research questions for *all* students, but rather to investigate the individual and group cases in order to gain an understanding of their cognition and learning in small group contexts. Questions of generalizibility should not extend beyond these limits.

4.7. Summary

This was a qualitative, descriptive study, conducted in the naturalistic setting of three suburban classrooms, at two schools. The research questions required the collection of rich, thick data over a period of twelve months. The principal data sources were student learning journals and the transcribed discussions of five target groups. Case study methods were applied to the target groups in order to investigate the students' cognition and learning resulting from their participation in five cooperative small-group lessons. Data reduction and display created categories and units for analysis and detailed findings were generated inductively as micro-analysis was undertaken.

CHAPTER FIVE

FIVE CASE STUDIES OF STUDENT LEARNING AND COGNITION IN COOPERATIVE SMALL GROUPS

5.1. Overview

The chapter reports the results of the five case studies and provides the basis for theory generation in the subsequent chapters. The chapter begins with a description of the initial analysis of the data. General findings from all data sources are described. The bulk of the chapter consists of a report on the case studies of the five target groups including examples of student data. Each student participant is treated as a case study within a wider case study of the group.

5.2. Introduction

Data were analysed through several phases with each phase examining data in more detail, allowing for data reduction and preparation for analysis and display. The units of analysis were the knowledge and/or concepts the students reported and student utterances during small group discussion. This introductory section outlines broad findings generated from the first analyses and describes the preparation and structure of the case studies. The case studies include substantial elections from the data corpus in order to strengthen the richness and validity of the research (see chapter 4).

Journal response categories

The first analysis of journal data for all students (*N=87*) generated six categories of student journal responses (Table 5). These were *prior knowledge, text (information and concepts gained from lesson text), discussion (information and concepts gained from group discussion), students' "own" constructions, mis-constructions* and *teacher* *effects* (*information gained from teacher interventions with the group or whole class*). A further category, *affective statements* was added later. This first analysis of student journals indicated that mis-constructions and affective statements were potentially a rich source of information about student learning. These categories seemed to provide valid student mental representations of their learning experiences during the lessons. Therefore, analysis proceeded on the assumption that all categories were of equal value regardless of the accuracy of information and concepts represented by the participants. These categories became the basic organizing structure for the journal data, leading to further coding.

TABLE 5
Categories of learning journal responses

Category	*Description*	*Example*
Prior knowledge	Material known prior to lessons.	Antarctica is a polar region.
Text	Information gained from reading lesson text.	Ice in Antarctica can be over three kilometres thick.
Discussion	Information gained from group discussion during lessons.	Weather balloons are launched from Antarctic bases.
Own construction	Correct constructions of knowledge produced by an individual student. This category included knowledge not gained from the lessons.	A gas called Helium flies the weather balloons.
Mis-construction	Information constructed incorrectly; sometimes more than one piece of information was formed into these constructs.	Scott left his animals on an island.
Teacher effects	Information gained from the teachers' interventions with the group or whole class.	Shackleton and his crew had to live on the ice when their ship was stuck.
Affective statements	Learning journal responses of an emotive, vague or irrelevant nature. Responses not directly related to lesson content.	You are lucky to come back alive.

General findings from student discussion data

An early finding from the first analysis of the transcript data was the extent to which student discussion was influenced by the *evaluative climate* in the classroom (Doyle, 1983). Although the researcher intent was that students should engage with the task by becoming involved in quality, in-depth discussion, the classroom evaluative climate and teacher interventions, particularly by Teacher B1 (School B) were often directed towards children using correct English in their worksheet responses. Findings pertaining to evaluative climate are discussed in more detail in the case studies and in chapter six.

Other aspects of evaluative climate were evident during the first analysis of the transcripts. These extended to the students' focus on completing tasks, suggesting that task completion was emphasized as part of the evaluative climate in the participating classes. Cross analysis of worksheet and transcript data indicated that *task completion* was, to varying degrees, a priority for all target groups. This focus became part of the groups' preferred method of operation and combined with other factors to produce a group "culture". The group culture appeared highly influential in the groups' performance. Some groups were focussed on completing some tasks as quickly as possible, providing brief answers involving minimal elaboration or discussion. Others were concerned with producing quality responses. The dominant student in the group usually determined this culture.

A further element of group culture was revealed by initial analyses of the transcripts which noted that some groups were more engaged with the tasks than others. Some groups seemed to spend a majority of their time in off-task talk and this appeared to correlate with student performance on the tests and in learning journals. Groups that seemed anxious to engage in in-depth type discussion appeared to make the most academic gains from the lessons. The findings about group culture are elaborated in the case studies and chapter six.

A further initial finding from the transcript data was that student utterances during group discussion sometimes consisted of more than one distinct statement or idea. Therefore, analysis and reporting of utterances was undertaken using each separate statement as the unit of analysis.

Effects of students' chronological ages

Younger students' responses to the lessons were generally appropriate to their age and ability but the value of small-group cooperative learning for very young ch[illegible] was questioned because of the early analyses. The younger student participants (Cale, Billy and Hannah) seemed to experience more difficulty in engaging with the lesson text and the tasks than did the older students. All lesson texts were read aloud to reduce these problems and students were reminded to ask for teacher assistance if difficulties persisted (see chapter four). Despite these measures, the younger students tended to exhibit passive behaviours (see chapter six).

Another student, Joel (group A1) was a year younger than his peers and had no difficulty dealing with the text or task demands but tended to be relatively quiet in discussion. The researcher speculated that this might have been due to age-induced status differentials. Older students seemed to possess greater prior knowledge of the subject matter and were thus of higher status, contributing more to discussion and seeming to make academic gains. Questions of age differentials are elaborated in the case studies and the remaining chapters.

General findings from learning journals and preparation of concept maps

The case studies feature *concept maps* for each student, derived from journal data and test results. The concept maps were a means of reducing, displaying and analysing the journal and test data. Journal data collected *mid-lesson* were not included in the concept maps. Initial analysis of mid-lesson journals indicated that some of the students had misunderstood the researchers' requirements. Instead of writing all they knew about the topic they tended to write just what they had learned in the previous lesson (see chapter four). This did not occur in the post-lesson and subsequent journals because the researcher clarified this point for the students. To improve validity and reliability, the mid-lesson data were included in the tracking tables used for the second phase of analysis but not in the case study concept maps. Consequently, if available, four sets of journal data were included in the concept maps for each target group member. These journals were the pre-lesson (indicating prior knowledge), post-lesson (the day after the final lesson), three-month and twelve-month (three months and twelve months after the lessons respectively). The journals were matched to the corresponding sets of test data. The individual case studies include numerical representations of the tracking tables, indicating the incidence of the various categories (Table 5) at each of the four data collection points. Mid-lesson data are summarized in these tables.

The early analyses found that text-related codes seemed to dominate the students' journal responses and that entries linked directly to worksheet discussion questions seemed less prominent. This was not surprising given the volume of new material presented as text in the lessons. Micro-analysis of student talk using the MAKITAB instrument and cross-referencing of the concept maps allowed for further interpretation of the journals and connections to be made between group discussion and student learning.

Student journals were recorded verbatim unless meaning was not affected by abbreviation. For example, "Scott's team died in the Antarctic" might be abbreviated to "Scott's team died" in a concept map. One student reported "Shackleton's ship got stuck in the ice and they had to sail back in a raft". Statements such as this were included verbatim in the concept maps (Figures 5-76) because they defined a uniqueness in an individual student's mental representations of their lesson experiences. Observation had confirmed the early analysis that student responses to journal writing were highly individual and idiosyncratic. Verbatim reporting was seen as a means of highlighting these features.

The first analysis of the journal data indicated that the students' learning from the unit had formed around the broad content themes (*geography, history, natural history* and *living and working in Antarctica*) presented in the lessons. These themes were reflected in the student learning journals and they provided the basic structure for the concept maps. Most journal entries could be related to theses themes and in several cases, students produced journal statements that were linked to more than one theme.

Related to these themes were general concepts that seemed to be shared by most of the study participants. These included concepts derived from student prior knowledge. General concepts such as Antarctica as a very cold place and wildlife such as penguins living there provided an overview of student knowledge. A common mis-conception was that polar bears live in Antarctica. These concepts are discussed further within the case studies.

Student prior knowledge had the potential to influence the group context. Therefore all prior knowledge (pre-lesson) and other journal entries (post-lesson, three-month, twelve-month) which could be attributed to sources outside the lessons were included in the concept maps.

<u>Use of test results</u>

Pre-test scores indicated the scope and variability of student prior knowledge when coupled with the pre-lesson journal in the pre-lesson concept map. The focus in the tests was on the specific information known to students before the lessons rather than on the numerical scores. Material already known was tracked through subsequent journals and tests.

Post-lesson, three-month and twelve-month test scores provided an objective view of student learning from the unit. Information was assumed learned if the student consistently scored a particular test item correct. Relationships between correct test responses and journal writings were established in the concept maps.

Validating the test had revealed that item 2 (Appendix G) provided conflicting information because the stem was stated in negative terms. A correct response could indicate the student knew "Antarctica is the fifth largest continent", "the ice is thick in Antarctica", "no country owns Antarctica" and "Antarctic winters have very short days" (Appendix G). In order to avoid confusion, correct responses to this question were represented in the concept maps as "ice is thick". They were not considered when generating findings unless the student confirmed the above information in a journal entry.

Structure of the case studies

The case studies begin with a group profile, generated from teacher and observational data. The profiles are followed by descriptions of group processes evident in the observational data and transcripts. Phenomena such as *dominant* students, *passive* students and other group processes are discussed in these sections, including considerations of the group culture described above. Analysis of transcripts indicating individual participation rates and group on-task/off-task talk are included in table form in these sections.

The group processes section is followed by descriptions of individual learning outcomes from the lessons. These descriptions are set against students' concept maps.

Each case study concludes with descriptions of possible group influences on the students' learning.

5.3. Case study 1 (group A1, school A)

Profile

Group A1 comprised two male and two female students, Clark, Joel, Abi and Amanda. Clark, and Abi were in year four (nine year olds) and Amanda was in year five (ten years old) at the commencement of the study. Joel was in year four at school but was only eight years old. He had been advanced into a year two class early in his first year at school. Observation of attendance registers indicated that Amanda was a regular absentee. She left school B before post-lesson and subsequent data were collected. Amanda was a middle to low achiever who exhibited learned helpless characteristics (Barry & King, 1998; Good & Brophy, 2000). Clark, Abi and Joel were high academic achievers.

Group processes in the discussion

The group co-operated successfully and demonstrated an awareness of the rules and roles of small group work. Clark and Abi occupied relatively high proportions of the discussion time (Table 6). Their substantive contribution was significant. Amanda attempted to contribute through most lessons. She had already studied Antarctica the previous year so she began confidently but her contributions waned and she became progressively more passive over the course of the lessons.

The group seemed highly motivated to complete the tasks and remained on task for the majority of discussion time (Table 7). The tape transcripts exaggerated the group's on task behaviour slightly because by lesson three, the members had begun to turn off the tape recorder while they were writing answers and when they were off task. Observation confirmed that the group's off task times were infrequent.

TABLE 6

Group A 1 Summary of total statements made in group discussion

Student name	*Total statements*	*(%)*
Clark	283	30.46
Abi	272	29.30
Joel	204	22.00
Amanda	170	18.30

Abi appeared very motivated to keep the group on task and was unhappy with the other group members if they argued, even though the arguments were usually over the content of the group's answers. She also acted to appease Amanda when she had difficulty with the task, showing a willingness to provide help when necessary, such as in this lesson four exchange.

Amanda: Youse, I didn't get finished on this...

Clark: What?

Abi: This one.

(procedural discussion)

Amanda: I haven't even finished the whales yet youse.

Abi: OK what have you wrote?

Abi also seemed more aware than her peers that the discussions were being recorded. She would often remind the group of the need to co-operate and follow the discussion rules.

Joel normally conducted himself quietly in class and this was also evident in the discussions. He spoke relatively rarely but he made some important contributions. On some occasions he was ignored by the group, possibly because of his lower age status and observed quiet nature. Observation indicated that Joel was not normally a very assertive student but journal and test data indicated that he was nonetheless actively engaged in the lessons.

TABLE 7

Group A 1 task related and non-task related talk*

Lesson number (total statements)	*Task related talk (%)*	*Non-task related talk (%)*
1 (160)	97	3
2 (197)	82	18
3 (217)	90	10
4 (238)	90	10
5 (117)	94	6
Means	90.6	9.4

* Note totals are recorded statements. Students sometimes switched recorder off.

The group's style of working in the early stages revolved around discussing all questions first and then writing their answers. This changed over the course of the lessons so that the focus on writing answers went together with discussion. They would often make statements to the group about what they were writing and they shared ideas as they wrote answers. Spelling and other correct usage was a slight concern for this group but did not pre-occupy them. Amanda found it difficult to keep up with the others and she tended to retreat off task relatively easily. As the lessons proceeded

Amanda began to assert herself by attempting to determine task actions (MAKITAB code TS05, see Appendices H & I). The group accepted these efforts but usually ignored Amanda's attempts to contribute to content related discussion.

Group A1 individual case studies

Clark

Clark displayed a good general knowledge of Antarctica and provided a rich source of data. His journals indicated definite links to discussion codes suggesting that he had gained from the discussions. Analysis of the concept maps revealed that many of Clark's journal statements were also indirectly related to discussion as well as other codes such as text. This student seemed capable of learning from multiple sources as indicated by the number of text and teacher effect codes reported (Table 8). Reading subject matter in the lesson text seemed particularly well remembered by Clark.

An interesting feature of Clark's work was the incidence of own constructions and mis-constructions, particularly in the twelve-month journal. Some of these statements were stable over time but most seemed to be continuing to evolve. Clark's own constructions about food being preserved in the cold temperatures of Antarctica provided evidence of this evolutionary process (Figures 5-8).

> Food lasts a long time because it's like a freezer.
>
> (*Clark, post-lesson journal*)
>
> Like a giant freezer so if you found food there it would be OK to eat.
>
> (*Clark, three-month journal*)
>
> Tinned food can be preserved for a long time because Antarctica is like a freezer.
>
> (*Clark, twelve-month journal*)

At each learning journal, Clark added new own constructions and mis-constructions and these bore little resemblance to his earlier efforts.

TABLE 8

Distribution of journal codes and test scores

Group A 1-Clark

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	4		2			6
Test scores (%)	55		95	80	75	
Text		6	11	12	9	38
Discussion		7	4	1	4	16
Own constructions		4	5	3	5	17
Mis-constructions	2	1	1		5	9
Teacher effects		4	5	2	2	13
Affective statements						

*includes three journal entries

The influence of Clark's prior knowledge was evident in several instances. He reported that "Captain Scott and his team travelled to Antarctica" in his pre-lesson journal. How this knowledge was elaborated over the lessons is illustrated by this sequence of journal writings (Figures 6 & 7).

Scott's team second to South Pole.

Scott's team died because they had to pull the sleds themselves.

Amundsen first to South Pole.

(Clark, post-lesson journal)

Scott's team were pet lovers and they pulled the sled themselves.

Scott's team died within a couple of kilometres of a food depot.

Scott's team pulled the sleds themselves.

Amundsen beat Scott to Antarctica.

(Clark, three-month journal)

By the twelve-month journal (Figure 8), these concepts had become a mis-construction, "Scott Amundsen was in a race to get to Antarctica.". The process of developing mis-constructions was common with Clark's work. His pre-lesson journal entry " Scientists go there to study" proved enduring with scientists (or meteorologists) mentioned at each journal. The development of this concept may have been facilitated by discussion in lessons two and four.

Clark's discussion about Robert Scott was connected to current information about a modern expedition that planned to emulate Scott's methods. This information had not been provided during the lessons.

Some people are going to pull the sleighs themselves like Scott's team.

(Clark, three-month journal)

Some of Clark's recall appeared unpredictable. In the post-lesson journal, he reported a number of pieces of information about Antarctic wildlife (Figure 6). These were omitted from the three-month journal but re-appeared at twelve months. This knowledge also seemed linked to discussion. Unpredictability was also apparent in Clark's writings on Cook and blizzards and in his post-lesson journal he wrote a paragraph about Shackleton's expedition but did not seem to recall it later.

Shackleton's ship stuck in ice. He removed the food and supplies onto the ice and had to live on the ice for a while.

(Clark, post-lesson journal)

Clark consistently remembered that protective clothing was needed in Antarctica. He represented these ideas in all journals. By three-months, the term thermal clothing had been added. At twelve months, the notion of protective clothing had been expanded to include goggles and connected to concepts about blizzards.

The clothing is inner clothing, outer clothing, gloves, boots, beanies and goggles.

(Clark, post-lesson journal)

Thermal clothing is very important.

(Clark, three-month journal)

You have to pack thermal clothing because it's very cold.

People who go outside have to wear at least three layers of clothes.

You can't see anything in a blizzard and you have to wear goggles to protect your eyes.

(Clark, twelve-month journal)

Clark also displayed good recall of information about the kinds of jobs people do in Antarctica. This material was well discussed in the group.

There are eight jobs in Antarctica. Some of the jobs are cook, meteorologist, nurse, engineer, mechanic, scientist and maybe biologist.

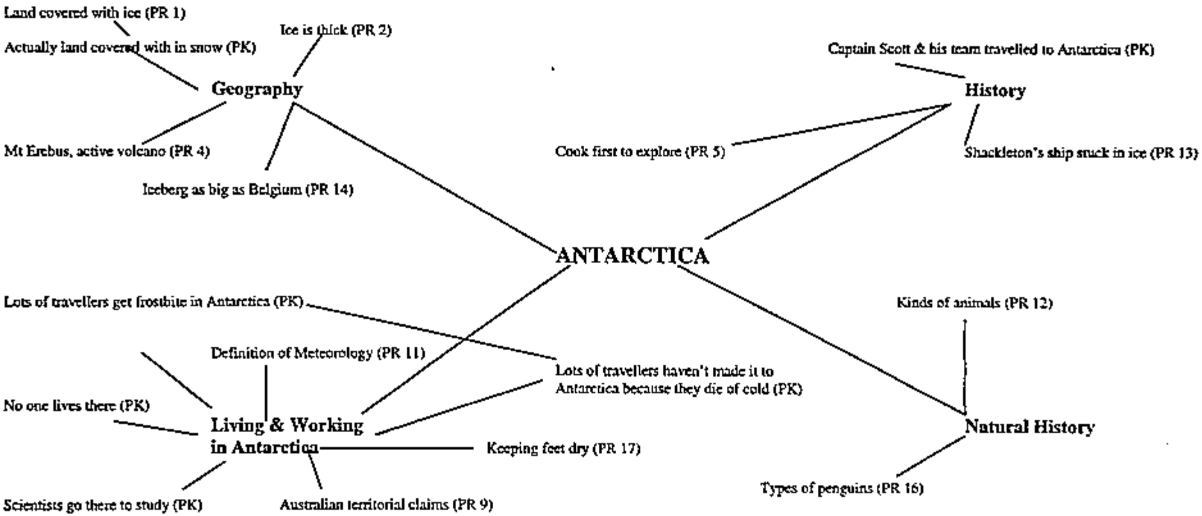
(Clark, post-lesson journal)

Some workers that are taken there are chef, scientists, meteorologist, doctor and nurse.

(Clark, twelve-month journal)

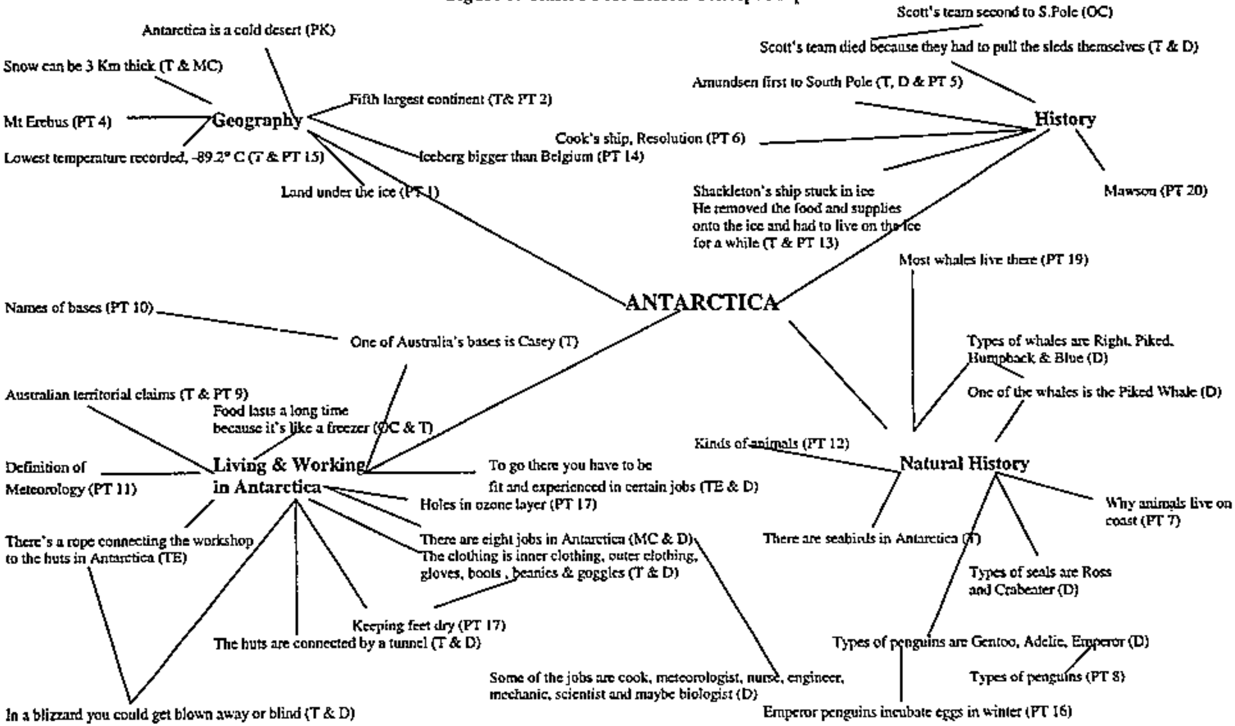
Clark's concept maps (Figures 5-8) in the following pages reveal a student who gained academically from the lessons. He was able to recall substantial portions of information and had developed detailed concepts over the study's duration. The sources of his learning were diverse including lesson text, small group discussion and teacher influences. His recall from reading text material was particularly strong although substantial influences of small group talk were also discerned.

Figure 5: Clark's Pre-Lesson Concept Map



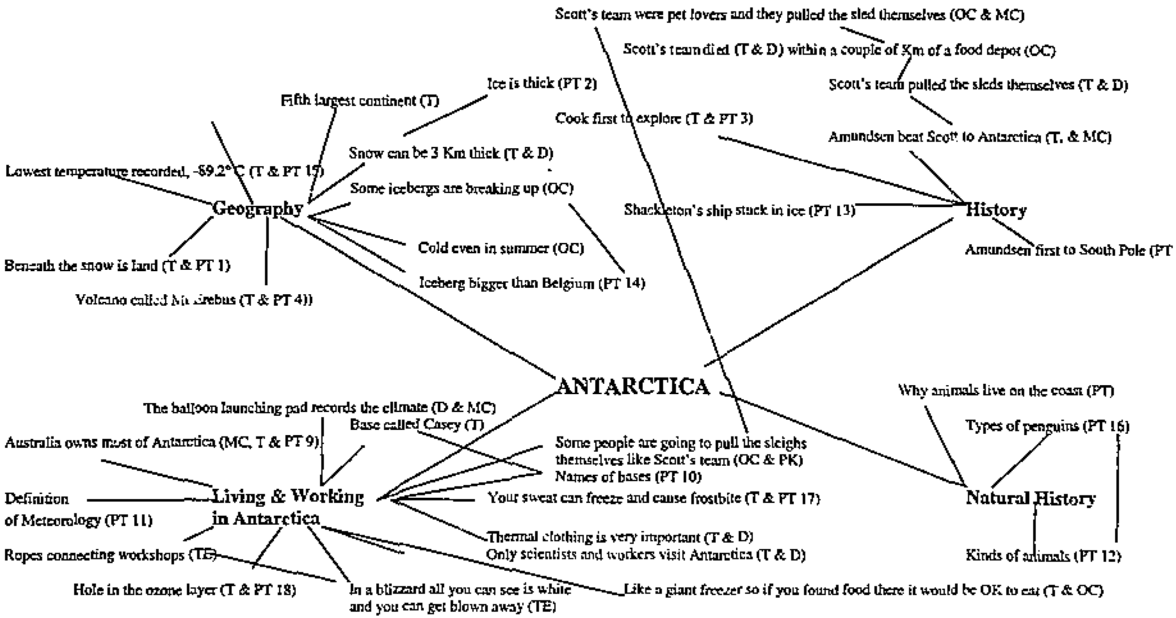
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 6: Clark's Post-Lesson Concept Map



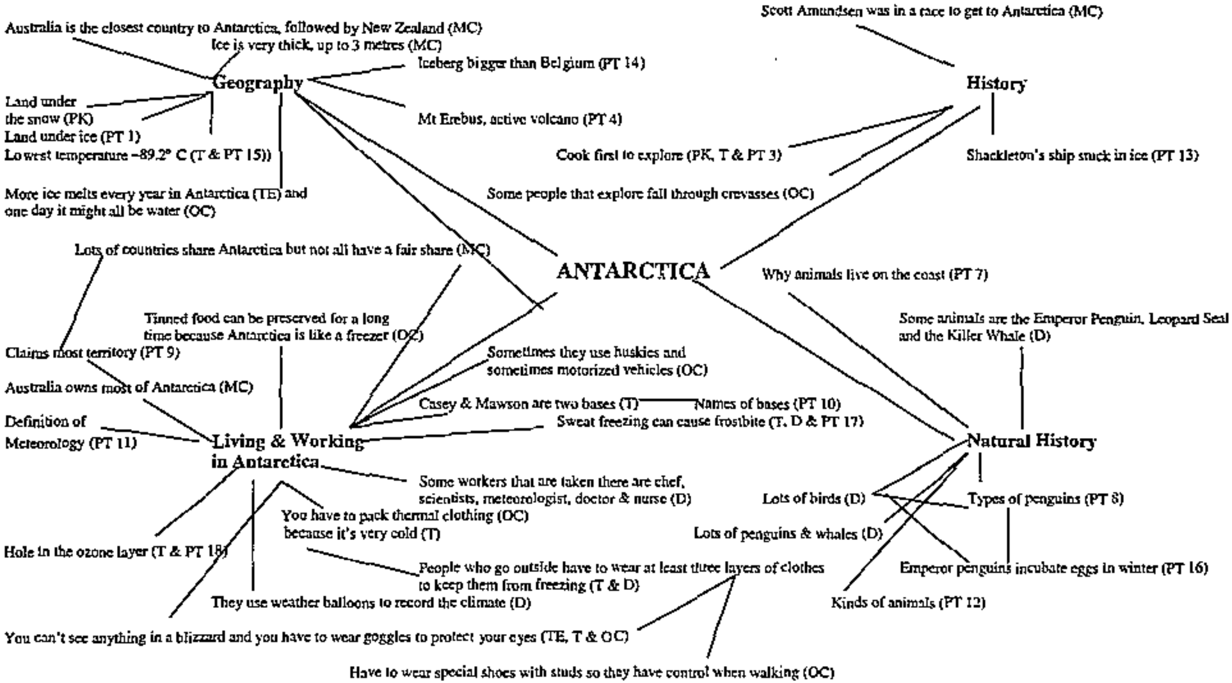
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 7: Clark's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 8: Clark's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Abi

Abi exhibited good prior knowledge of the topic, reporting facts like "Antarctica is a polar region" and " James Cook was the first to explore Antarctica" (Figure 9). The "cold place" notion was developed by Abi into a focus onto specific temperatures, " the coldest continent" (post-lesson journal) and eventually into " a frigid zone in the southern hemisphere" (twelve-month journal).

The consistency of discussion codes reported seemed to indicate that this student gained from the discussion. The concept of a tunnel joining buildings at the base (lesson two) was one example of a long term, consistent outcome of discussion (Figures 10-12). Over time, Abi reported less text codes and more discussion, mis-construction and own construction codes (see Table 9). Similar to Clark, Abi continued to produce new mis-constructions and own constructions until the final journal, indicating a student with changing mental representations of the subject matter.

TABLE 9

Distribution of journal codes and test scores

Group A 1-Abi

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	6	1				7
Test scores (%)	45		70	65	55	
Text		3	2	7	1	13
Discussion		6	4	4	4	18
Own constructions		8	3	2	5	18
Mis-constructions		1		2	6	9
Teacher effects		2	1	1	2	6
Affective statements						

*includes three journal entries

The combination of various pieces of information into mis-constructions was illustrated well by Abi's recall of information about Scott and Amundsen. Reference to these explorers appeared first at the three-month journal. The following extracts illustrate how Abi mis-constructed the information.

> Robert Scott & Amundsen had a race.
>
> Amundsen's team used dogs to pull their sleds and Scott's team used people.
>
> The first team there was Amundsen's.
>
> James Cook sailed around the coast.
>
> Shackleton's ship was stuck in the ice.
>
> *(Abi, three-month journal)*
>
> A land explorer went sailing on a ship with a crew and landed in Antarctica. I think his name was Rolland or Robert. His ship got stuck in the ice and he survived by sleeping on the ship. *(Abi, twelve-month journal)*

The influence of discussion on Abi's learning was apparent in her post-lesson journal entry that seemed to stem from talking about weather balloons. The discussion seemed to assist Abi to understand the material and produce an own construction.

> They have a piece of string and on the end is an object, usually a camera. They launch the balloon in the air with a gas called Helium. The balloon keeps expanding while the camera keeps taking photos. *(Abi, post-lesson journal)*

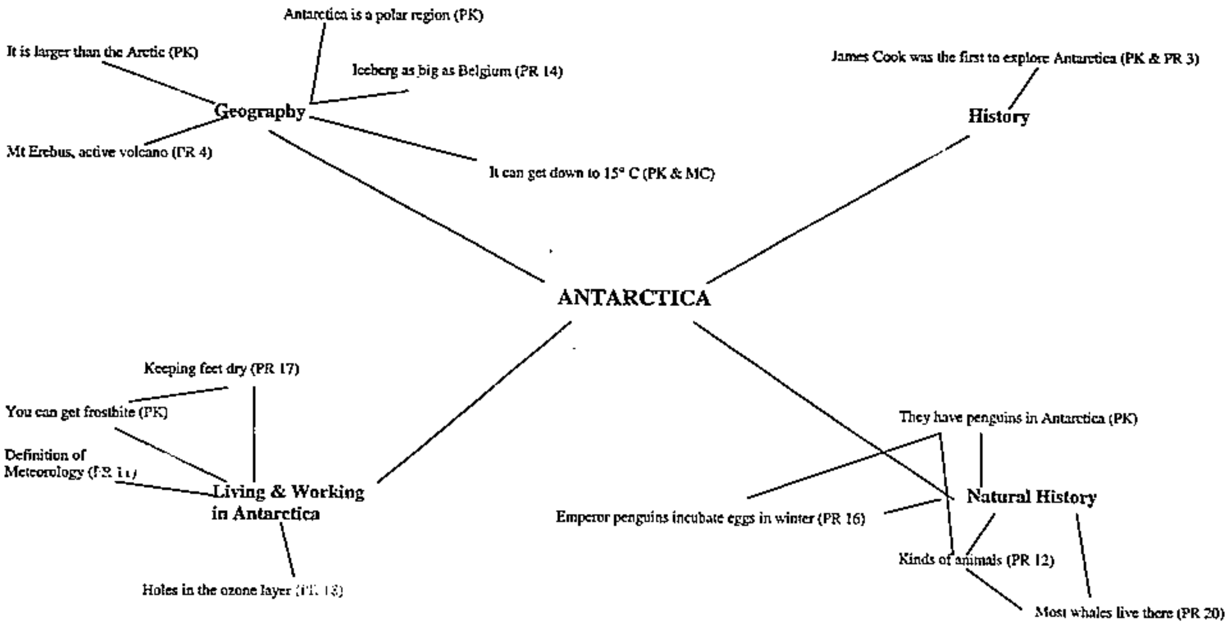
Abi's prior knowledge of the gas helium was not derived from the discussion and may have been gained from listening to another group because the group did not use the term in any of their discussions. Prior knowledge proved significant and durable with Abi. Her first journal noted Cook as the first person to explore Antarctica and that penguins lived there. Cook was not mentioned at the post-lesson journal but re-appeared at three-months, "James Cook sailed around the coast" and again at twelve months, "Cook was the first person to find Antarctica" (Figures 11 & 12). Knowledge about penguins and whales was extended by the post-lesson journal and was recalled again at three and twelve months.

> Some whales are fin, killer, blue, humpback, right.
>
> Some species of penguins are weddel, emperor, chinstrap, adelie.
>
> *(Abi, post-lesson journal)*
>
> There are also various whales, seals and seabirds.
>
> Some types of penguins are adelie and emperor.
>
> *(Abi, three-month journal)*
>
> The humpback and blue whale often swim there.
>
> The white whales often swim around the shores of Antarctica.
>
> Emperor penguin is very common.
>
> The seals swim gracefully and the sea life is incredible.
>
> *(Abi, twelve-month journal)*

Abi provided data from other sources that enriched her responses to the lessons. She was aware of Antarctic tourism in the post-lesson journal and elaborated on this at three-months (Figures 10 & 11). This concept was not included in the lessons. She acknowledged that this was information she had "learnt somewhere else" (Figure 11). In her final journal she mentioned avalanches, a concept also not described in the lessons or by the teachers. Abi confirmed in a brief discussion with the researcher that she had heard of avalanches in a television documentary.

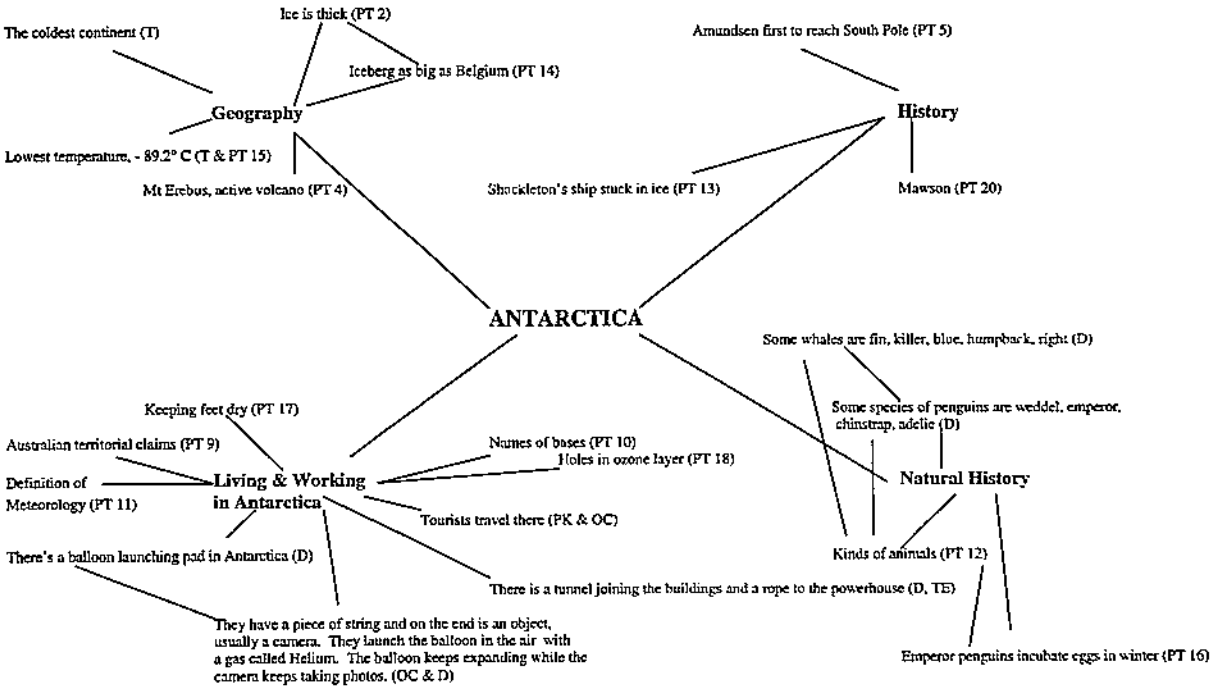
Abi demonstrated some of the influences small group talk could have on a student's learning. She remembered a high proportion of discussion-related material as is indicated in her concept maps in the pages following. Her involvement in discussion seemed to enhance the production of her own constructs as evidenced through her own constructions and mis-constructions. As was noted above, Abi was particularly aware of the need to work cooperatively. She was the student most likely to remind her group of discussion rules and try to include all group members. This suggested a student for whom cooperative learning was a beneficial learning context.

Figure 9: Abi's Pre-Lesson Concept Map



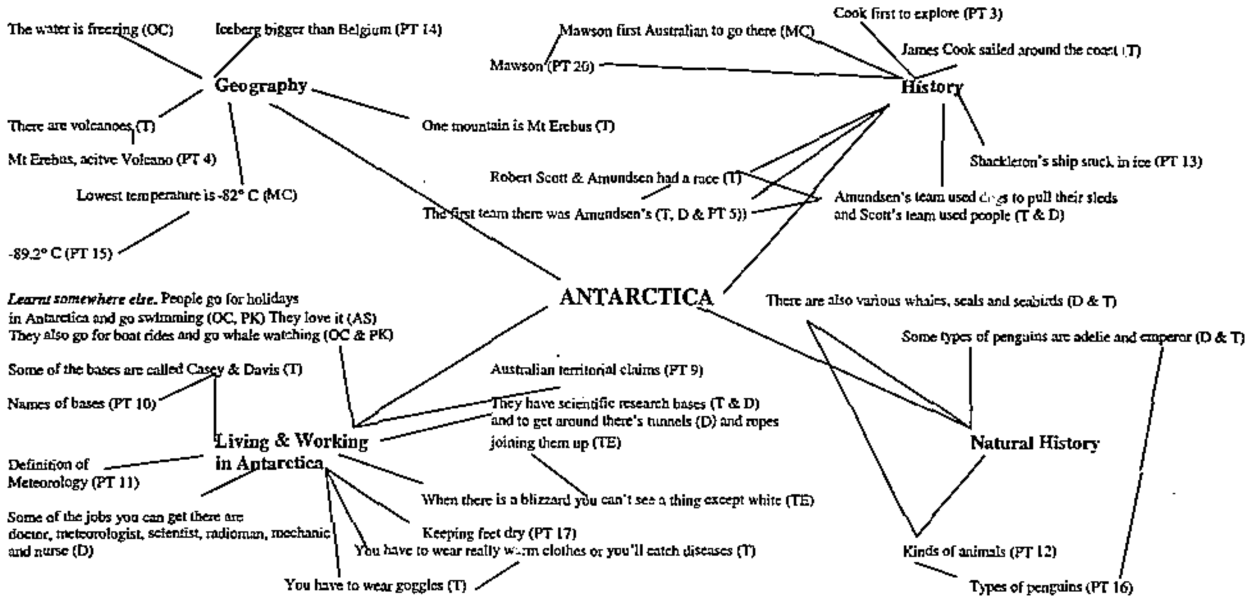
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 10: Abi's Post-Lesson Concept Map



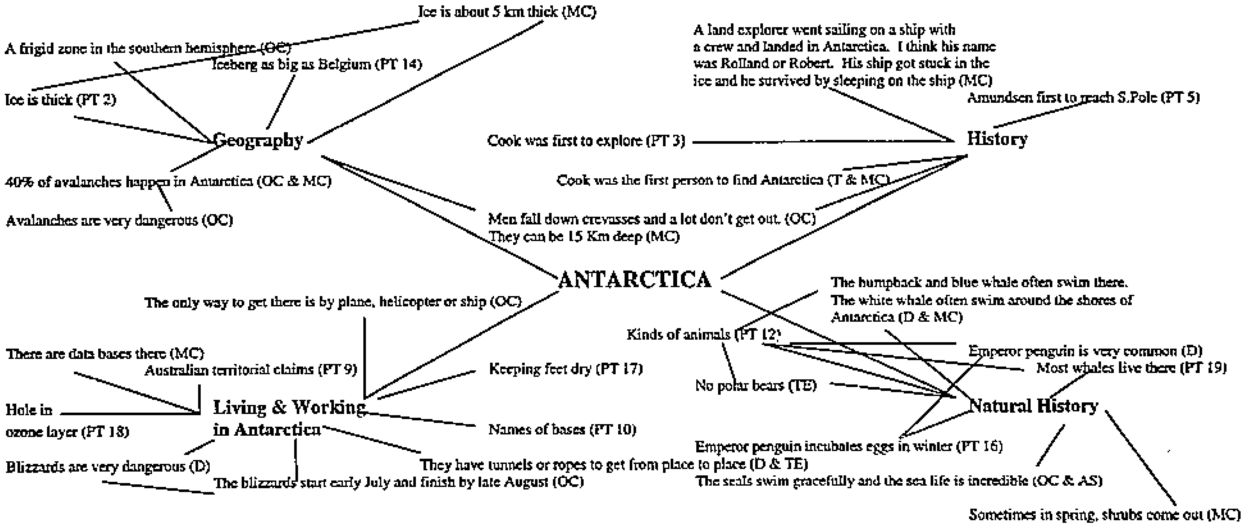
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure ' 1: Abi's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 12: Abi's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Joel

Although Joel appeared reticent during the discussion his journal work indicated a student actively involved in listening. He reported high proportions of discussion codes post-lesson and this continued to the three-month journal. At that time the text codes and own constructions also increased (see Table 10). By twelve months, discussion codes were not as prevalent.

TABLE 10

Distribution of journal codes and test scores

Group A 1-Joel

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	6					6
Test scores (%)	30		85	70	70	
Text		3	1	8	4	16
Discussion		5	7	4	2	18
Own constructions		4	1	3	2	10
Mis-constructions		2	1	1	1	5
Teacher effects		3	3	1	1	8
Affective statements						

*includes three journal entries

Joel tended to evolve new mis-constructions and own constructions similarly to Clark and Abi. The group discussed at length the use of dogs for pulling sleds and the lack of dogs as a possible cause for the death of Scott and his party. Joel transformed this into an own construction " Amundsen's team beat Scott's because dogs pulled their sleigh" (three-month journal). By twelve months this notion had been transformed further.

They normally use huskies to pull the sleigh around instead of using all their energy.

When times get desperate, people kill the dogs and eat them.

(Joel, twelve-month journal)

The influence of discussion on Joel's learning was further evident in his writings on blizzards and the connecting tunnel in lesson two. Joel referred consistently to the need for goggles for eye protection during blizzards (Figures15 & 16). This was an own construction based on a teacher whole class intervention, text statements about blizzards and discussion. Joel linked the teacher statement that blizzards can cause blindness and inferred the need for goggles (see Appendix J).

Blizzards can blind you. Blizzards can blow you away.

(Joel, post-lesson journal)

Blizzards could blow you away and blind you if you're not wearing goggles.

(Joel, three-month journal)

They must have goggles to prepare for blizzards.

(Joel, twelve-month journal)

The related discussion about tunnels connecting buildings in lesson two (Appendix J) was also consistently recalled by Joel. He also linked this to the use of guide ropes at the base.

> Tunnels connecting rooms are handy in bad weather.
>
> At night they use ropes to find their way. (Joel, post-lesson journal)
>
> They use tunnels at their base.
>
> They use a rope to get around at night.
>
> *(Joel, three-month journal)*
>
> They have a rope out to the toilet in case of it being dark.
>
> They must have goggles to prepare for blizzards.
>
> *(Joel, twelve-month journal)*

Joel integrated several of the above ideas into a longer paragraph in his final journal. The following entry indicates Joel's transformation of knowledge and the connection of different pieces of information into a coherent statement.

> The station is linked up as one house. All the rooms are linked up *(tunnel)*. If they didn't and they had to cross outside to another place, they might get swept away if there is a blizzard.
>
> *(Joel, twelve-month journal)*

Joel's use of prior knowledge was evident with the "cold place" concept. His prior knowledge may have influenced the focus on blizzards, tunnels and protective clothing described above. He recalled substantial pieces of information connected to these concepts.

It's still cold in summer. Temperature is always minus something. Ice is everywhere.

Icebergs can be the size of a park

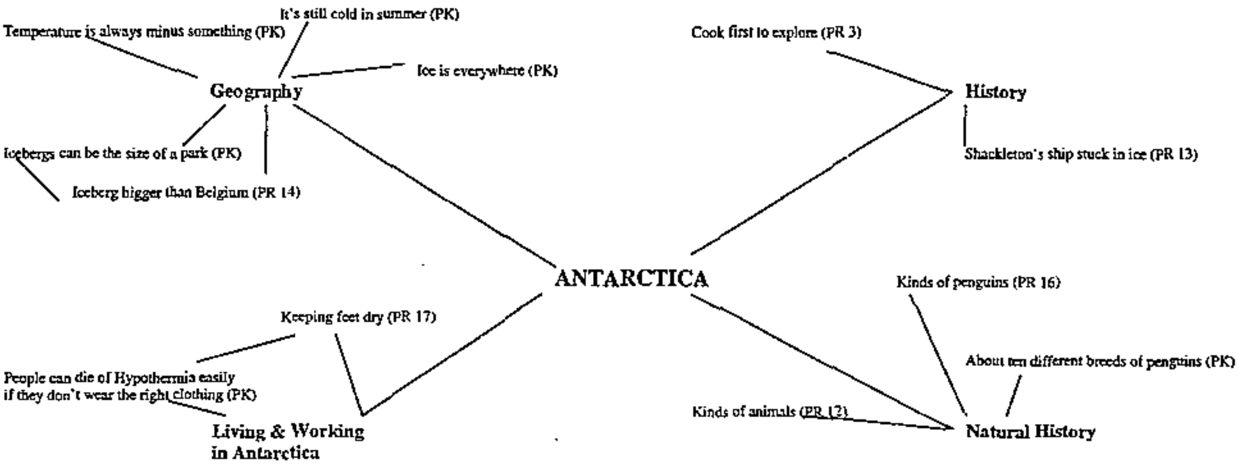
People can die of Hypothermia easily if they don't wear the right clothing.

(Joel, pre-lesson journal)

In later journals, Joel presented prior knowledge again such as "Sometimes called a cold desert"(post-lesson journal) and "Antarctica is supposed to be getting bigger" (three-month journal). He correctly used the term "Hypothermia" in the pre-lesson journal but this was not referred to again. A gap also existed in his recall of the use of weather balloons in Antarctica.

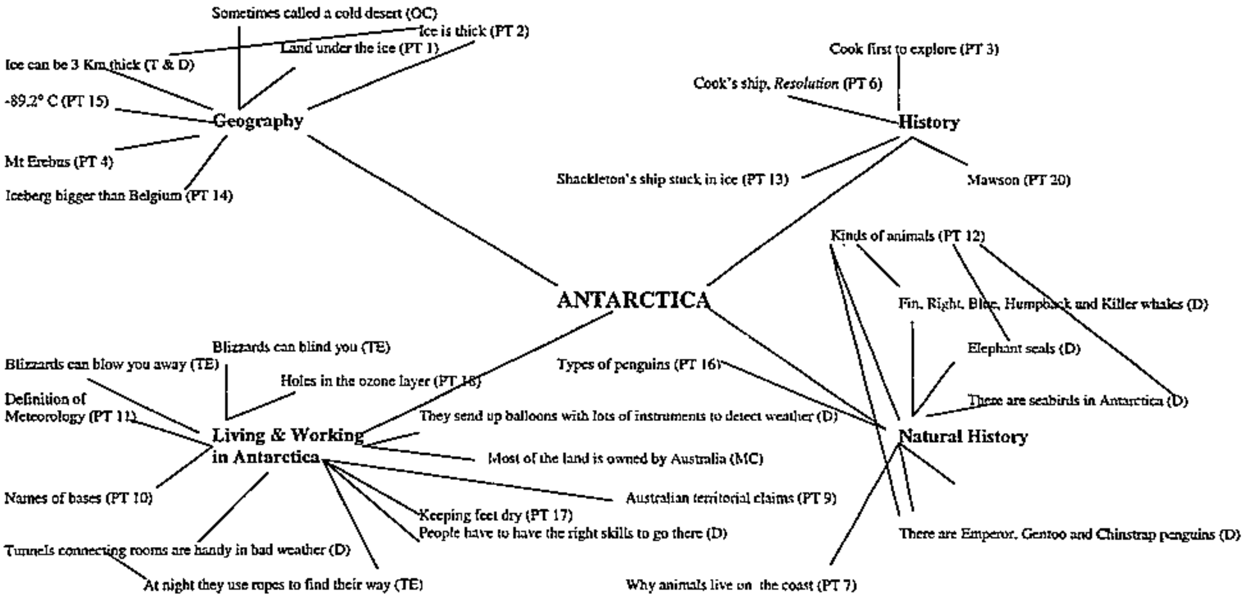
As the concept maps in the following pages indicate, Joel gained academically from the lessons. His main area of recall seemed to be the theme of *Living and Working in Antarctica,* particularly after the twelve-month interval. Cooperative learning seemed to provide a useful learning situation for this student.

Figure 13: Joel's Pre-Lesson Concept Map



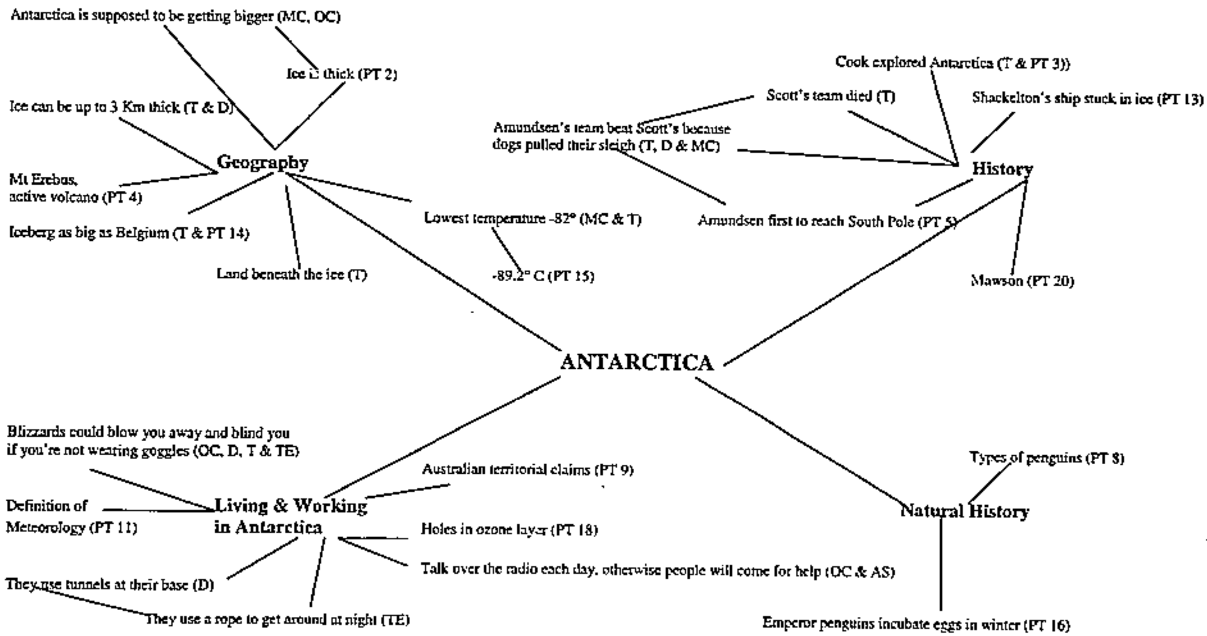
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 14: Joel's Post-Lesson Concept Map



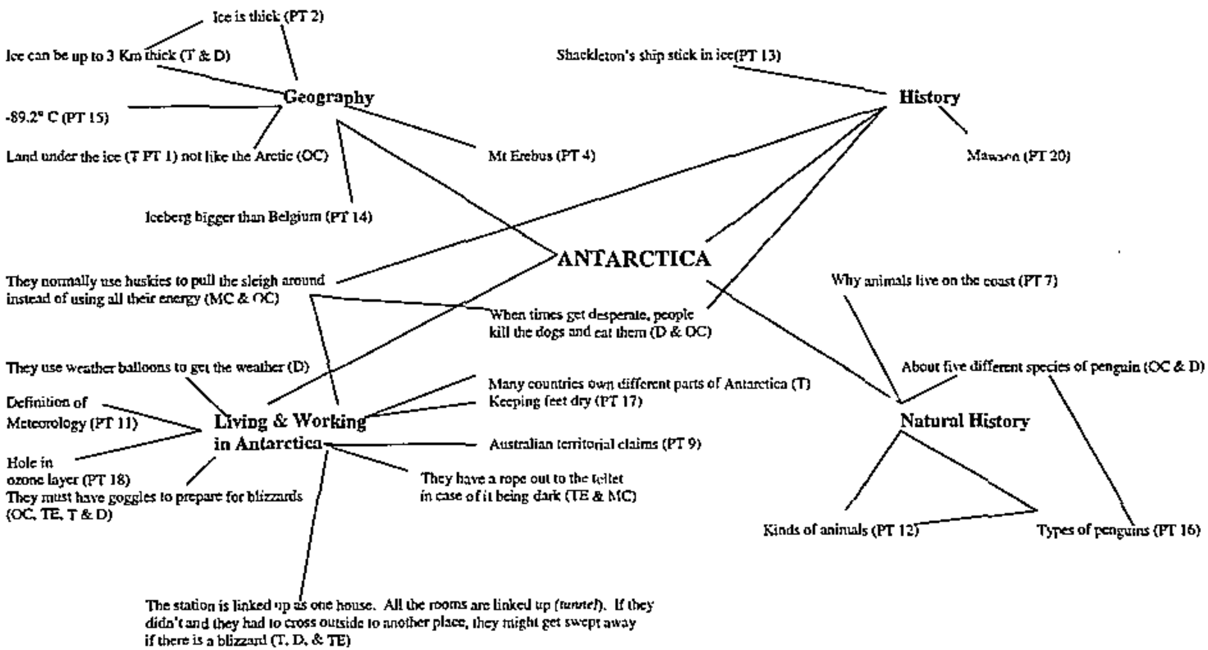
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 15: Joel's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 16: Joel's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Amanda

Amanda left School A before the post-lesson and remaining data were collected. She did not attend school on the days prior knowledge data were collected. Analysis of her mid-lesson data indicated a student having difficulty engaging with the lesson content. She provided 17 journal entries over the three mid-lesson journals (see Table 11). Of these, 5 were coded as text, 3 were discussion codes, 6 were coded as mis-constructions, 2 were own constructions and 1 was coded as teacher effects. Amanda's role in her group's talk was discussed in the group processes section above. In general, she did not appear to gain much from cooperative learning but this was typical of her passive behaviour in general class activities.

TABLE 11

Distribution of journal codes and test scores

Group A 1-Amanda**

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge						
Test scores (%)	35					
Text		5				5
Discussion		3				3
Own constructions		2				2
Mis-constructions	2	6				8
Teacher effects		1				1
Affective statements						

*includes three journal entries

**This student left School A after lesson completion. No data available.

<u>Knowledge and concept development within the group</u>

Evidence existed of several co-constructions of knowledge within this group. Concepts about tunnels and ropes joining buildings for protection from blizzards were consistent across the group and reported by Abi and Joel in all journals. In the final journal, a focus of Clark's was on equipment required for working outside in Antarctica and in this context he referred to the lack of visibility in a blizzard, a concept related to the guide ropes. The following exchange was the group's only direct discussion on tunnels during lesson two. The discussion involves comprehending the task, proposing a solution and discussing representation of the answer (MAKITAB codes TS08, TS10 and TS 14, see Appendices H & I).

Abi:	Why do you think there's a tunnel joining the buildings.
Clark:	So like if there's any bad weather they can just move through the tunnel.
Abi:	(*writing answer to question. Others off task; favourite colour discussion. Returns groups to task*). If there is bad weather.
Clark:	I just wrote...in case of bad weather they can go through the tunnel...
Joel:	... I am going to write if there's bad weather you can go through the tunnel without getting hurt.

The group's talk about tunnels, ropes and blizzards, discussed in various contexts, seemed to be connected and transformed by the students. All students wrote consistently about blizzards in their journals. The following journal entry by Joel exemplifies the students' transformation of several related ideas over an extended time.

The station is linked up as one house. All the rooms are linked up *(tunnel)*. If they didn't and they had to cross outside to another place, they might get swept away if there is a blizzard.

(Joel, twelve-month journal)

The group's discussion about the role of dogs in Antarctic exploration also produced consistent, long-term outcomes. The following extended exchange illustrates how the students co-constructed knowledge by applying both correct and incorrect prior knowledge and what they had learned from the lesson.

Amanda:	Can I read it out. Why do you think Scott's team died but Amundsen's lived. Give two reasons...
Abi:	I think because Scott's team tried to like have ...tried to...
Clark:	They tried to pull the sleds themselves.
Abi:	Yeah... so there would have been a lot of weight.
Amanda:	No that was when their dogs died...
Clark:	*(picks up the mis-construction and runs with it)*...yeah their dogs died so when they were pulling the sleds they wouldn't have enough strength and they would get very hungry. Orr I know why they were so hungry they had to eat their dogs.
Amanda:	What?
Clark:	Or something like that.
Amanda:	Nooooo...
Clark:	Yeah but they got very sick.
Abi:	Read the thing (*worksheet*).

Clark:	Why do you think Scott's team died but Amundsen's lived.
Joel:	The text...
Clark:	It doesn't say it here it says it in a comprehension checkpoints (*reading text used by the class*) book that (indistinct).
Abi:	I think I know...because they wouldn't have enough strength to pull their sled by themselves. Guys just listen, they didn't have enough strength to pull the team by themselves.
Joel:	I know but Clark thinks they ate the dogs...
Abi:	They didn't.
Clark:	They got very hungry and they ran out of food.
Amanda:	Yeah I think that's actually true.
Abi:	How do you know?
Amanda:	Because it's in comprehension checkpoint one (*reading text*).
Clark:	Either that or Mr Z told us.
Amanda:	Yeah something like that.
Abi:	That was James Cook wasn't it?
Clark:	No we're talking about Scott's and Amundsen. James Cook didn't die there ...he was killed by native Americans or something.
Amanda:	Is it James Cook?
Abi:	What I am trying to say (becoming frustrated) is because they didn't have enough strength to pull the sled by themselves.

A mis-construction had occurred because of incorrect information obtained from a reading text where some students had read that Scott's team had eaten their dogs because of food shortages. The group tried to identify the source of their information but were unsure. This discussion continued past the exchange above, occupying a substantial portion of the total discussion for lesson three (58%). A majority of this discussion was of the in-depth, task enhancing type (MAKITAB codes TS08 to TS14, Appendices H & I). The group also discussed dogs and ponies in the pre-lesson discussion for lesson four.

TABLE 12

GROUP A1: MAKITAB ANALYSIS OF ON TASK TALK (TS CODES ONLY)

Codes	*lesson 1*	*lesson 2*	*lesson 3*	*lesson 4*	*lesson 5*	*Total Statements*	*%*
TS01							
TS02	14	12	17	7	7	57	7.9
TS05	3	2	2	4	2	13	1.8
TS06							
TS07			1			1	0.1
TS08	26	35	29	28	3	121	16.7
TS09	13	11	14	5	2	45	6.2
TS10	2	9	17	41	16	85	11.8
TS11	32	37	85	41	52	247	34.2
TS12	2		6	5	4	17	2.3
TS13							
TS14	10	22	39	33	4	108	14.9
TS15	4	1	6	2	5	18	2.5
TS16	6	2	1	1	1	11	1.5
Lesson Totals	112	131	217	167	96		

The high level of task enhancing talk produced by this group is indicated on Table 12. The codes TS08-TS11 were particularly prominent, accounting for 68.9 % of the group's talk overall with the MAKITAB code (TS11) involving negotiating, arguing and reacting to ideas the most common type of talk engaged in by this group.

Table 12 also illustrates the relationship between the kinds of task and the kinds of talk. This seemed most noticeable when comparing the talk in lesson four and five. The worksheet questions for all lessons were generally of an open-ended type but the group A1 students interpreted the lesson four questions as requiring routine-type answers. Hence they produced high levels of the TS08 (16.7%), TS10 (24.5%) and TS14 (19.7%) codes (Appendices H & I), indicating that the students responded quickly with proposals for answers and represented them on the worksheet with little in-depth talk. The TS11 code associated with "mulling over" a question appeared as a low 24.5% in this lesson's talk. By contrast, the very open-ended questions in lesson five produced a majority of TS11 talk (54.1%). The TS11 coded talk seemed to be associated most with student learning. Talk codes TS09-13 and TS15 were subsequently termed *quality talk* for the purposes of this study (see chapter six).

The students' discussions about Antarctic wildlife in lesson four appeared to have stable long-term outcomes. Discussion for the worksheet was elaborate, occupying 37% of all discussion. Observation confirmed that the students were well engaged in the topic, rapidly proposing ideas and re-acting to their peers' suggestions. The concept that Antarctica had a variety of species appeared well established by the discussion as these journal entries indicate.

The humpback and blue whale often swim there.

The white whale often swim around the shores of Antarctica.

Emperor penguin is very common.

(Abi, twelve-month journal)

Some animals are the Emperor Penguin, Leopard Seal and the Killer Whale.

Lots of penguins and whales.

(Clark, twelve-month journal)

About five different species of penguin.

(Joel, twelve-month journal)

The group's discussion did not always seem to impact noticeably upon long-term outcomes. Several instances were discerned where discussion was not reflected in journals. The following exchange (lesson four) is an example of where a discussion did not lead to recall in journals.

Clark:	Why do you think the animals live in or near the sea? (reading question)
Joel:	Cos they like it there?
Abi:	Well I think that because they are adapted to it?
Amanda:	Cos that's where they're born?
Joel:	Cos that's their main habitat
Clark:	And it's got lots of um...
Abi:	...food, cos that's where the food is...
Clark:	...krill and plateau (indistinct).
Abi:	That's where the food is.
Clark:	Yeah. (he was thinking the same thing)
Joel:	That's their main...

Abi: ...why don't we put...

Clark: (finishing her thought)...that they are adapted to the conditions and it's their main habitat.

Joel: And there's the food there.

The above type of exchange involving prior knowledge (habitat, krill, adaptations) would normally be expected to produce long-term outcomes when compared to other data. In this instance no reference to animals living on the coast was made in journals and only Joel and Clark scored the relevant test item correct.

With the exception of Amanda, cooperative learning appeared to benefit the students in group A1, allowing them an opportunity to apply their prior and newly acquired knowledge effectively. Even after an extended period, Abi, Clark and Joel demonstrated rich knowledge and conceptual development. Abi, Clark and Joel were very academically able students who performed to the teacher's expectations. Amanda's performance in the cooperative learning sessions also typified her general classroom performance. In this sense, the cooperative lessons may not have been any more beneficial to Amanda than whole class lessons.

5.4. Case study 2 (group A 2, school A)

Profile

Group A 2 comprised two female and two male students, Rianne, Melanie, David and Paul. Melanie was in year five (ten years old) at the commencement of the study and the other students were in year four (nine year olds). The year four students in the group were strong academically. Paul had been accepted into an academic enrichment program. Although he was generally a quiet student Paul was highly motivated. David was a high achiever who exhibited an innate curiosity. In whole class contexts David was always a strong contributor who displayed a wide general knowledge. Rianne was normally a high achiever whose academic performances fluctuated. She displayed strong creative abilities in Art and Drama. Melanie was generally a middle achiever who had some minor difficulties with English. She was a socially active student who spent considerable effort in negotiating social situations among her peers.

Group processes in the discussion

This group usually worked harmoniously and three students (David, Melanie and Rianne) appeared to gain most from the discussions.

David tended to assume a dominant role in the group; leading or setting the agenda of the discussion, returning the group to task and being prepared to "tease out" ideas in order to achieve a satisfactory answer. The group developed a "culture" of being prepared to engage in extended periods of these kinds of talk. David was not only concerned with completing the task but was also anxious to produce a quality response. The following lesson five exchange illustrates David's key role as a leader and negotiator.

David: It doesn't mean he's studied the things they need to do down there.

Rianne: I agree with David.

Melanie: OK. I'll do Ben for that yes.

David: So we all decide on Ben?

(general agreement)

David: OK. Pick Ben.

Table 13 indicates that Paul also made substantial contributions to the discussion but this seemed to have less long-term effects on his learning than on the other group members. Note that Paul did not attend during lesson one but he made 27.72% of all statements in the remaining four lessons.

TABLE 13

Group A 2 Summary of total statements in group discussion (all lessons)

Student name	*Total statements*	*Percentage (%)*
Rianne	191	24.61
David	263	33.89
Paul (absent lesson one)	155	28.07
		(20.62 including lesson one)
Melanie	167	21.52

Rianne and Melanie were not generally passive in the group although the latter began to contribute more procedural types of talk and less content related talk as the lessons progressed. Rianne and Melanie seemed to gain from the discussion but David and Paul were the main contributors. Evidence existed where Rianne had recalled explicitly a comment made by another student (see below), suggesting that she had been well engaged in at least some of the discussion.

The group's interactions sometimes consisted mainly of exchanges between David and Paul. Observation confirmed that the majority of the group's lesson time was spent on-task (Table 14) indicating a strong task motivation. Like group A1, this group was also observed turning off the audio-tape machine occasionally when they were off-task and some of their off-task talk occurred after they believed they had completed the task.

TABLE 14

Group A 2 task related and non-task related talk

Lesson number (total statements)	*Task related talk (%)*	*Non-task related talk (%)*
1 (170)	82	18
2 (122)	94	6
3 (136)	92	8
4 (186)	90	10
5 (162)	91	9
Means	89.8	10.2

Group A2 individual case studies

Rianne

Table 15 indicates how Rianne continued to generate new own constructions and mis-constructions over the twelve-month period. These categories of her journal entries seemed to continue to evolve and many links to the group's discussions were discerned. This suggested a student who had actively engaged with the task via discussion and benefited from the opportunities provided in the cooperative setting. The following journal extracts indicate Rianne's focus on Antarctic base personnel, which was discussed at length by her group.

Only experienced and trained people go there.

(Rianne, post-lesson journal)

You need to be highly trained to go there.

(Rianne, three-month journal)

You need special people like nurses.

People go there to study things.

(Rianne, twelve-month journal)

Rianne sometimes developed her journal entries into themes. She made several journal entries that were linked conceptually to each other as indicated by the following examples, indicating that she had connected these ideas into her mental representations.

Only seals and penguins live there.

Animals live on the coast. Their natural diet is in the sea.

Most whales live in Antarctic waters.

(Rianne, post-lesson journal)

Only cold water animals.

Very few animals live there.

Only animals live there.

Whales normally live there.

(Rianne, three-month journal)

Only animals like penguins could survive.

A tiger or that sort of animal could not live there.

Whales go there for a while.

(Rianne, twelve-month journal)

TABLE 15

Distribution of journal codes and test scores

Group A 2-Rianne

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	5	2	1	3		11
Test scores (%)	20		65	75	40	
Text		19	9	11	8	47
Discussion		12	5	5	1	23
Own constructions	1	1	1	5	12	20
Mis-constructions	3	5	2	3	7	20
Teacher effects		3	2		2	7
Affective statements					2	2

*includes three journal entries

The concept about the kinds of animals that live in Antarctica followed definite themes across all of Rianne's journals and by the twelve-month journal this had developed into the idea that mammals like tigers could not live there and that only animals adapted to the cold could survive. Rianne linked this concept to human survival, "nobody could live there" in her twelve-month journal.

Another example of Rianne's conceptual development was with the notion that Antarctic explorers sometimes die. This idea first appeared in the three-month journal, "Two groups raced; one group died". By the twelve-month journal, this information had been transformed into several related statements.

> You are lucky to come back safely.
>
> Most make it back alive.
>
> Explorers sometimes go there.
>
> They get a big welcome.
>
> Some explorers die.
>
> *(Rianne, twelve-month journal)*

The statements directly related to explorers were also linked conceptually to concepts about frostbite, blizzards and the cold conditions generally.

Rianne provided instances where specific pieces of information were recalled consistently, though unpredictably, over time. Her pre-lesson journal included the statement, "You travel around Antarctica in a buggy with caterpillar wheels. Normal wheels would crack the ice". This prior knowledge was overlooked in the intervening journals but was recalled in the final journal.

> Explorers have special equipment to survive.
>
> Devices to get around. Buggies, ropes.

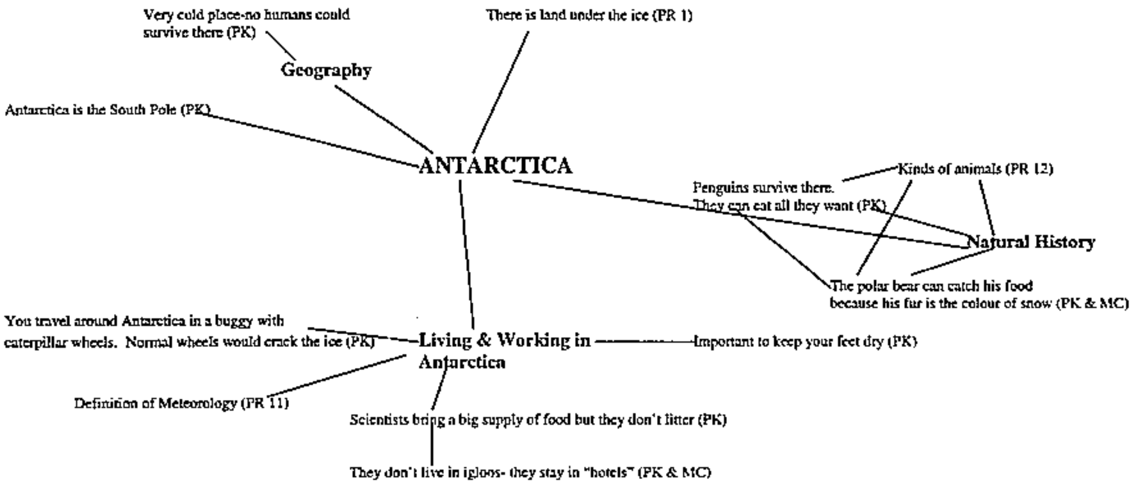
Caterpillar wheels there.

(Rianne, twelve-month journal)

Rianne also provided evidence of the influence of prior knowledge. She reported that "Scientists bring a big supply of food but they don't litter" in her pre-lesson journal and repeated this information through all journals (Figures 18,19 & 20). No reference was made to litter in lesson texts or discussion so this was Rianne's unique representation of ideas from her prior knowledge.

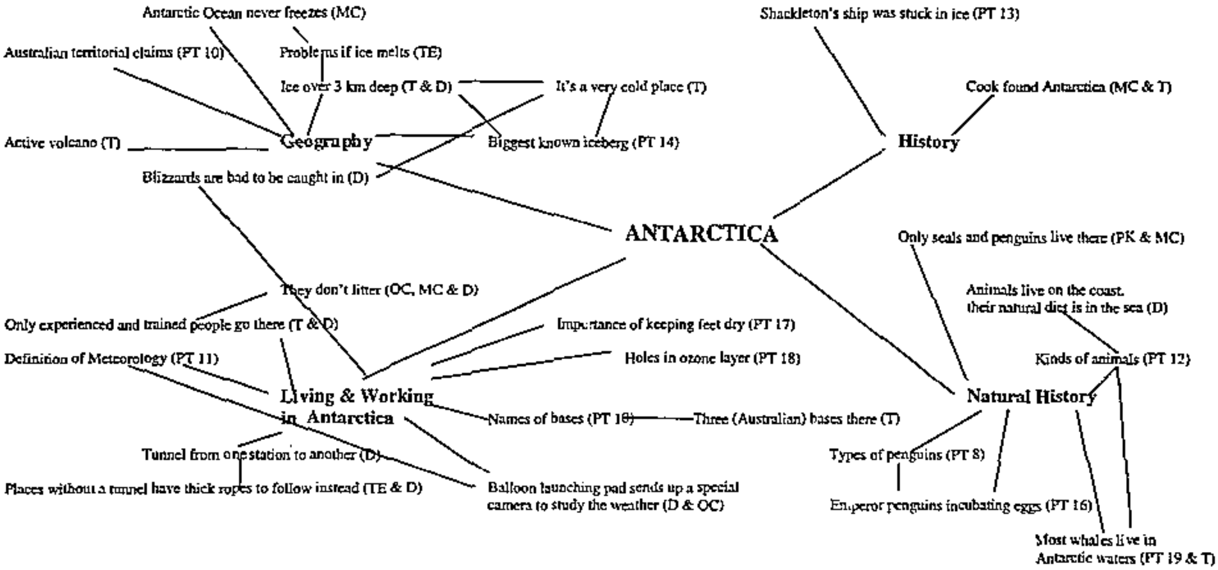
Rianne stated in one mid-lesson journal, "Scott's team found an island just off Antarctica and left his animals there (that's what David said) and set up a base there". This indicated the effects small group discussion had on Rianne because she was able to remember a specific moment in the discussion and had noted which group member provided the information. Rianne's concept maps indicate a student who gained substantially from the cooperative discussions in her group, although she was not the major contributor. She appeared to think creatively. This was evident in the kinds of own constructions and affective statements Rianne made, such as "most make it back alive" and "you are lucky to come back safely".

Figure 17: Rianne's Pre-Lesson Concept Map



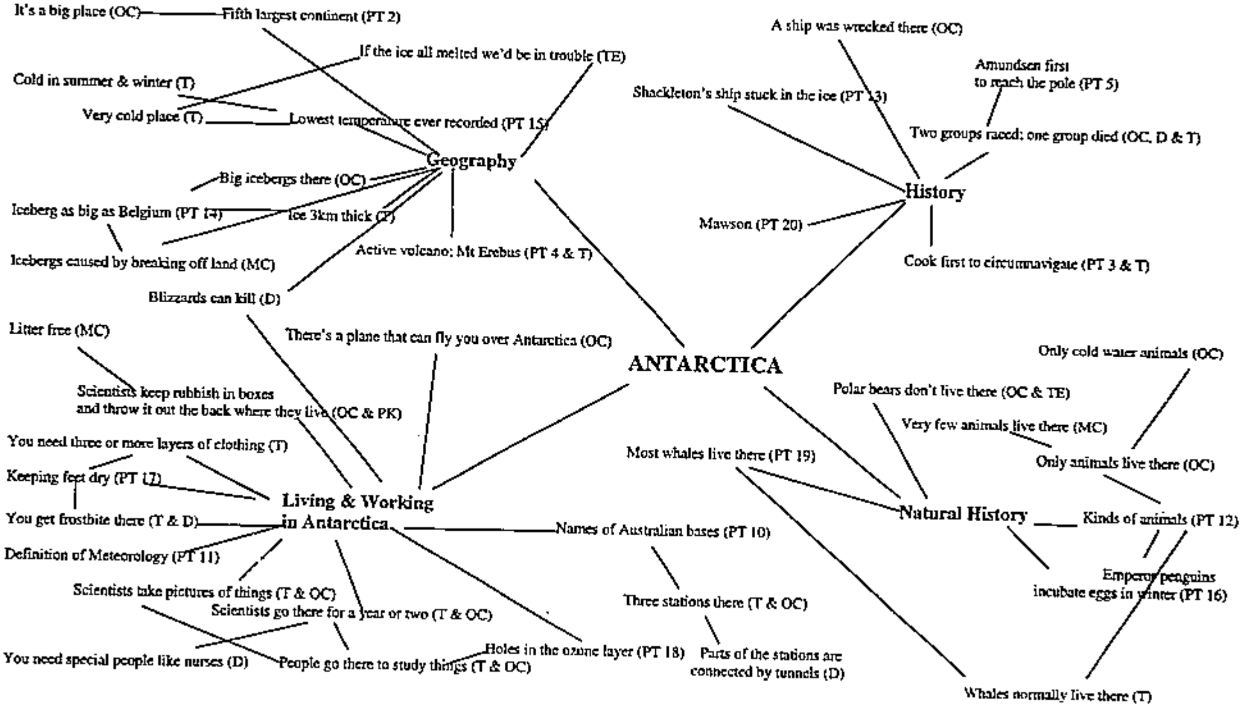
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 18: Rianne's Post-Lesson Concept Map



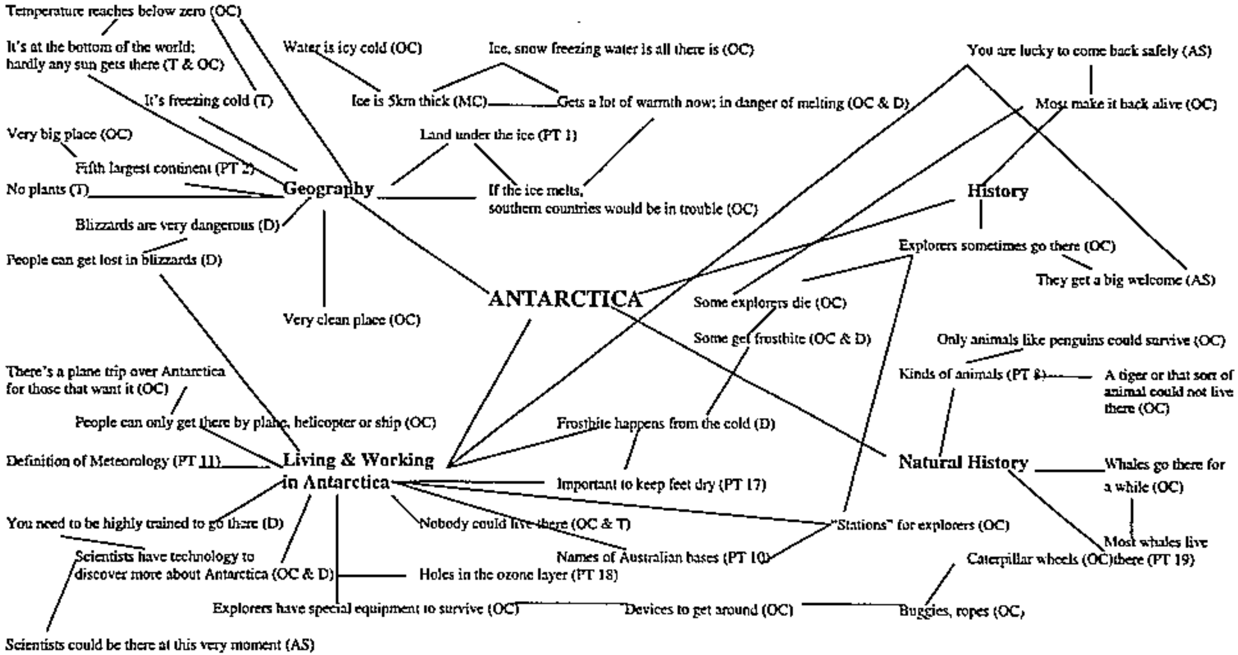
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions.

Figure 19: Rianne's Three Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions;

Figure 20: Rianne's Twelve Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

David

David's consistently high test scores indicated good recall of information (Table 16). Similar to Rianne, David produced continually developing and evolving own constructions and mis-constructions. David's twelve-month journal was a particularly rich source of own constructions. He seemed to bring together various pieces of information into new constructs, developing increasingly sophisticated representations of his ideas. David began with a good general knowledge of the topic and there were some links to his journal entries but his pre-lesson journal statements around the natural history theme were not later developed very fully (Figures 21-24).

TABLE 16

Distribution of journal codes and test scores

Group A 2-David

	Pre lesson	*Mid lesson* *	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	4	4		1		9
Test scores (%)	45		95	85	90	
Text		19	8	13	9	49
Discussion		2	3	1	3	9
Own constructions		5	3	5	10	23
Mis-constructions	6	5	1	3	3	18
Teacher effects		1	2	2	4	9
Affective statements						

* includes three journal entries

Analysis of David's journals indicated that he had benefited from the discussions. In lesson one, the group had become involved in a lengthy discussion about the thickness of the ice in Antarctica.

Rianne: Why is the ice so thick in Antarctica?

David: Because it's so cold there and because it's surrounded by water all the water would freeze up?

Melanie: Or because of blizzards?

Paul: Why? Who cares about blizzards. Blizzards are snow not... (*indistinct*).

David: ...and I don't...would wind um have anything to do with ice?

Rianne: Yeah....

Melanie: I don't know

Paul: Probably cos it's so cold in Antarctica all the water beneath the surface...all that gets frozen and then it gets (*indistinct*).

In the above exchange, blizzards had been associated together with the "ice is thick" talk, and this seemed to be reflected later in David's journal (Figures 22-24). The group answer to this question did not satisfy David so he returned them to discuss it again after the other questions had been completed. He appeared intrigued by the idea that ice could be as thick as three kilometres.

David: Well let's just go back to question one again. Why would it (*the ice*) just go three kilometres thick?

This elaborated discussion appeared to have a long-term impact on David's learning. The concept of ice in Antarctica had been transformed into an array of related ideas by the three and twelve-month journals.

Every year the ice stretches out for miles.

(David, three-month journal)

Ice melting due to global warming.

Problems if ice melts.

There's only snow & ice in the centre of Antarctica.

Ice over 3 kilometres thick.

Large numbers of icebergs.

Covered in ice and crevasses; difficult to cross.

Travelling is difficult due to icebergs and pack ice.

Many ships get caught in pack ice. Special ships called ice-breakers are used.

(David, twelve-month journal)

The idea of special ships and travelling difficulties seemed linked to the ice concepts at twelve months, as indicated by the extract below. David also remembered that Shackleton's ship had been stuck in the ice after three and twelve months (Figures 23 & 24).

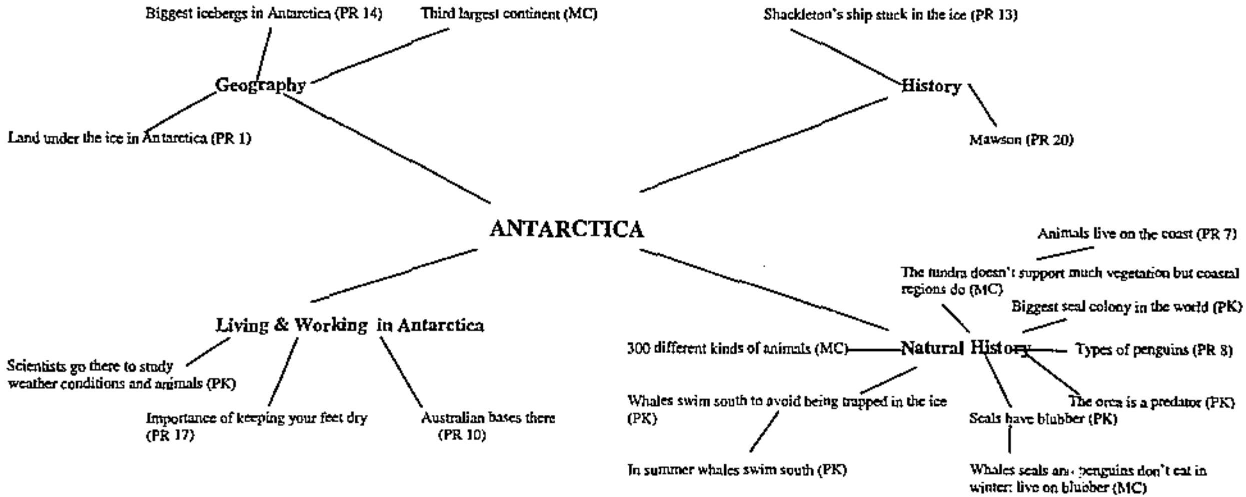
Big ships send small boats ashore. They have to be careful of shallows and falling glaciers.

(David, twelve-month journal)

Other journal statements relating to the "cold" concept were prevalent in David's journals. He described blizzards at the three-month journal, included his only entry about the tunnels and ropes joining buildings and recalled blizzards again in the twelve-month journal (Figures 23 & 24). Tunnels were mentioned in only 11 statements over the five lessons, but David's recalled tunnels at twelve-months despite the brief treatment given to the question. This suggested an unpredictability to David's recall. His journal writings became more sophisticated over time and new connections between ideas seemed to be made. These connections appeared to relate to David's willingness to undertake in-depth discussion. The concept maps in the following pages indicate David's evolving conceptual development over the study's duration. Further discussion influences were reflected in David's journal after the group had discussed the Scott expedition at length. This group had also been exposed to incorrect information about Scott's use of sled dogs, similarly to group A1 (see case study one) and the researcher intervened to correct the mis-constructions that were developing. David's recall around this discussion was accurate.

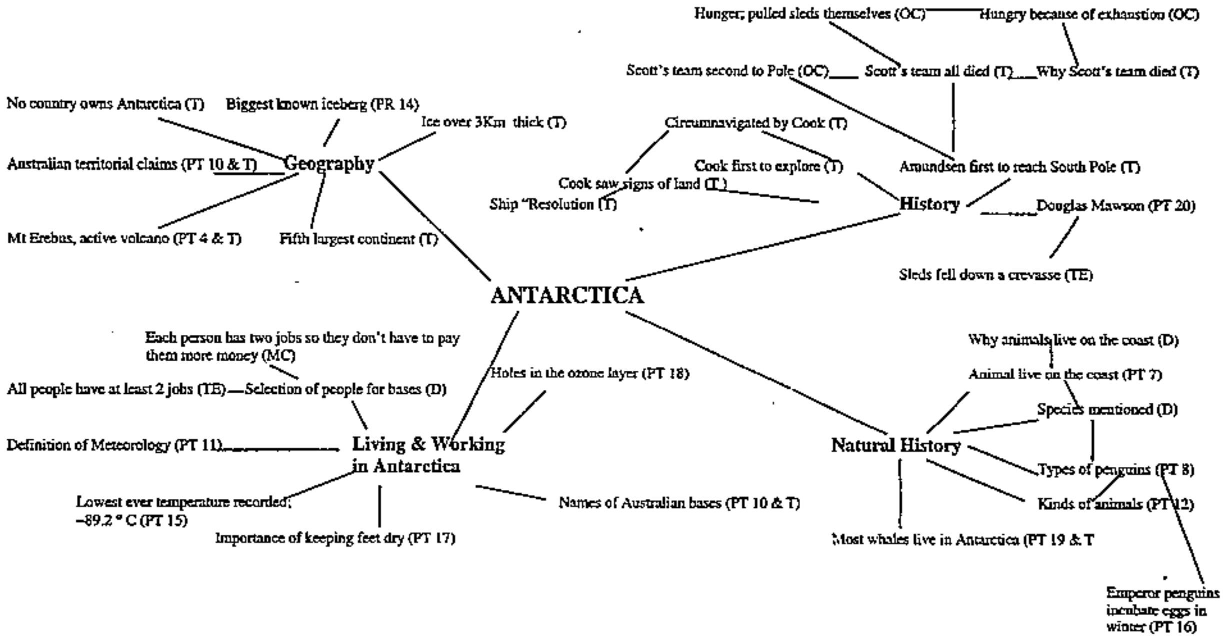
> Scott's team died because of hunger and they pulled sleds themselves. Hungry because of exhaustion.
>
> Scott's team second to Pole. Scott's team all died.
>
> Amundsen first to reach South Pole.
>
> *(David, post-lesson journal)*
>
> The first person to reach the South Pole was Roald Amundsen.
>
> The second man was Scott who also died on the way back to his ship.
>
> *(David, three-month journal)*
>
> The first person to reach the South Pole was Roald Armedson who was Norwegian. At the same time an Englishman named Scott was trying to reach the South Pole. On the return journey he died along with his party.
>
> *(David, twelve-month journal)*

Figure 21: David's Pre-Lesson Concept Map



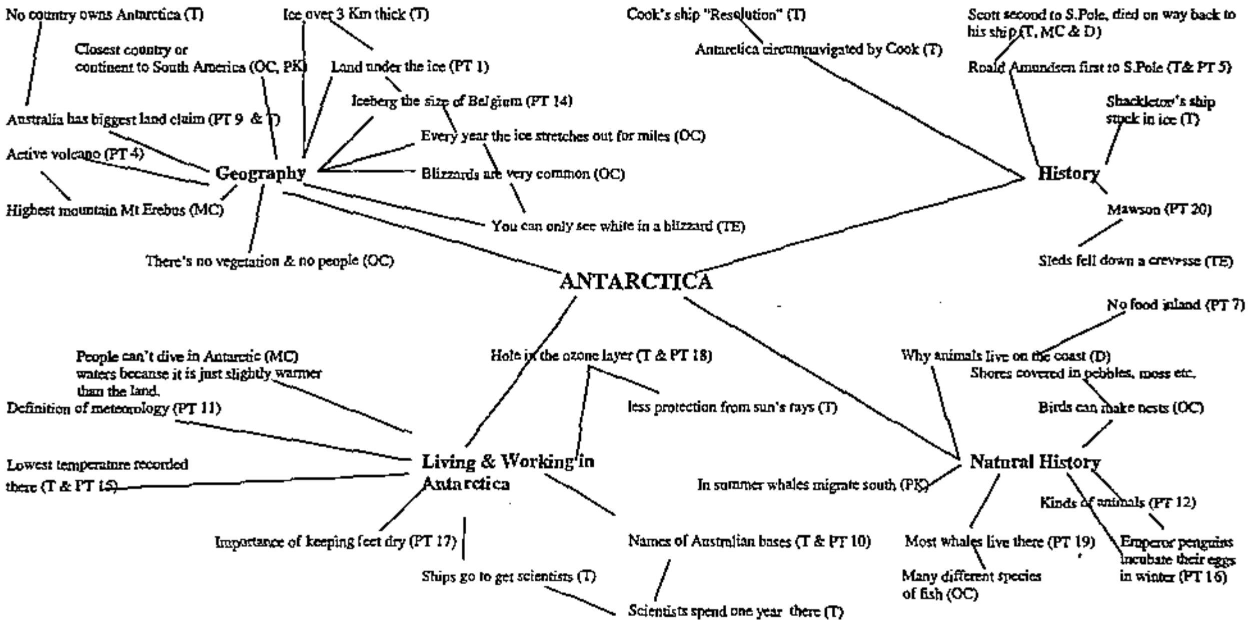
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 22: David's Post-Lesson Concept Map



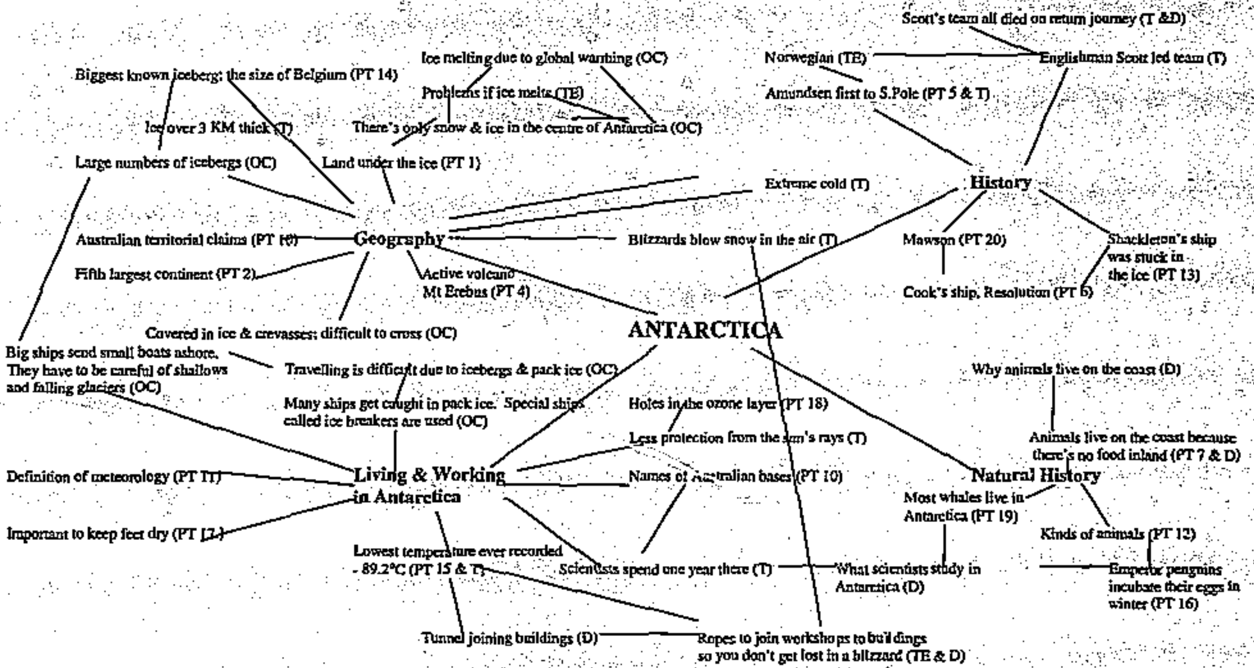
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 23: David's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 24: David's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Paul

The first analysis of the journal data indicated that Paul seemed to gain less from the cooperative experience than the other group members. Most of his learning journal responses were from the lesson text category (Table 17) suggesting that Paul had learned better directly from the instructional materials.

TABLE 17

Distribution of journal codes and test scores

Group A 2-Paul

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	7	8		1	1	17
Test scores (%)	45		95	95	75	
Text		12	12	11	8	43
Discussion		4	7	1	2	14
Own constructions		4	2		1	7
Mis-constructions	1	4	1	3	8	17
Teacher effects		2	1	3	1	7
Affective statements						

*includes three journal entries

His mid-lesson, post-lesson and three-month journals included several statements derived from discussion but direct links to these diminished over the long-term. Like Rianne, Paul produced high levels of mis-constructions at the twelve-month learning journal but provided only one own construction. Table 17 indicates a student who, though seeming to be actively engaged in discussion (see Table 13), appeared to learn best directly from text.

Further analysis was conducted in order to find if the discussion influences on Paul had evolved into mis-constructions in the long term. An example of this was found in the group's elaborated discussion on the causes of death of Scott's party. Paul seemed to relate this notion to his prior knowledge "lots of people die in Antarctica" (Figure 25) to eventually produce "a lot of people die trying to reach the South Pole" (Figure 28). In the intervening journals, Paul made several references to the Scott/Amundsen expeditions.

> Scott's team died because they pulled the sleds themselves.
>
> Scott's team was second.
>
> Amundsen first to reach South Pole.
>
> Amundsen reached the Pole December, 1911; Scott; January, 1912.
>
> *(Paul, post-lesson journal)*
>
> All Scott's men died.
>
> Scott's team did not use dog sleds.
>
> Scott's team reached the Pole second in 1912.
>
> Amundsen first to Pole in 1911.
>
> Amundsen was Norwegian.
>
> *(Paul, three-month journal)*

The influence of discussion on Paul's long term outcomes appeared inconsistent. In discussions about species of animals found in Antarctica (lesson 4, Appendix J) MAKITAB analysis indicated that the group did not engage in elaborated discussion, preferring to routinely answer the question. This discussion seemed to limit Paul's journal responses to "One type of whale is called the Humpback" and "Some penguins are the adelie, emperor and gentoo" at the post-lesson journal and "Penguins are one of the few species inhabiting Antarctica" at twelve-months.

Another inconsistent discussion influence was Paul's response to discussion about difficulties faced by Shackleton's expedition in lesson three (Appendix J). The group discussed the question briefly, Rianne stating "they camped on the ice" and at the three-month journal Paul recalled "Shackleton's men camped on the ice and watched their ship sink" but this information was not recalled later.

Paul's "cold place" concept development was revealed by all journals (Figures 25-28). The idea that Antarctica was land covered with ice was repeated consistently; "Antarctica is actually land covered with snow"(Figure 25) and further information, including some prior knowledge, was added as the concept developed.

Coldest recorded temperature –89.2°C. Coldest in space -289°C.

Antarctica has below freezing temperatures.

(Paul, post-lesson journal)

The coldest temperature on earth was -82°C, which was recorded in Antarctica.

The ice can be over 1km deep.

(Paul, three-month journal)

Icebergs are floating around everywhere.

Antarctica slowly melting away.

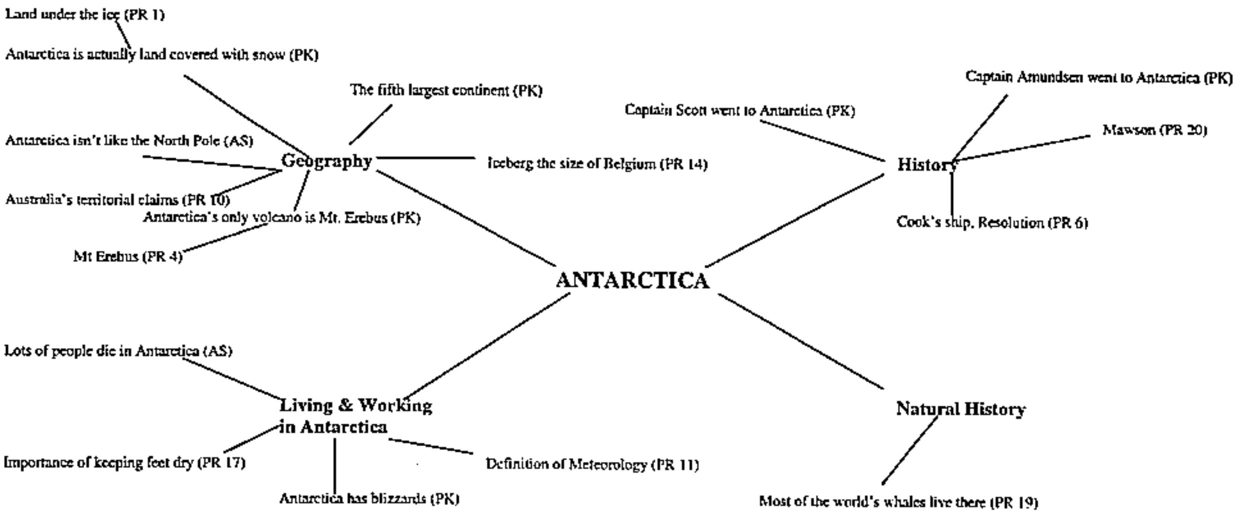
Glaciers form frequently.

(Paul, twelve-month journal)

Paul also demonstrated that he could recall pieces of information that seemed unrelated to broader concepts. His prior knowledge that Antarctica was the fifth largest continent was reported in all journals (Figures 25-28). In his three-month journal he wrote "a peninsula in South America almost touches Antarctica" an own construction from prior knowledge that appeared again at twelve months as "one part of Antarctica nearly touches South America". David also reported this information independently at three-months (Figure 27).

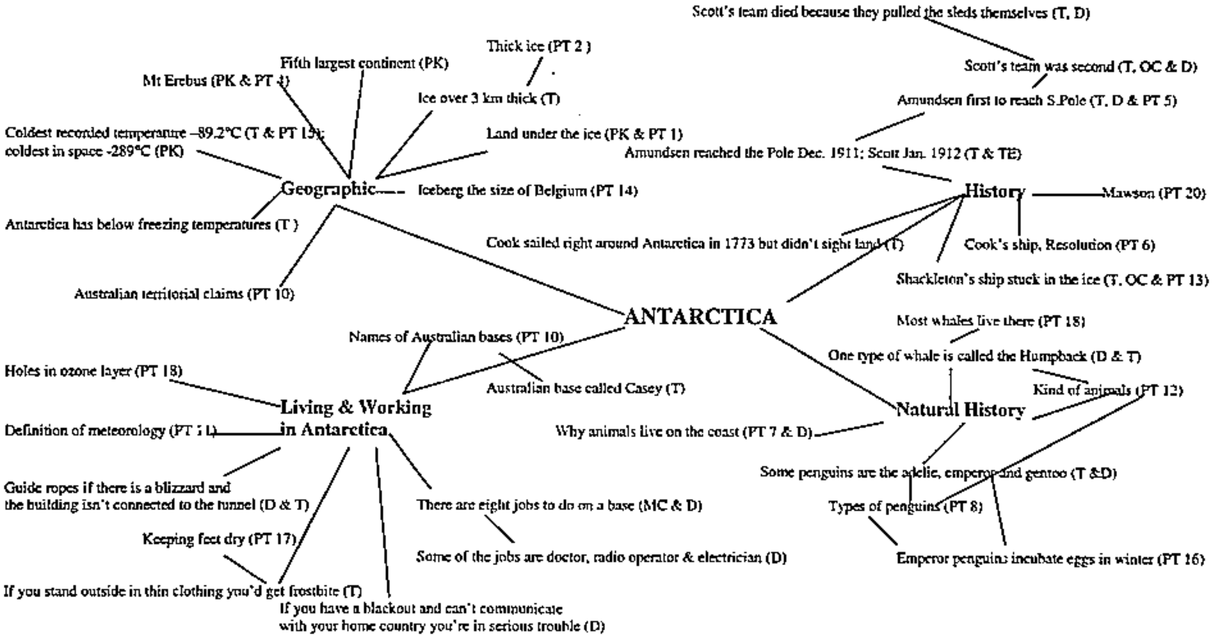
The concept maps (Figures 25-28) indicate that this student exhibited an unpredictability and an individuality in what he remembered. The mechanisms activating the students' memories appeared problematic and this seemed particularly noticeable in Paul's case.

Figure 25: Paul's Pre-Lesson Concept Map



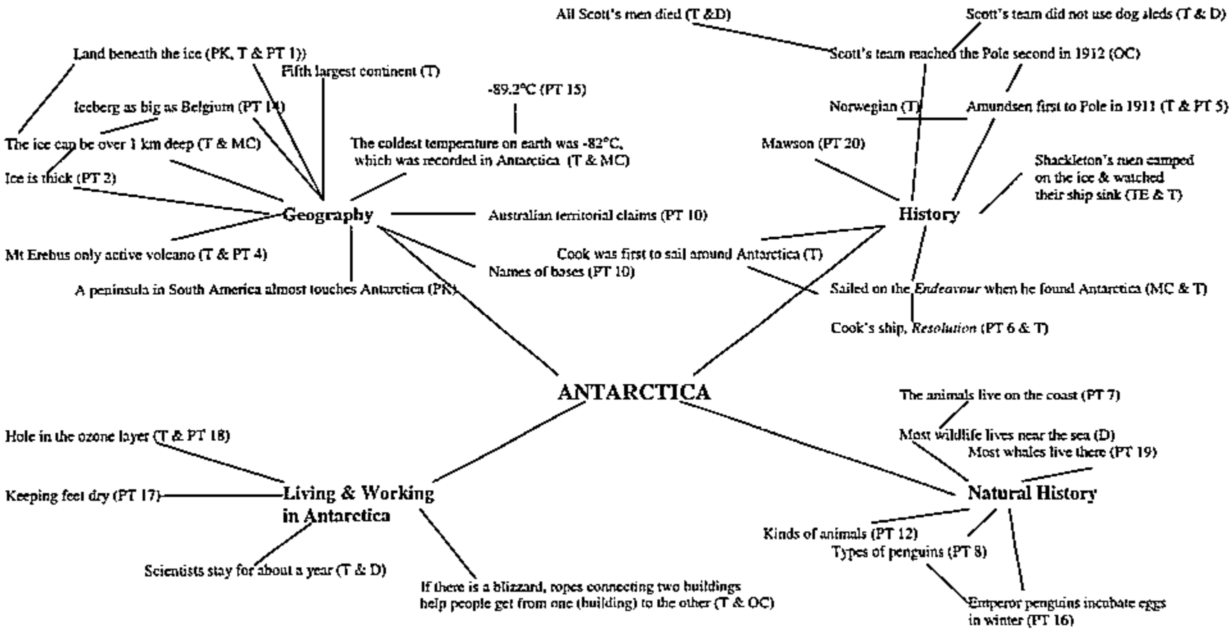
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 26: Paul's Post-Lesson Concept Map



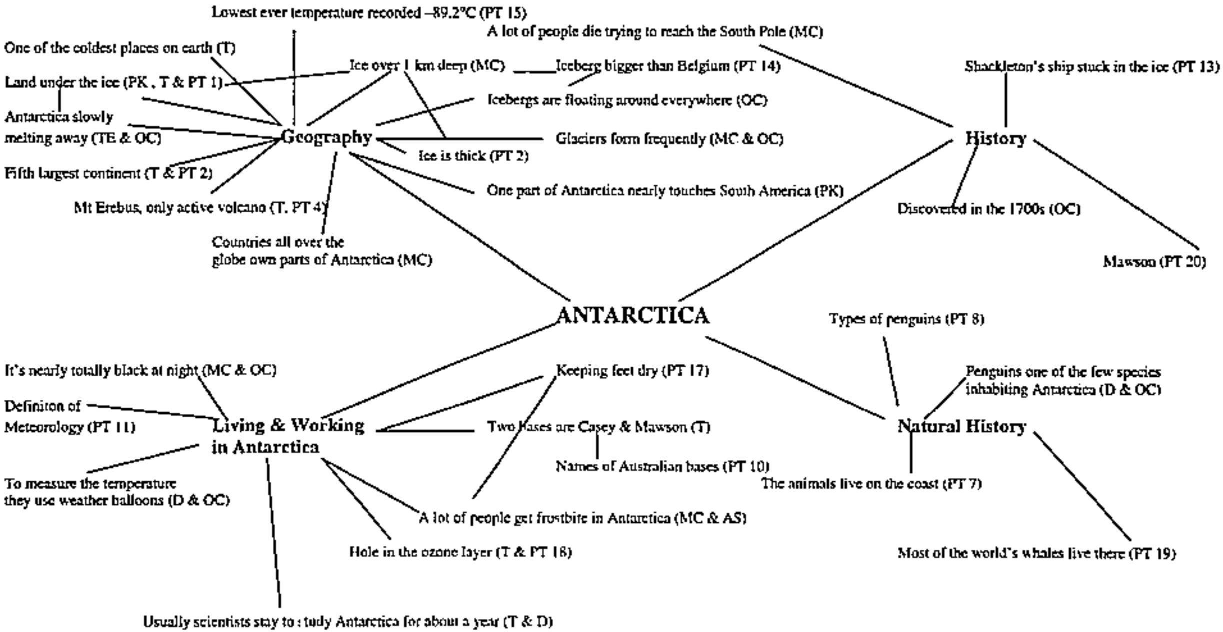
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 27: Paul's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 28: Paul's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

<u>Melanie</u>

Melanie was the group's lower achiever and she seemed to experience difficulty with accurate recall of information. Although she did not participate as actively as David, Rianne and Paul in discussion, her three-month learning journal (Figure 31) indicated an involved student.

Melanie's main contribution to the discussion was in procedural terms and some "common sense" type statements. She had already studied Antarctica the year before but she had not retained enough knowledge for her to be able to make a stronger contribution to the discussion. This was not always the case such as in one instance where Melanie was able to apply her prior knowledge of high temperatures at the equator to help clarify incorrect assertions being made by the other group members. The group was discussing the thickness of the ice question and had become side-tracked onto an irrelevant line of thought.

Paul:	Well when it gets further down into the earth it gets hotter...
Melanie:	Yeah cos it's closer to the equator...
Paul:	...no it doesn't.
David:	You can't get closer to the equator...it has to go right through Australia and past all those countries to get to the equator.

Her mid-lesson learning journals (Table 18) included a high proportion of discussion category entries but these tended to dissipate and a pattern emerged of increasing mis-constructions over time. Melanie demonstrated good recall at three-months but after twelve months her test scores and journal indicated she could recall relatively little.

TABLE 18

Distribution of journal codes and test scores

Group A 2-Melanie

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	5					5
Test scores (%)	30		65	50	35	
Text		6	1	4	3	14
Discussion		7	3	1	3	14
Own constructions						
Mis-constructions		8	1	11	3	23
Teacher effects		1				1
Affective statements						

*includes three journals

Discussion appeared to benefit Melanie. An example of this was the group's discussion about Scott's team and their use of sled dogs, which seemed to have a strong influence on Melanie's three-month journal. At the post-lesson journal she wrote, "Scott's team did not use dogs or ponies because they thought it was cruel" and this idea was expanded at three-months into a rich array of mainly mis-constructed journal entries. These are re-produced verbatim below.

> Most of Scott's team died because they thought it was cruel to make the husky dogs pull the sleigh so they pulled the sleigh themselves. The other team thought it would not hurt the husky dogs so they used them. On the way they ran out of food and ate them so they died. Finally, Scott's team were last to Antarctica. Even though the other teams killed the dogs they were still first there because they used dogs half way there.

(Melanie, three-month journal)

Melanie continued with two further references to explorers but any reference to the history category was not recalled at twelve months (Figure 32).

Three explorers, Cook, Scott & Amundsen.

Cook & Amundsen used dogs.

(Melanie, three-month journal)

This student had prior knowledge that tourists went to Antarctica (Figure 29). Discussion about the role of scientists seemed to be merged with this concept to create a focus on the measurement of temperature. These concepts may have been related to her general concept of the "cold place" and that scientists spend one year in Antarctica.

Tourists go there to figure out information about what degrees it is.

They take pictures and bring them back for proof.

(Melanie, pre-lesson journal)

Curiously, Melanie used the term, "temperature" correctly at the three-month journal but returned to "what degrees it is" at twelve-months.

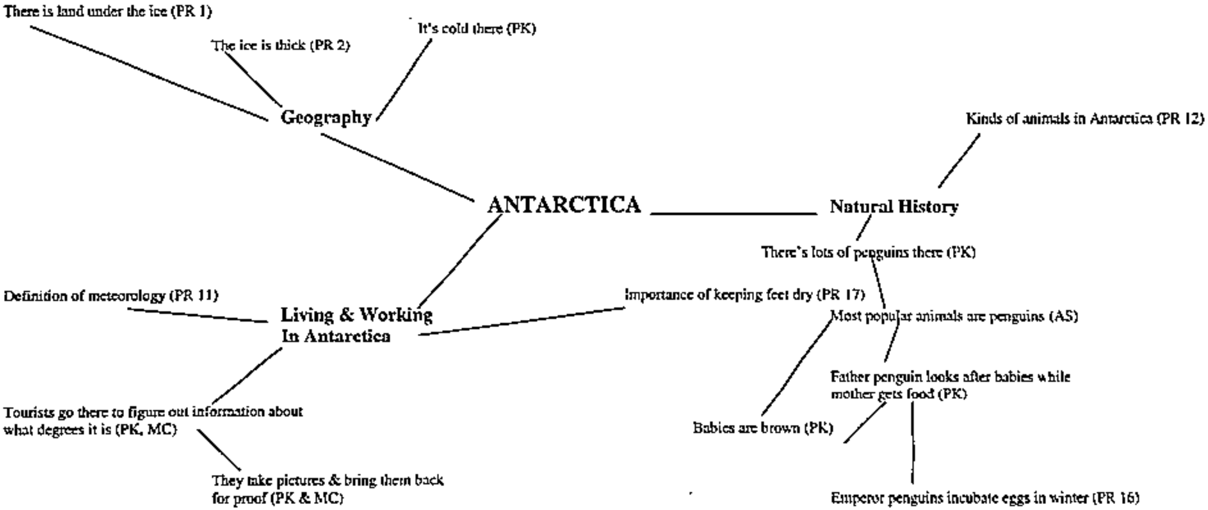
Scientists go there to investigate blizzards and what degrees it is.

(Melanie, twelve-month journal)

A link from prior knowledge through all journals was found with Melanie's writings about penguins (Figure 29). References to penguins persisted in all journals (Figures 30-32) until the final entry, "Some of the animals there are penguins, polar bears and different types of birds".

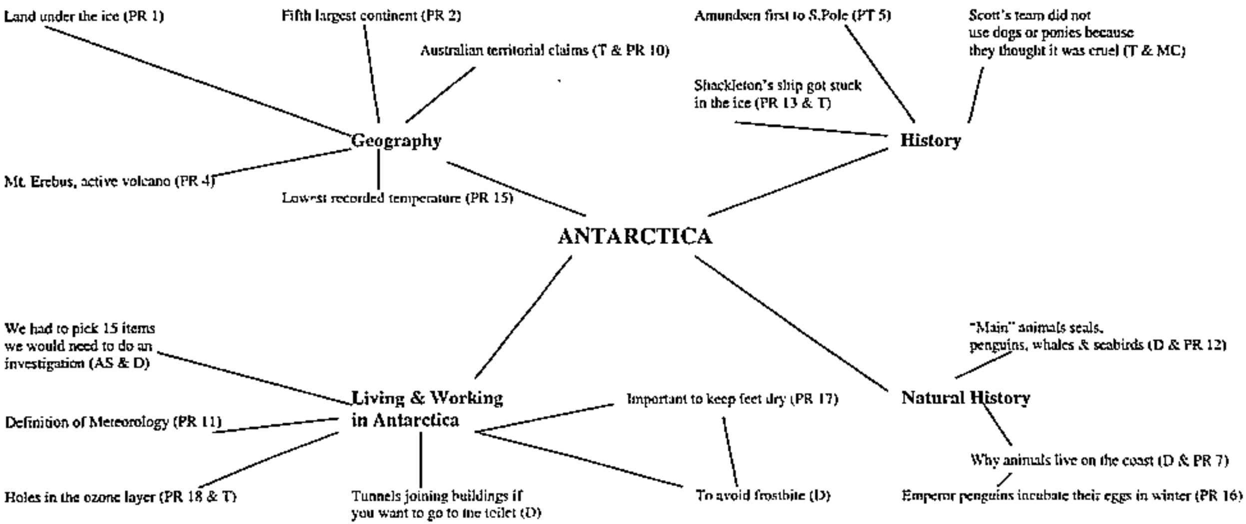
An examination of Melanie's concept maps in the following pages (Figures 29-32) indicates a student who represented her knowledge using an individual turn of phrase. Her medium term (three-month) recall appeared strong but she seemed to experience difficulty in the long term.

Figure 29: Melanie's Pre-Lesson Concept Map



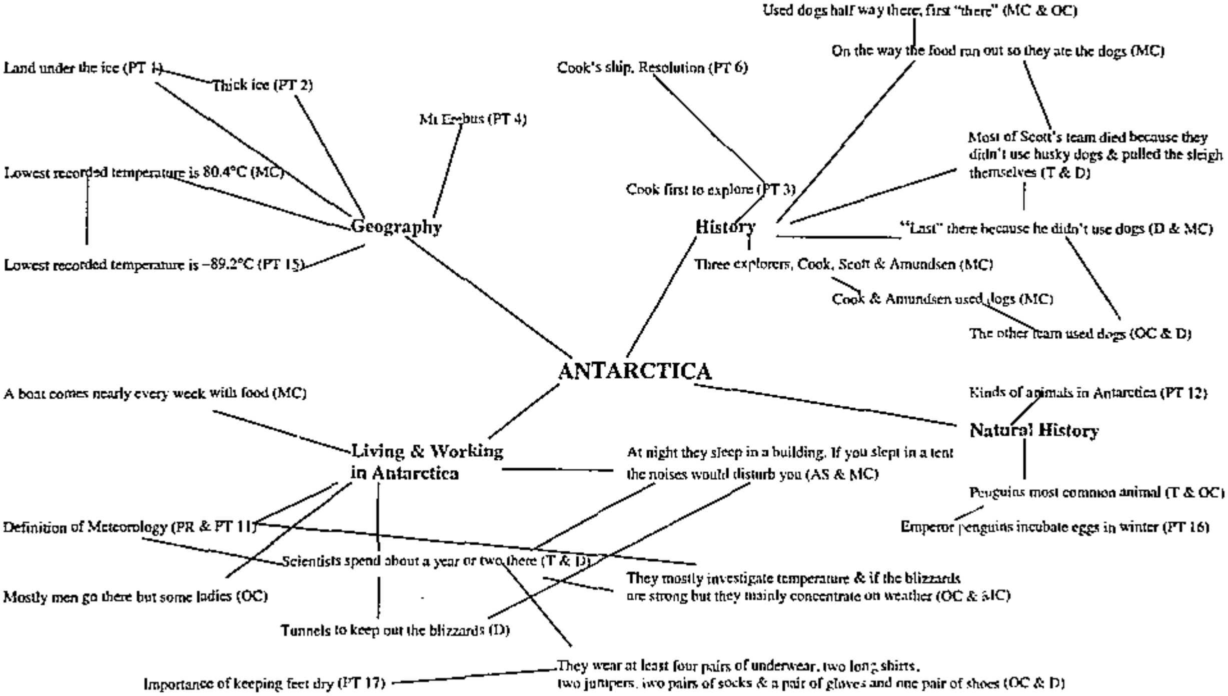
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 30: Melanie's Post-Lesson Concept Map



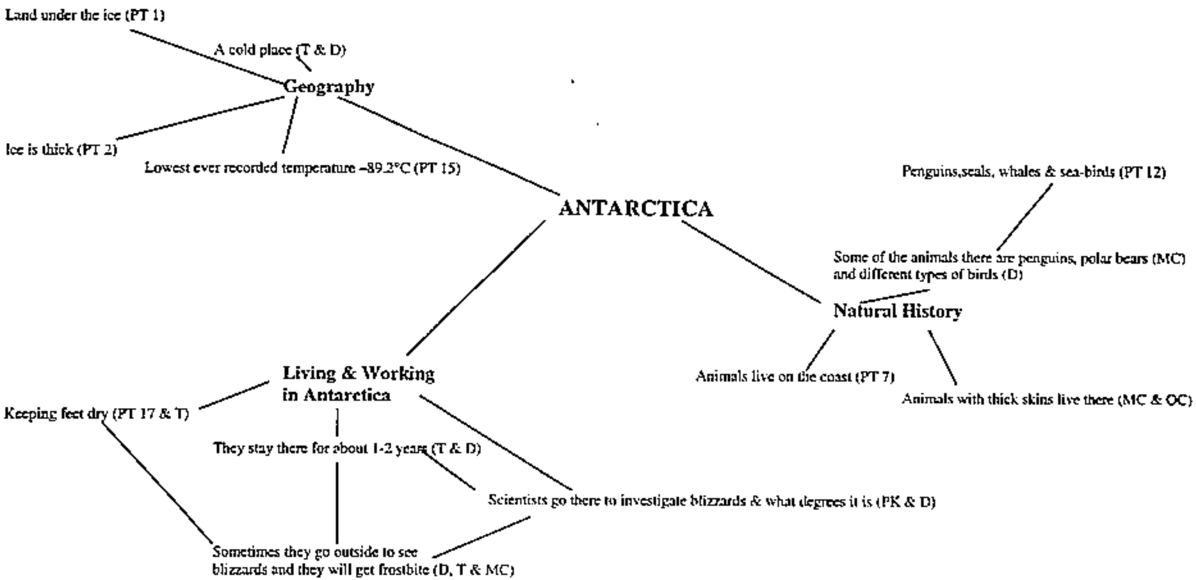
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 31: Melanie's Three-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 32: Melanie's Twelve-Month Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Knowledge and concept development within the group

As was described above, this group worked effectively together and all members benefited to varying degrees from the group experience. Table 19 indicates a group that engaged in generally high levels of task enhancing talk (TS08-TS11, 77.6% overall), with particularly high levels of MAKITAB code TS11 (44.3%).

TABLE 19

GROUP A2

MAKITAB ANALYSIS ON TASK TALK (TS CODES ONLY)

Codes	*lesson 1*	*lesson 2*	*lesson 3*	*lesson 4*	*lesson 5*	*Total statements*	*%*
TS01			1			1	0.1
TS02	11	8	3	9	2	33	4.6
TS05				3	1	4	0.5
TS06							
TS07							
TS08	15	12	4	40	54	125	17.4
TS09	7	6	6	2	9	30	4.2
TS10	17	19	22	19	7	84	11.7
TS11	81	44	65	34	95	319	44.3
TS12	1	2		6	4	13	1.8
TS13		1		16	2	19	2.6
TS14	3	3	5	27	3	41	5.7
TS15	3		16		6	25	3.5
TS16		13		12	1	26	3.6
Lesson Totals	138	108	122	168	184		

These students, particularly David and Paul, appeared inquisitive about the subject matter and were more prepared than the other participating groups to "tease out" their ideas through talk. Apart from the prominence of the TS11 code, simply the amount of talk produced in this group indicated students who were willing to discuss questions at length. As was described above, this tendency was due largely to David's influence. The group also tended to be inclusive of all members. Although David and to a lesser extent Paul, tended to lead the discussion, all members were listened to at various times. Lesson four tended to elicit routine responses in all groups due to the nature of the discussion questions but group A2 still produced almost the same amount of TS11 as TS08 talk (Appendices I & J). These students were able to apply their knowledge to address the open-ended questions in lessons four and five. In lesson five in particular, they engaged in lengthy debate about the relative merits of the various candidates for the Antarctic expedition.

Several influences of discussion on long term learning among the group have already been described in the individual case studies above but a particularly informative discussion was the one about the Scott expedition. The group became involved in an in-depth discussion about the "dogs" issue. Similarly to group A1, this group had read some incorrect information about Scott's team being forced to eat their sled dogs. This became a focus of some of their discussion in lesson three. The following extended exchange provides insights into a group grappling with their prior knowledge and new material.

David: Or maybe because they had ran out of...Scott's team might have ran out of supplies because they were doing more work...

Paul:	...or Scott's team could have like landed on an outer part *(of Antarctica)* and they walked further and used up more supplies...
David:	...or they ran out of supplies but this is really what they
Rianne:	Scott *(indistinct).*
David:	They could have ran out of supplies and had to eat their dogs and the dogs might have had a disease.
Rianne:	It said Scott's team reached the Pole later and they all died. They had tried to pull the sleds themselves.
Paul:	Yeah cos they ate the dogs.
David:	And um the dogs had a disease and um it might have if they didn't do it themselves then they might have let the dogs pull it and then they might not the disease might not have spread.
Paul:	They might have had to eat the dogs on the way to the Pole.
David:	Yeah but if there was a blizzard they couldn't...Amundsen's team got um caught in a blizzard as well.
Rianne:	Yeah but maybe Amundsen's team was already there and they *(Scott's team)* were still walking...
David:	...or maybe Amundsen's team came in from another direction (*builds on Paul's idea from earlier*).
Paul:	They probably did cos that's why Scott's team died. They took longer to walk to the Pole...maybe.

Journal depictions of these events were particularly rich at three-months and still appeared in some form for all students except Melanie at twelve months. In Paul these representations could be traced back to his prior knowledge (Figure 25).

A general concept that people lived and worked in Antarctica was evident in three students (David, Melanie & Rianne) from the pre-lesson to the final journal. Some of the talk in lesson one, two and three centred around the kinds things scientists do in Antarctica. The group explored these ideas effectively and later they were represented variously by the students.

> Ships go to get scientists.
>
> *(David, three-month journal)*
>
> Scientists go there to investigate blizzards & what degrees it is.
>
> *(Melanie, twelve-month journal)*
>
> To measure the temperature they use weather balloons.
>
> *(Paul, twelve-month journal)*
>
> Scientists take pictures of things.
>
> Scientists go there for a year or two.
>
> *(Rianne, three-month journal)*

The journals also included references to related ideas such as tunnels connecting buildings, the presence of bases and the various support roles at the bases. The influence of discussion and links to prior knowledge were very evident in this instance. Concepts about wildlife in general and penguins in particular were also tracked from prior knowledge to the lesson texts, through discussion and into student representations in their journals.

Some of this group's discussion provided evidence of how confusion could be created by incorrect prior knowledge in conjunction with incorrect or irrelevant assertions. In this example from lesson one, note how the students explored ideas with their talk. They returned to the "ice is thick" discussion later and managed to provide a satisfactory explanation.

Rianne: What do you think, how do you think the ice gets so thick?

Paul: The ice is so thick because the water freezers up. That's what you wrote!

David: Well if it freezes so much why doesn't it freeze the whole world.

Rianne: Because... *(thinking)*

Paul: Well when it gets further down into the earth it gets hotter.

Melanie: Yeah cos its gets closer to the equator.

Paul: No it doesn't.

David: You can't get closer to the equator It has to go right across Aust. and past all those countries to get to the equator.

Paul: And past Indonesia.

Rianne: Past...

Melanie: Yeah but it gets hotter than down there *(indistinct)*

David: Well it can't go...

Paul: Africa

David: It can't go past um well it can't go too far around towards the bottom because if it does it will get burnt up by the core of the earth. So it can only go down for a certain distance.

Paul: So it would only freeze until it gets hotter cos then if it freezes again it will melt.

Despite the apparent confusion, the group setting allowed the students the opportunity to use talk to organize their thoughts. As was described above, David in particular was intrigued by this question and evidence existed that these discussions benefited his long-term learning.

This group operated successfully as a cooperative unit. They completed the required tasks and demonstrated long-term academic gains to varying degrees. David appeared to gain most from the discussion and this seemed to correlate to the effort he applied, particularly in his willingness to discuss questions at length. Despite being the most passive group member, Melanie also gained from the cooperative interactions of the group, exceeding expectations at three-months. Rianne and David also displayed rich conceptual development over time, some of which could be traced to their cooperative discussions.

5.5. Case study 3 (group B 1, school B)

Profile

This group consisted of two female and two male students, Cara, Kirsten, Aiden and Alan. All students were in year three (aged eight years) at the commencement of the study. According to teacher statements and observation, Cara and Aiden were middle achievers. Aiden tended to become talkative in class at inappropriate times. Kirsten was a low achiever, who lacked self-confidence at academic tasks. Alan was a middle achiever who was very popular with his classmates. The study teachers attributed his popularity to Alan's skills in social negotiation rather than to academic status.

Group processes in the discussion

In the absence of Alan in lesson one, Aiden tended to assume a dominant role in the group (see Table 20) making 48% of all statements. He became more passive when Alan returned for the second lesson. Alan was from then on responsible for creating the group "culture". Partly under Alan's influence, the group became more oriented to task completion and staying on task as the lessons progressed. Table 20 indicates the extent of each students' contribution to the discussion.

TABLE 20

Group B 1 Summary of task related statements made in group discussion (all lessons)

Student name	*Total on-task statements(total off-task statements)*	*% on-task (% off-task)*
Aiden	128 (259)	25.54 (46.44)
Cara	141 (198)	28.26 (35.23)
Kirsten	55 (54)	11.01 (9.6)
Alan	180* (49)	35.93 (8.7)

*(lessons 2-5 only)

MAKITAB analyses revealed that the emphasis on finishing the task seemed to inhibit quality discussion in this group. Alan tended to control the group worksheet and read aloud the questions for the group. He sometimes led the group in a reviewing process for each answer (MAKITAB code TS15, see Appendix I) although this had not been delineated by the researcher. Much of this group's talk revolved around presentation of the answers to the worksheet questions and less negotiating, arguing and reacting to other students' ideas.

Aiden seemed to propose any answer without much thought. When the group, particularly Alan, overlooked his thoughts, he tended to go off task. Table 20 indicates the high proportion of off task statements made by Aiden. Cara made attempts to be actively involved in the discussion but as the lessons progressed, her contributions were ignored by Alan and became ineffectual. The groups' talk became more on-task and effective by lessons four and five but MAKITAB analyses revealed that most of the talk was directed towards task completion and less towards thorough exploration of the questions.

Training in giving help, seeking help and group roles seemed ineffective for this group. This was most apparent in the group's treatment of Kirsten who was generally ignored or coerced into a passive role (Table 20). Kirsten's regular pattern of low classroom participation was repeated in the cooperative learning settings.

The overall task related and non-task related talk for this group (Table 21) indicates a group that spent most of their time off task. Hence the segregation of Table 20 into task related and non-task related talk. Evidence of dis-harmony existed when Alan made statements like "...I would like to work by myself, than with you" to entice his peers to follow his lead. Despite these difficulties, the group generally functioned well enough to complete tasks but this was only when they were following Alan's lead.

TABLE 21

Group B1 task related and non-task related talk

Lesson number (total statements)	*Task related talk (%)*	*Non-task related talk (%)*
1 (150)	32	68
2 (195)	32	68
3 (269)	36	64
4 (321)	69	31
5 (129)	67	33
Means	47.2	53.6

Group B1 individual case studies

Aiden

Aiden displayed a good prior knowledge of Antarctica in his learning journal and test scores. He reported that Antarctica was melting (Figure 33) but this was not developed further. The notion of extremely low temperatures was known before the lessons and this persisted into the final journal as a mis-construction; (Figure 36). The post-lesson journal contained several statements related to blizzards and this was also reported in the twelve-month journal.

The lowest temperature was –89.1° C; that is very cold.

Kids aren't allowed to go there because the blizzards are too strong.

When you go out in a blizzard you will go flying *(off your feet)*.

If you walk with your back facing the sky you won't go flying.

(Aiden, post-lesson journal)

Antarctica is cold; its top temperature is over -40°.

Blizzards are very strong so don't try running out of the house when one is on.

(Aiden, twelve-month journal)

Other knowledge relating to why animals live on the coast, the definition of meteorology and Shackleton's ship becoming stuck in the ice was recalled via the post-tests. Aiden's knowledge about Cook's voyage was evident consistently in journal and test data.

Aiden seemed to link various related concepts together. In the post-lesson journal he recalled that Mt Erebus is an active volcano in Antarctica. This was again recalled in the three-month journal but by the time of the twelve-month journal, the volcano had become Mt Cook. Aiden seemed to have linked his recall of Cook in Antarctica to the active volcano concept to produce a mis-construction.

TABLE 22

Distribution of journal codes and test scores

Group B 1-Aiden

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	5	1		1		7
Test scores (%)	45		70	70	40	
Text		10	4	3	6	23
Discussion		2	1	2	1	6
Own constructions		3	2	2	2	9
Mis-constructions	2	6	3	2	4	17
Teacher effects		2	1	2	2	7
Affective statements						

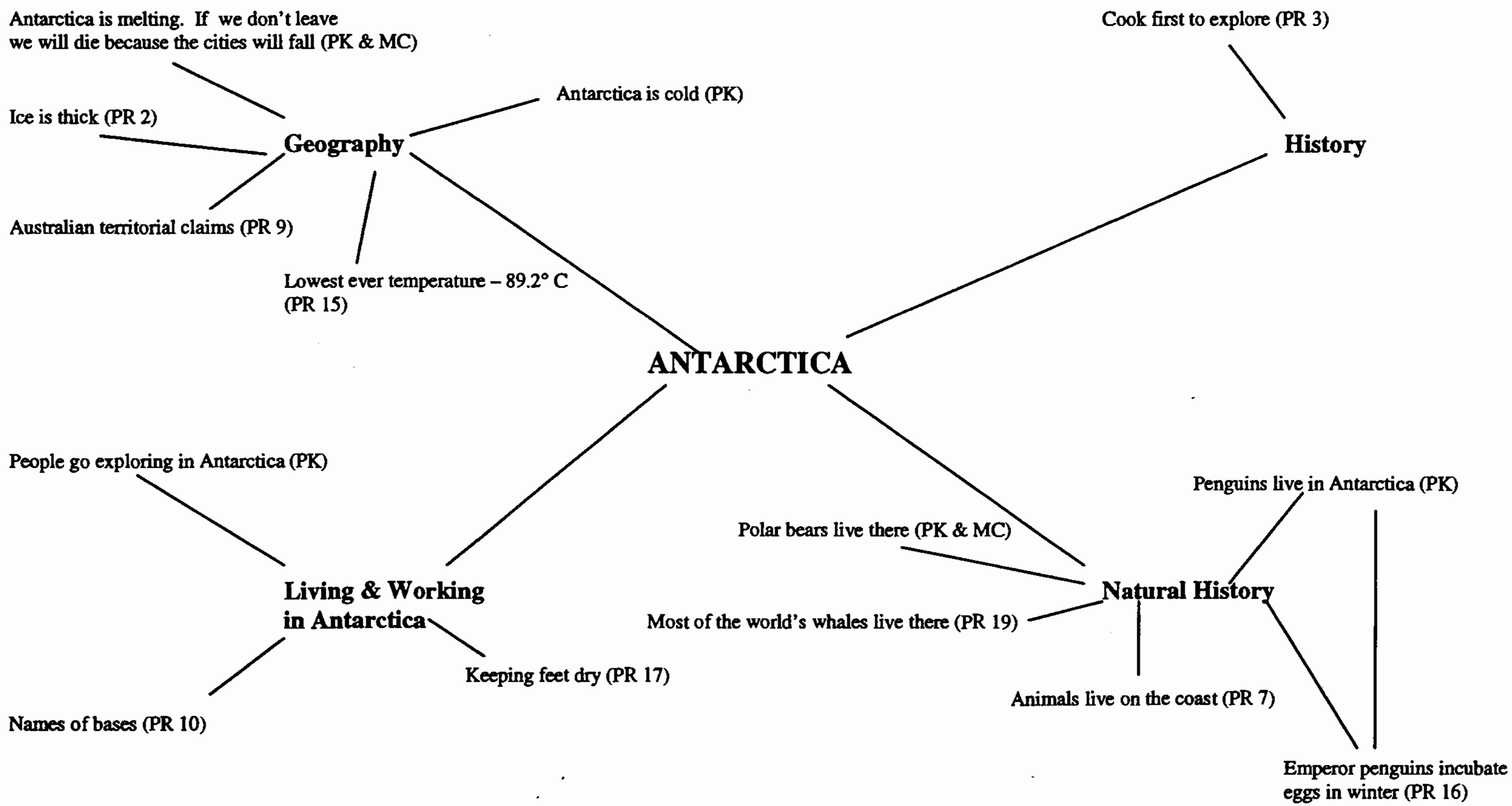
*includes three journal entries

Aiden repeated a pattern of producing new own constructions and mis-constructions. Table 22 indicates that he seemed to learn well from text. His mental representations of information and concepts were continuing to change. Aiden's twelve-month journal included increasingly sophisticated concepts that seemed to have developed over time. These related to the difficulty of living in Antarctica "...nobody permanently lives there for it is too cold for any lifestyle except for whales and penguins" and to territorial claims in Antarctica "...no country owns Antarctica but each country has a part of it".

The importance of teacher intervention was apparent in Aiden's data through the common mis-conception held by School B students that polar bears live in Antarctica. He stated that "polar bears live there" in his pre-lesson journal and this was not mentioned again until the twelve-month journal where he corrected his mis-conception following a timely whole class teacher intervention in lesson three. By twelve months, his knowledge had expanded to the extent that " polar bears live in the Arctic, not the Antarctic".

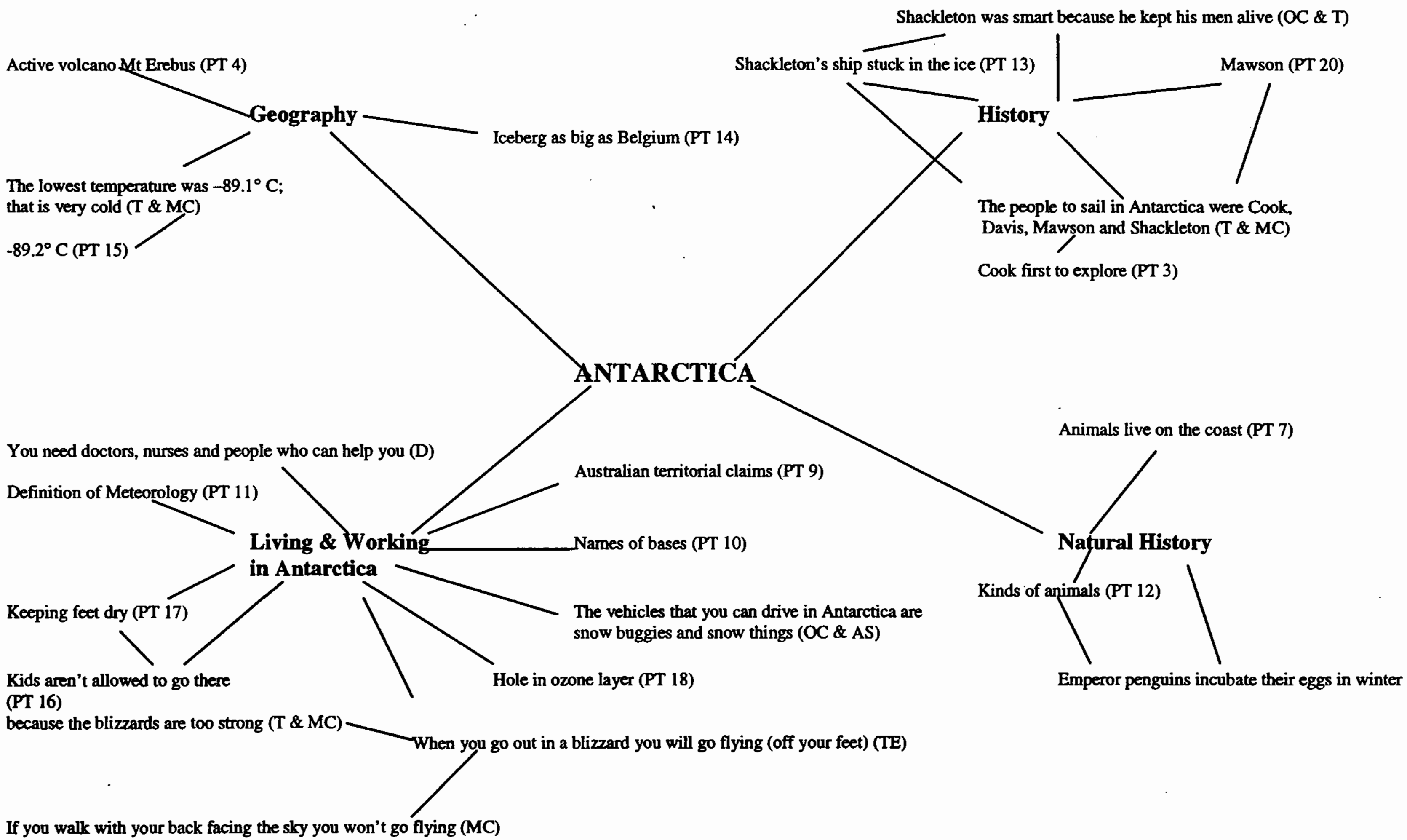
Aiden's concept maps (Figures 33-36) suggest a student who had gained from the cooperative setting of the lessons, despite high rates of off task talk and a prevalence of text related recall. Although he often made off task statements, evidence was found where Aiden appeared to benefit from the group's talk. An example of this was the influence the group's blizzard discussion (see next case study, Cara) seemed to have on Aiden's journal writings. He referred to blizzards in each journal after the lessons were completed and notions about buildings and the difficulty walking in a blizzard persisted.

Figure 33: Aiden's Pre-Lesson Concept Map



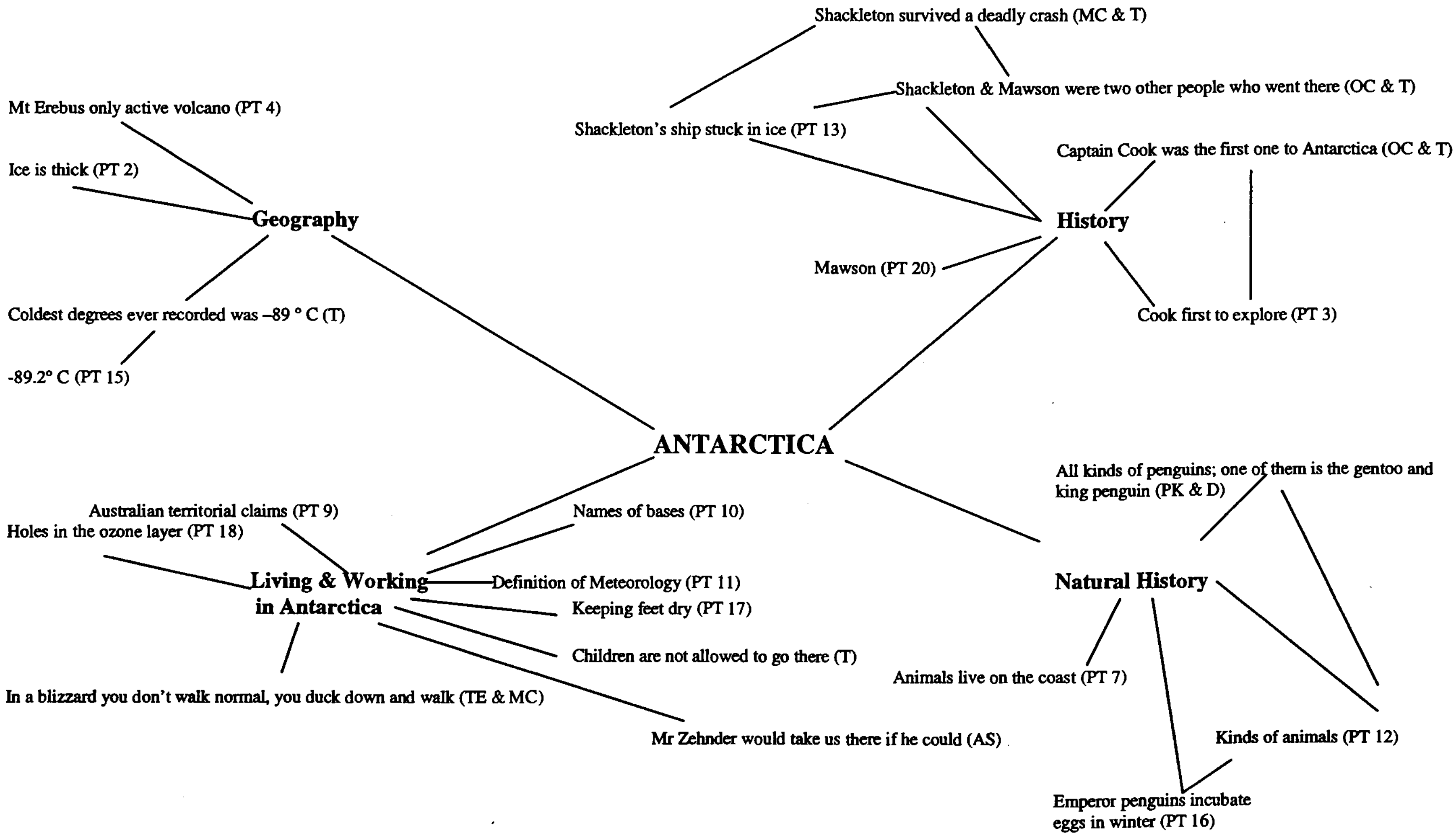
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 34: Aiden's Post-Lesson Concept Map



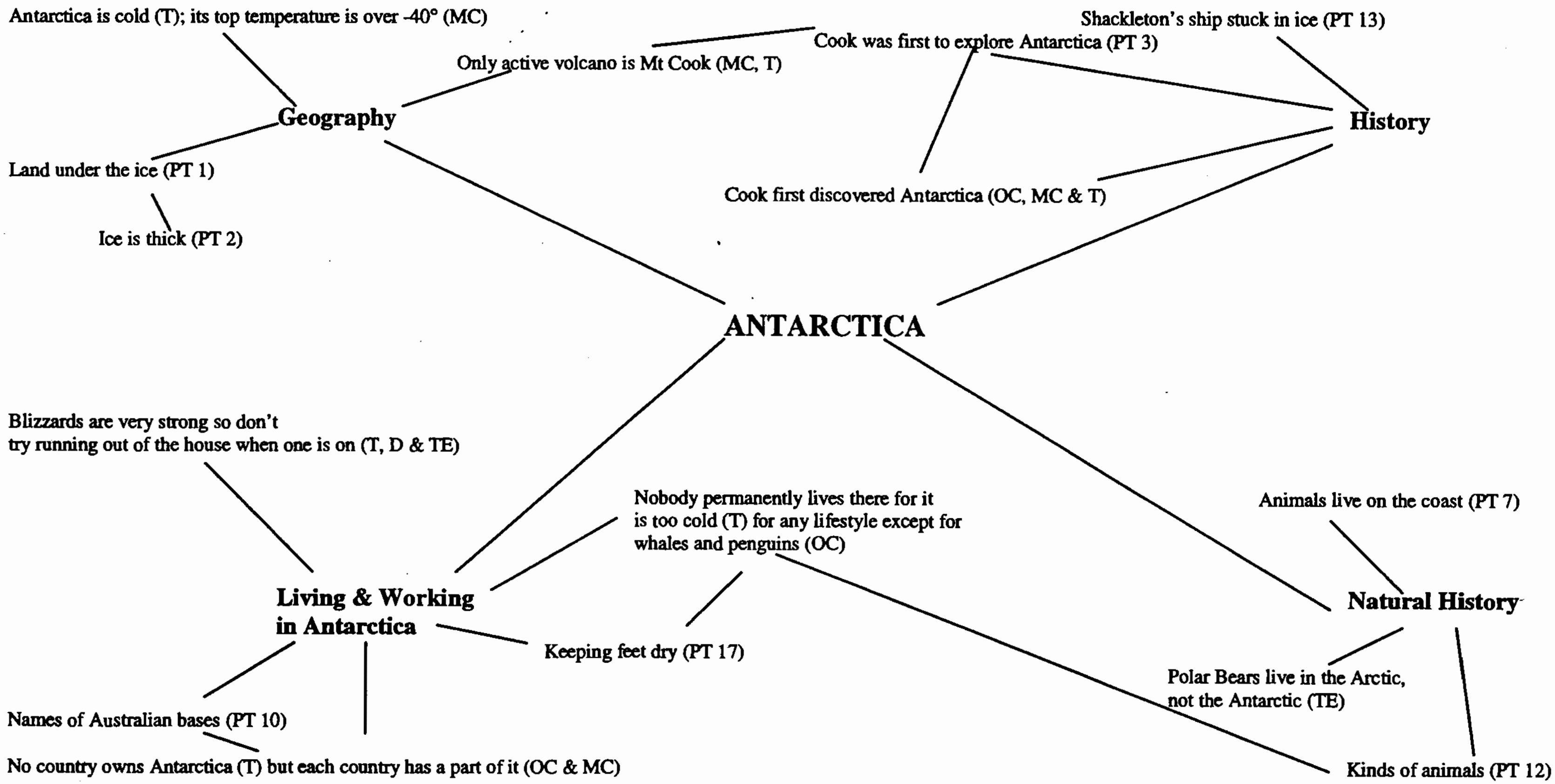
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 35: Aiden's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 36: Aiden's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Cara

Cara had some general concepts about Antarctica before the lessons, particularly the concept that Antarctica was a cold place. However, her test scores indicated she had some difficulty retaining information about the topic (see Table 23).

TABLE 23

Distribution of journal codes and test scores

Group B 1-Cara

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	4					4
Test scores (%)	30		65	40	30	
Text		8	1	5	5	19
Discussion		4	1	3		8
Own constructions						
Mis-constructions	2	3		1	3	9
Teacher effects		1	2	1		
Affective statements	1	1				2

*includes three journal entries

Cara's recall was mostly derived from lesson text. There also existed a mis-conception that Antarctica was at the North Pole but this was not repeated after the first journal. Statements like " a blizzard is as strong as a school building" were linked directly to discussion.

Aiden: Because a blizzard is a storm that can actually blow a:.. an elephant away and sixty people away at once.

Cara: No you mean a whole school away... a whole school away.

Kirsten:	More than a whole school actually.
Cara:	A school and an elephant probably.
Aiden:	OK give me a reason.
Kirsten:	Probably about two schools.
Cara:	Now here's the reason, now here's the reason.

A few moments later the discussion continued.

Aiden:	A blizzard storm can actually blow away a whole classroom with people inside at once.
Cara:	You mean a whole school?
Aiden:	I meant a whole school.

This discussion seemed to have a substantial impact on Cara's recall, at least immediately upon completion of the lessons. She wrote the following discussion-inspired statement linking school buildings and blizzards. This entry took the form of a mini-essay and included its own heading, an uncharacteristic form of writing in Cara's journals.

> *Antarctica Winds.*
>
> A blizzard is strong as a school building including the children. A very strong wind is called a blizzard. If you don't walk the right way in a blizzard the blizzard will pick you up and push you against something sharp and could kill you. In Antarctica there are all kinds of storms and winds.

Sometimes winds can be very dangerous so if you ever do see a strong wind in Antarctica try to get back inside because it could damage you or it might kill you so watch out.

(Cara, post-lesson journal)

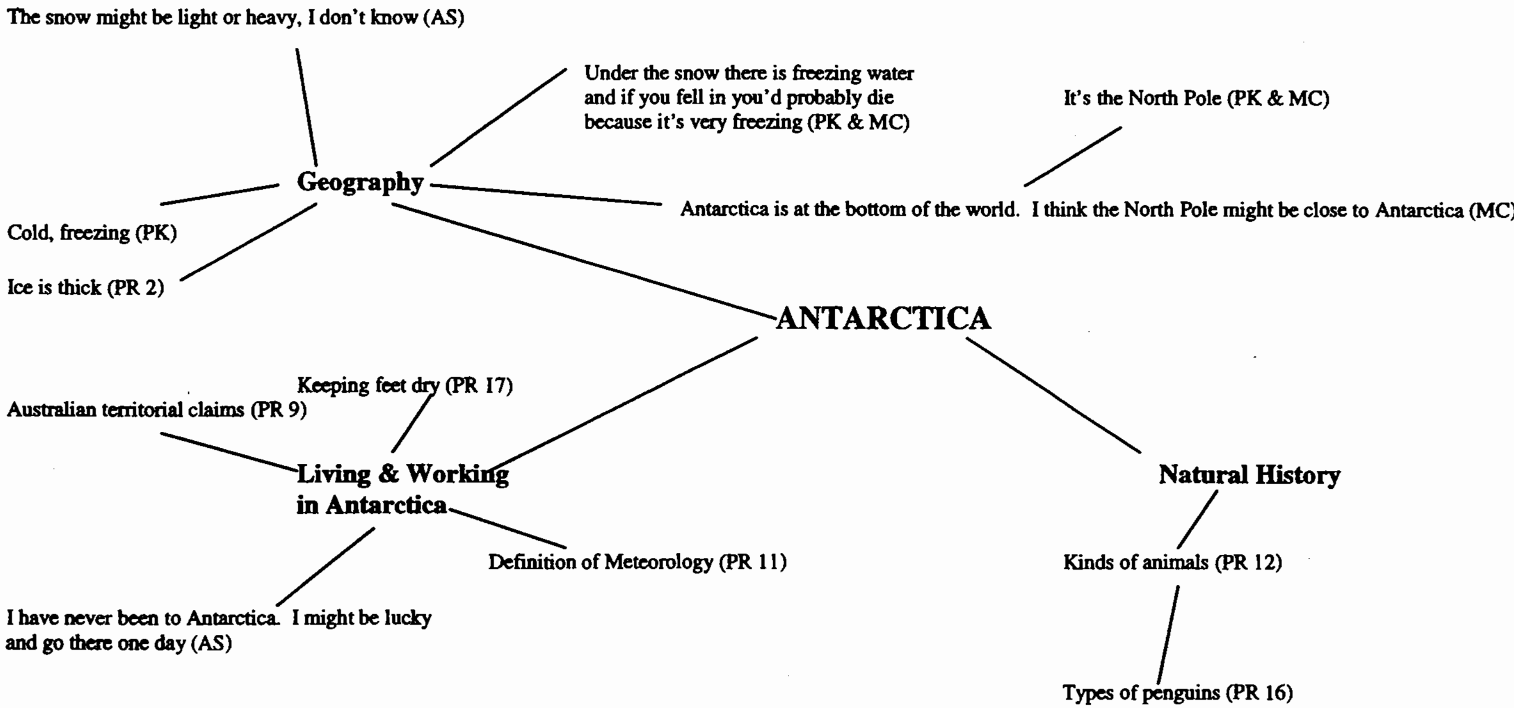
Despite the attention given to blizzards in this journal entry, the blizzard concept was not repeated at the three and twelve-month journal. Cara did report related concepts such as risk of frostbite, tunnels connecting buildings and the use of special clothing, "you have to wear special clothing like boots, clothes and special hat. You wear special gloves" but blizzards were not mentioned explicitly. Cara's mental representations of material seemed to continue to evolve as in the "special clothing" example. At twelve months, the clothing concept had been linked to frostbite, " if you go there in normal clothes you will get frostbite because you need special clothes".

Discussion seemed to influence Cara's development of concepts about James Cook. The concept that Cook had explored Antarctica appeared in the test data post-lesson and at three-months and again in the journal data at twelve months. The influence of discussion on the development of Cook concepts is described below.

Cara also provided an example of mis-construction in the final journal where she described how there was a " race to Antarctica and all the Scottish people died" (Figure 40). This mis-construction was produced from discussions in lesson three relating to Scott's ill-fated expedition to the South Pole.

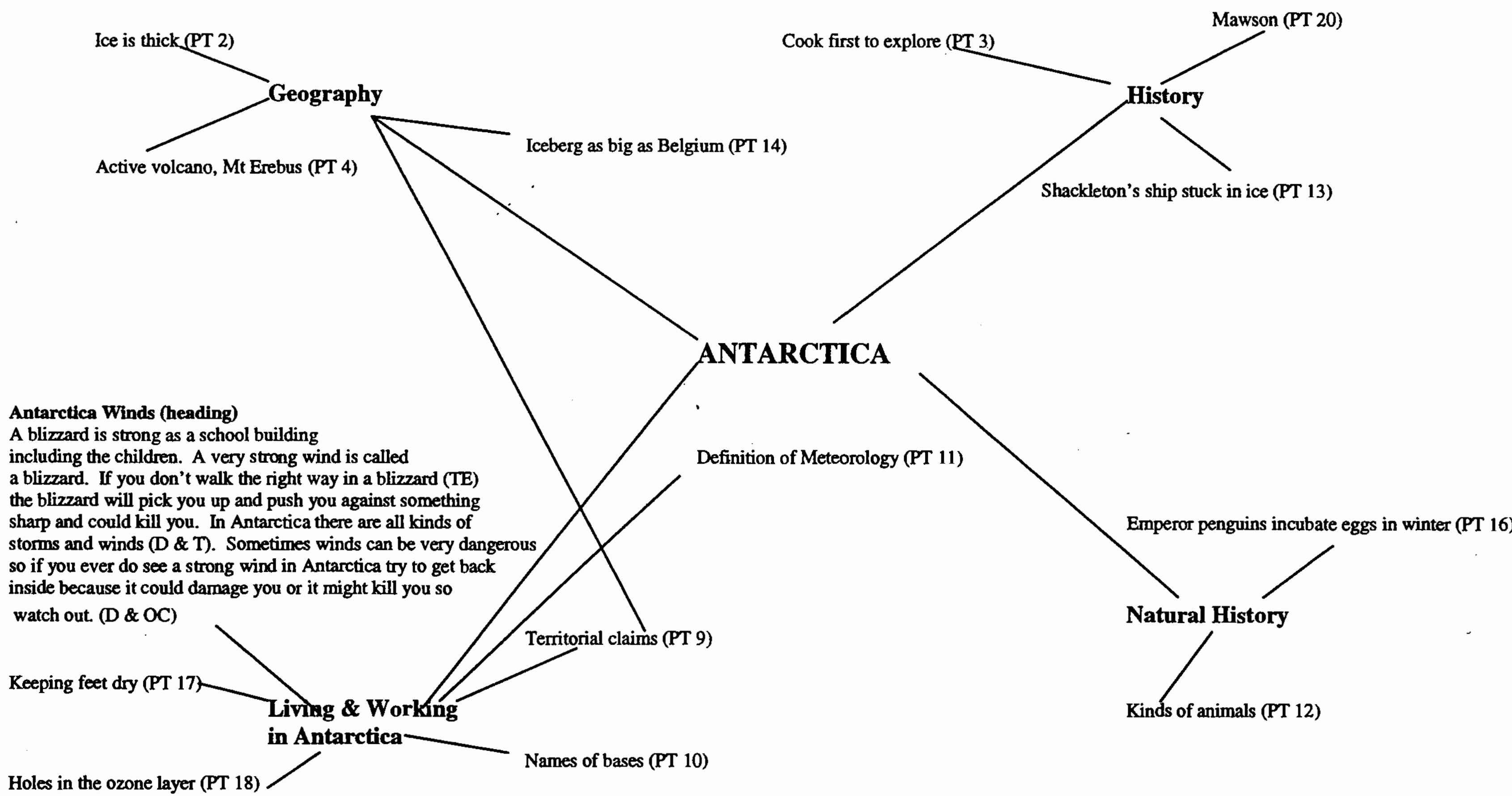
Cara's concept maps (Figures 37-40) suggest a student who made some gains from the lessons although she appeared to be hampered by difficulty in recalling information and concepts with consistency.

Figure 37: Cara's Pre-Lesson Concept Map



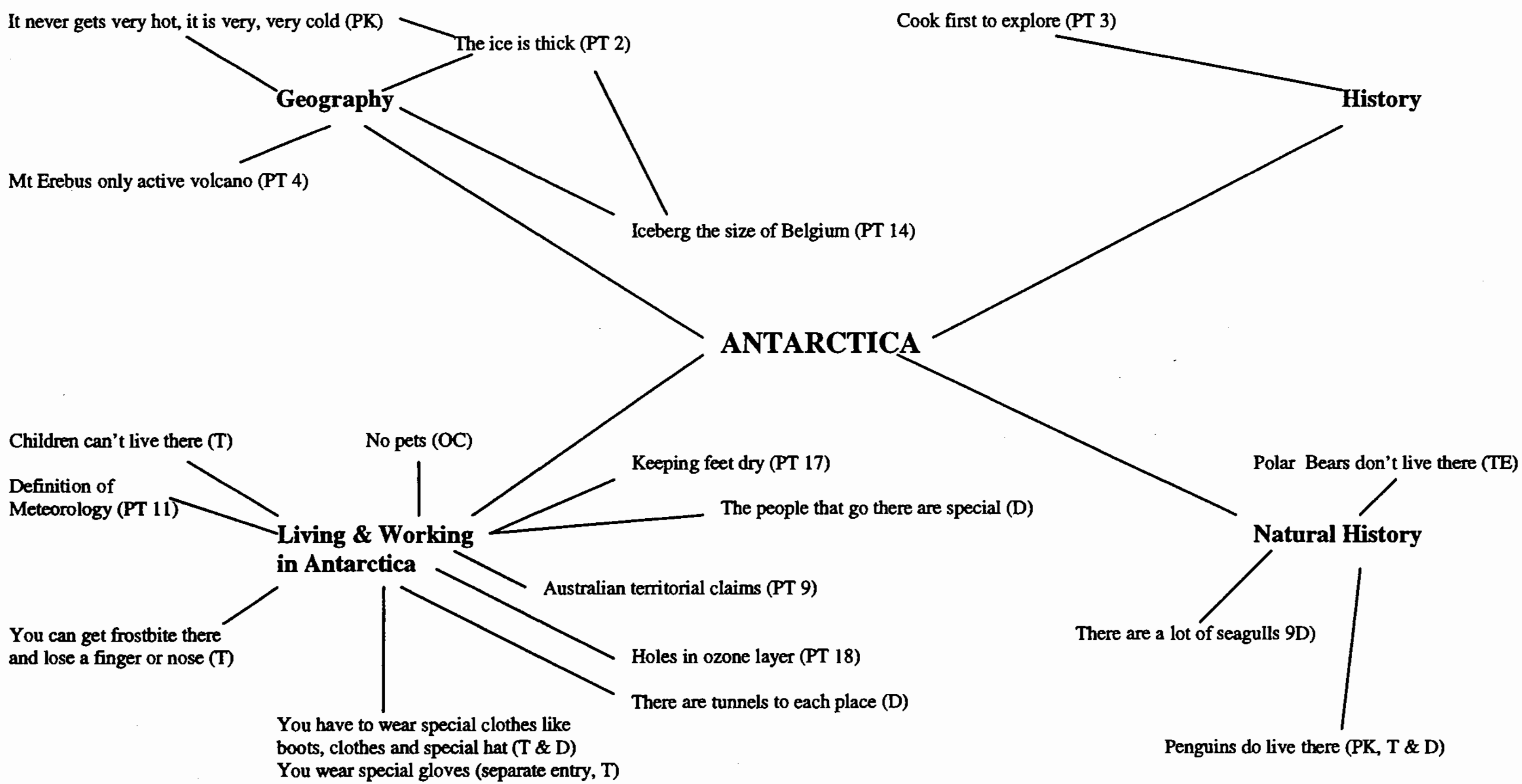
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 38: Cara's Post-Lesson Concept Map



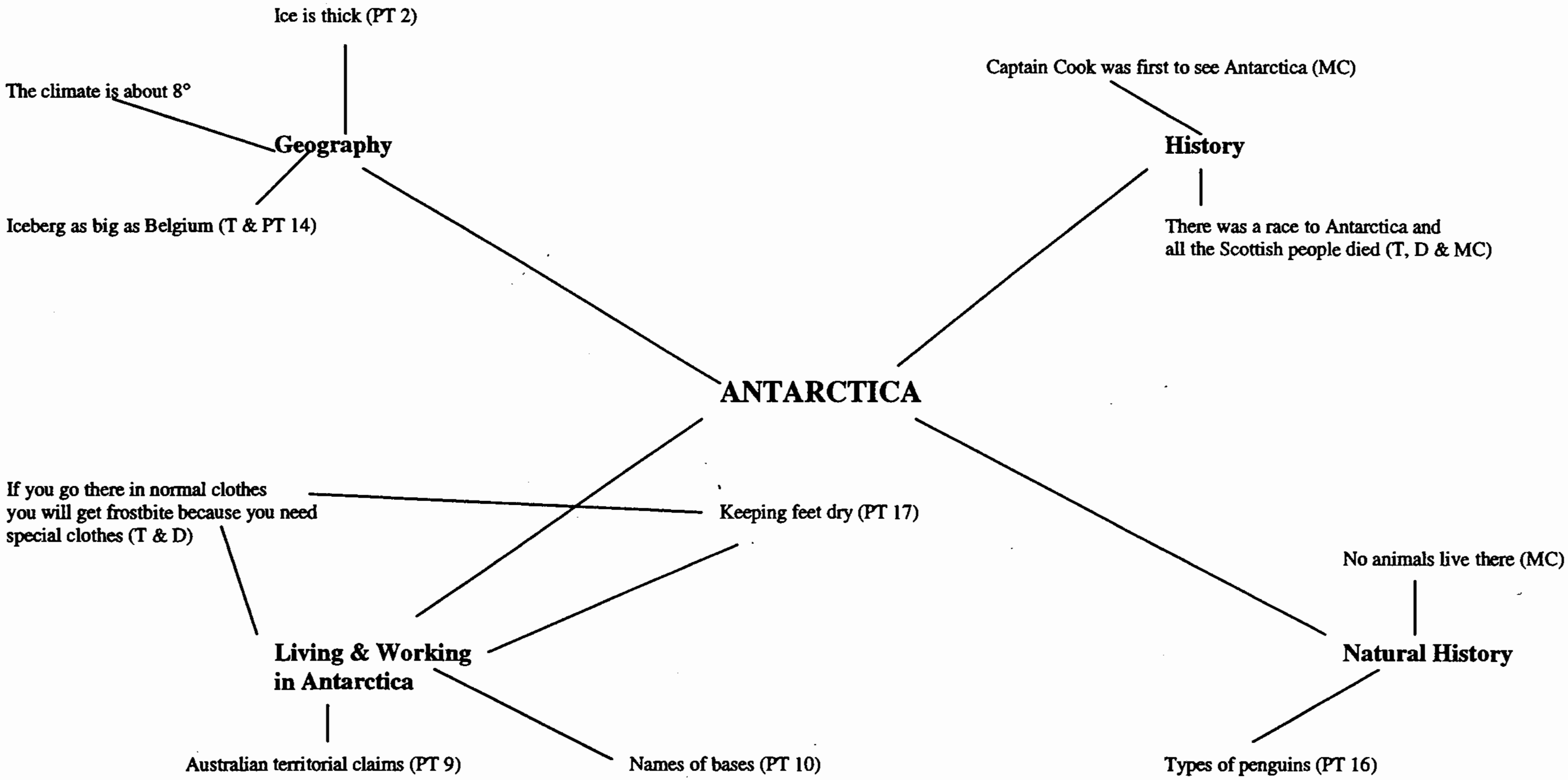
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 39: Cara's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 40: Cara's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Kirsten

Kirsten began with limited prior knowledge of the topic and experienced some difficulty engaging with the unit content during the lessons and over an extended time (see Table 24). General concepts like the extreme cold in Antarctica were retained in some form.

More durable were concepts about penguins "... the only animals there are penguins & whales" (twelve-month journal), living in Antarctica and the voyages of James Cook "... the first man on Antarctica Cook". The penguin concepts were linked to Kirsten's prior knowledge. Links were discerned between the group's discussions on penguins (lesson four) and Kirsten's eventual recall of the concept.

TABLE 24

Distribution of journal codes and test scores

Group B 1-Kirsten

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	2		1			3
Test scores (%)	25		40	15	35	
Text		6	2	1	3	12
Discussion		3	3	1	2	9
Own constructions			1			1
Mis-constructions	1	4	1	2	2	10
Teacher effects				1		
Affective statements						

*includes three journal entries

Similarly, James Cook was referred to in discussion (see final section this case study, below), although not as frequently. References to Cook appeared consistently in Kirsten's journals and she scored the test post-test item correct.

A man named James went to Antarctica.

(Kirsten, three-month journal)

The first man on Antarctica was Cook.

(Kirsten, twelve-month journal)

Concepts about frostbite, "you can get frostbite" were also evident in Kirsten's work from the three-month journal and by twelve months this had become "you can get frozen bits as well". Links were again discerned between these and the group's discussion (see below).

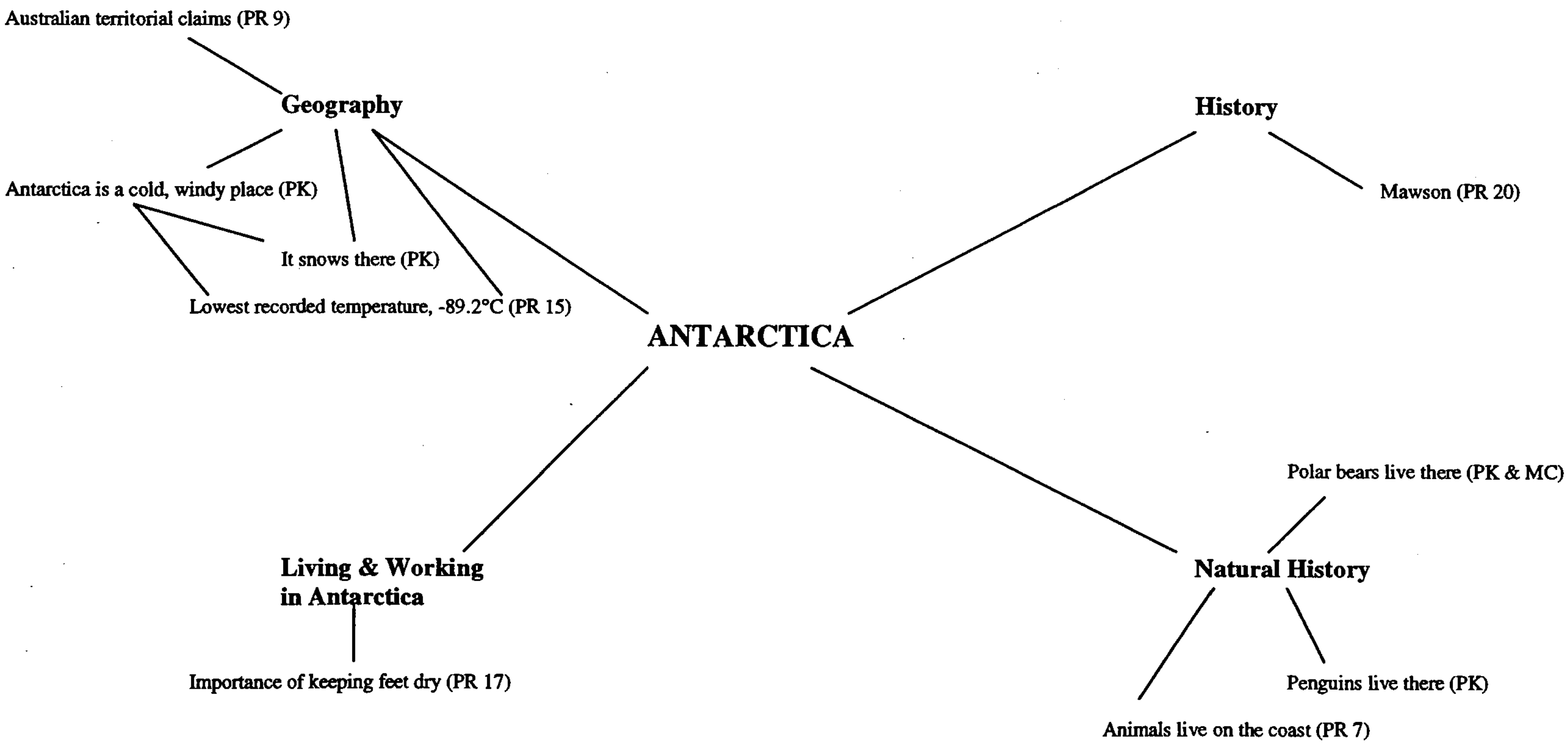
Despite her apparent passivity, some evidence existed that Kirsten had gained from the group experience when she was able to explain part of one answer (lesson 5) to teacher 1. She applied the concept that medical help may be needed in Antarctica.

Teacher 1: ... why did you choose Jane, Kirsten?

Kirsten: ... because Lucy might need help if someone hurts themselves.

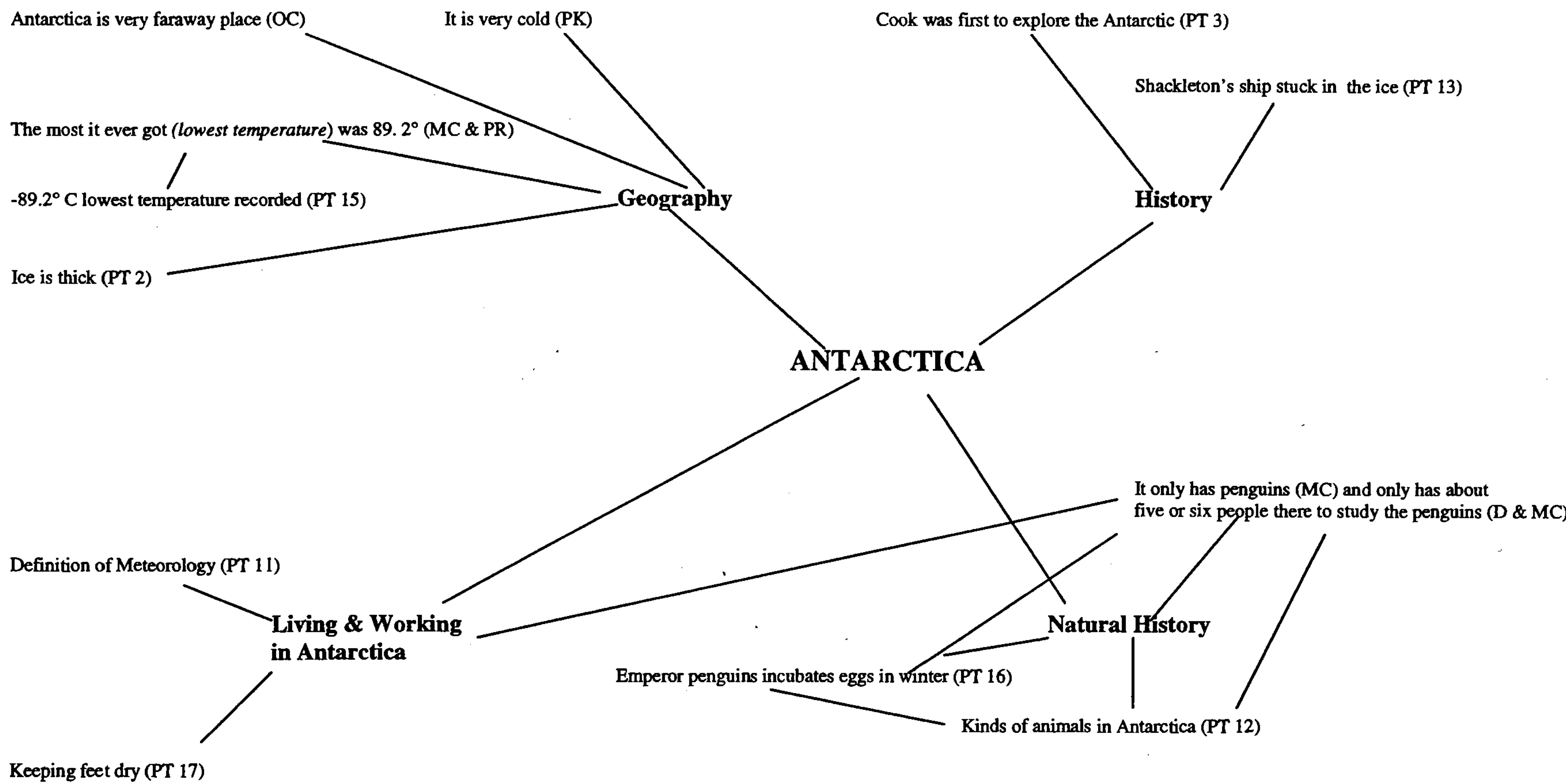
The following concept maps (Figures 41-44) reveal a student who experienced difficulty with the unit content. This was consistent with Kirsten's performance in regular class activities but the group talk seemed to assist her to recall some material presented in the lessons.

Figure 41: Kirsten's Pre-Lesson Concept Map



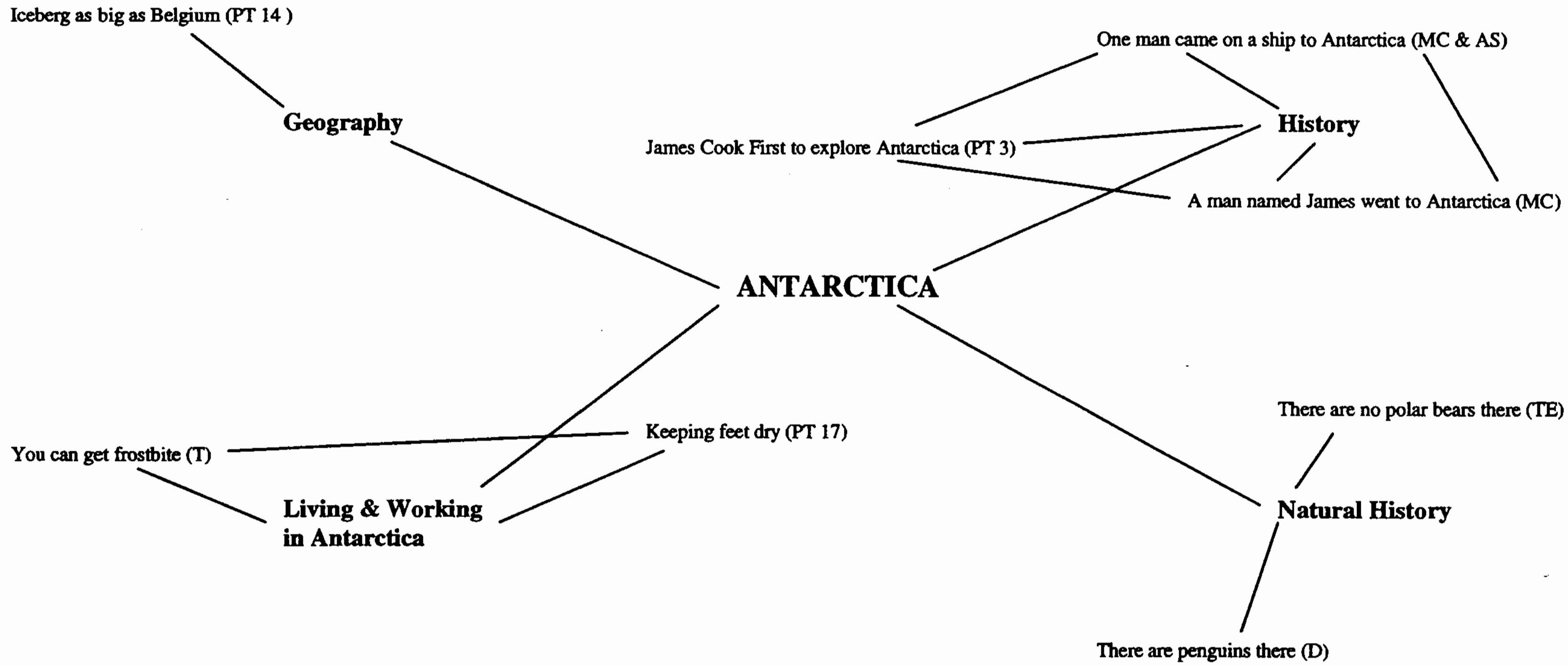
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 42: Kirsten's Post-Lesson Concept Map



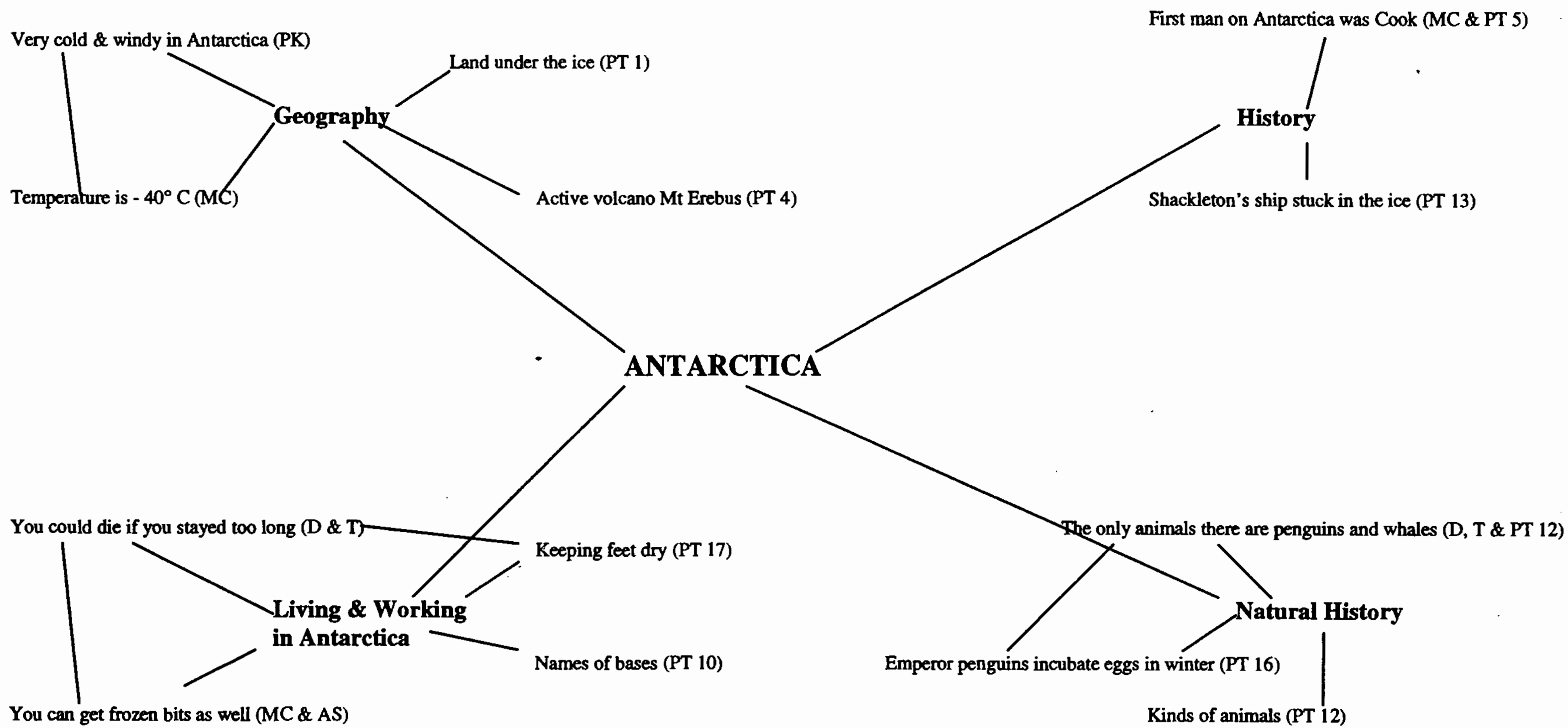
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 43: Kirsten's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 44: Kirsten's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Alan

Alan's journal and test data appeared inconsistent and even erratic at times. Some general knowledge of Antarctica was noted. The "coldest place on earth" concept was one of the few which proved durable, developing to include " it has been zero degrees before and even minus" in the final journal. Another example of Alan's inconsistent recall was where he remembered the concept of long Antarctic nights and winters writing "they have long nights than days and longer winters than summers" in his twelve-month journal, a notion that was never discussed and only described briefly in the lesson 2 text. Alan had not mentioned this previously and the concept may have developed from other experiences of Alan's between data collection points. This concept may also have been learnt directly from the lesson text but what prompted him to recall it at twelve months was problematic.

TABLE 25

Distribution of journal codes and test scores

Group B 1-Alan

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	6			1	1	8
Test scores (%)	35		55	35	30	
Text		8	3	1	4	16
Discussion		1		2		3
Own constructions		2		1		3
Mis-constructions	1			3	6	10
Teacher effects		1	1	1	1	4
Affective statements						

*includes three journal entries

Although Alan's recall seemed to have diminished by twelve months as indicated by the test scores (see Table 25), some concepts were elaborated and integrated into other concepts. For example, the "iceberg the size of Belgium" may have been incorporated into the own construction " lots of ships have been hit by icebergs, like *Titanic*" which included knowledge gained from outside the lessons. This journal statement may have been related to Shackleton's ship being stuck in the ice, described in the post-lesson and three-month journal.

Although learning journal entries between lessons (mid-lesson) were not generally treated as main data sources, an examination of these data revealed a high proportion of *text* codes (66% of all in-lesson journal entries). Although Alan seemed to "run" the group, assuming a dominant role, he did not seem to gain much from the experience. He seemed more likely to retain information from reading. The text codes almost disappeared at the three-month journal but re-appeared (33%) at the final journal (Table 25).

Another notable feature of Alan's journal work was the prominence of mis-constructions in the later journals (Table 25). At three-months this was 33% overall and by twelve months had risen to 50%. In common with other students described previously, he continued to develop new mis-constructions over time.

> James Cook was the first to travel to the South Pole.
>
> All of Shackleton's people died but none of Mawson's died or were injured.
>
> *(Alan, three-month journal)*
>
> No people live there but scientists have stayed there for a week or so.
>
> *(Alan, twelve-month journal)*

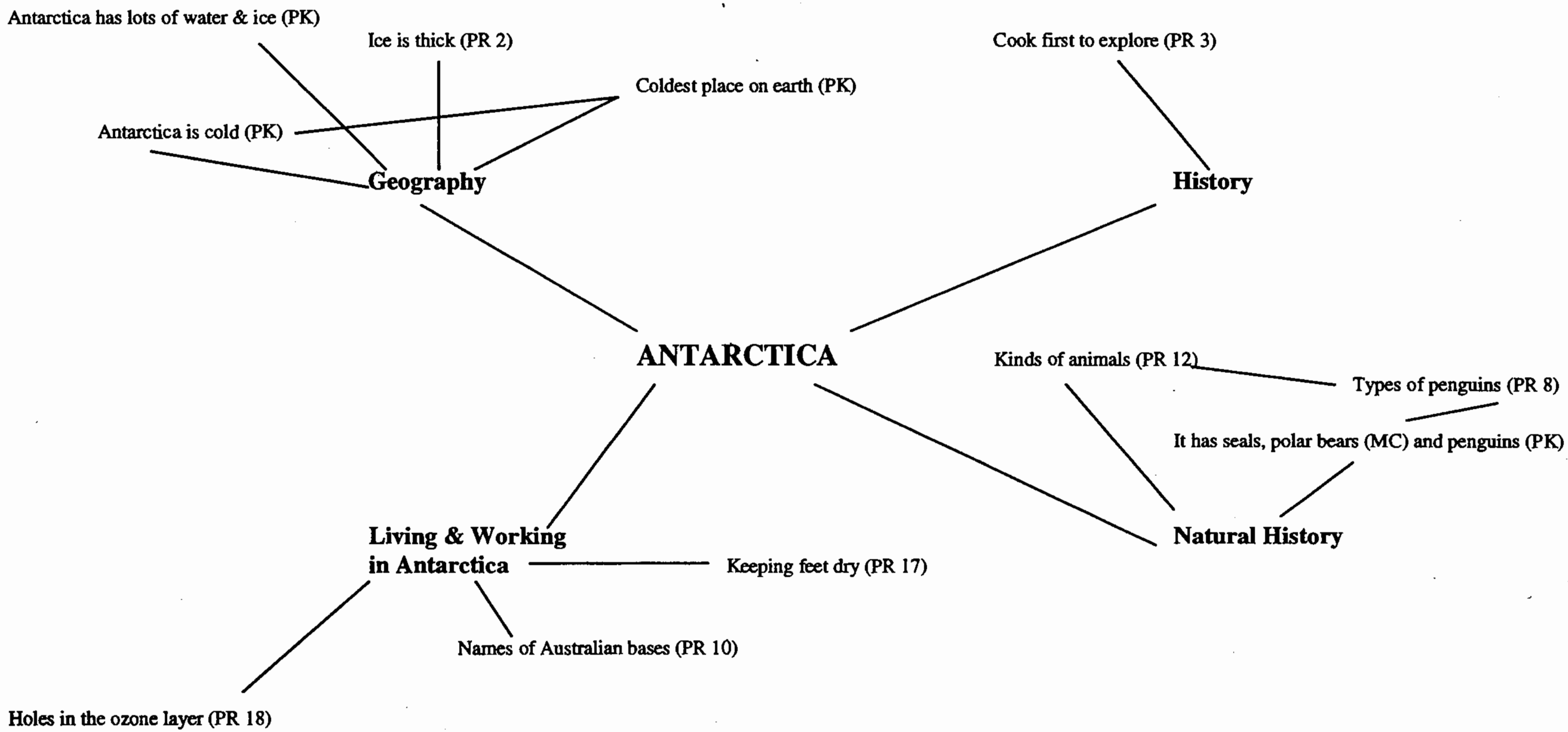
Various pieces of information were disjointed and reconnected to others such as in these examples from the three-month journal; " James Cook was the first to travel to the South Pole" and "Shackleton and Mawson had a race to the South Pole" (Figure 47).

The James Cook constructs provided another example of the unpredictability of Alan's journal work. He elaborated on Cook with a mini-essay (Figure 46), similar to Cara's blizzard effort (Figure 38) in the post-lesson journal and mentioned Cook again at three-months. The following example represents several sources of material being synthesised into one, at times erroneous, statement. Surprisingly, Cook was not mentioned at twelve months.

> James Cook was sailing around until he saw a seagull so he started to search for land but saw nothing, so his crew started to head for the ice. Before they touched the ice they sailed back to his country and told lots of people and told them all the gear he would need. He got all the gear and made it to Antarctica.

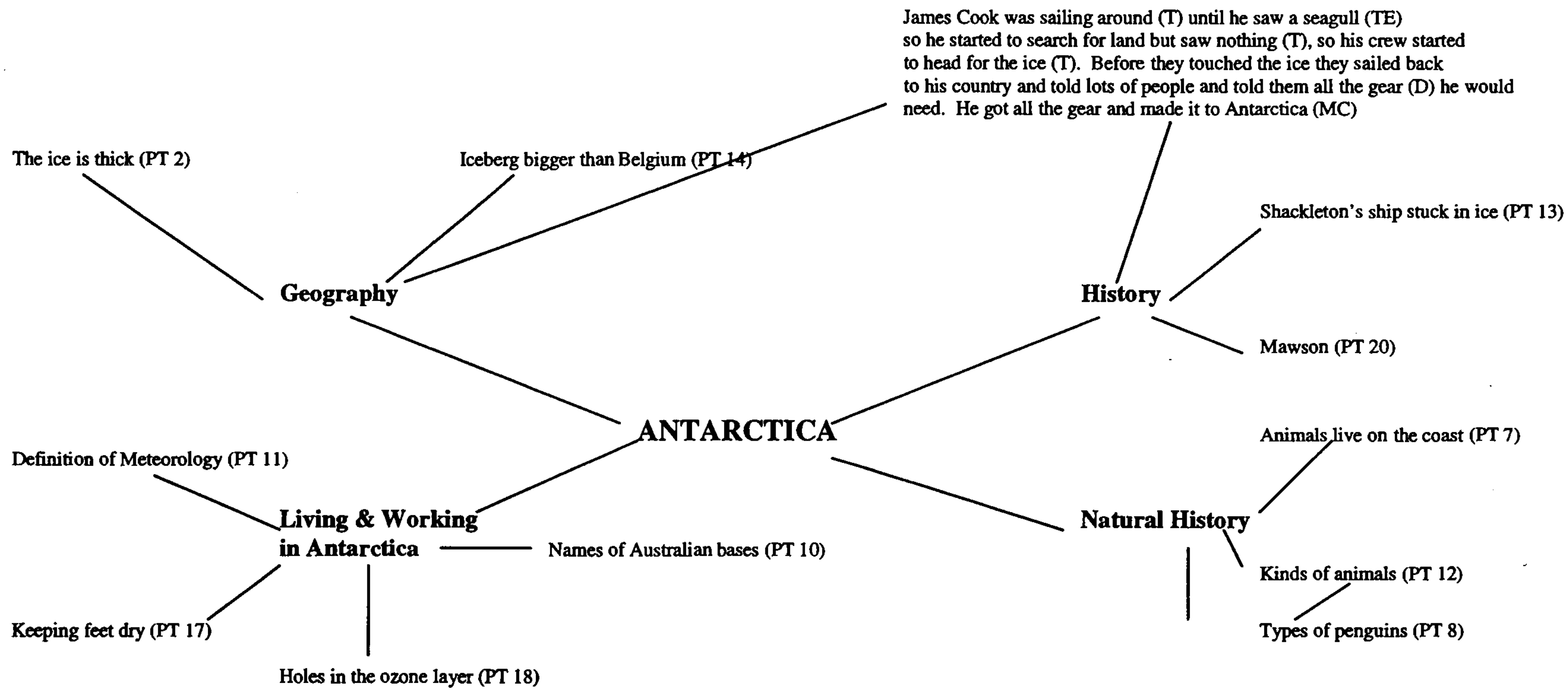
The following concept maps (Figures 45-48) highlight the inconsistencies with Alan's work. Observation suggested this student seemed to cooperate with the data collection to produce his best efforts but precisely what stimulated his recall remained problematic.

Figure 45: Alan's Pre-Lesson Concept Map



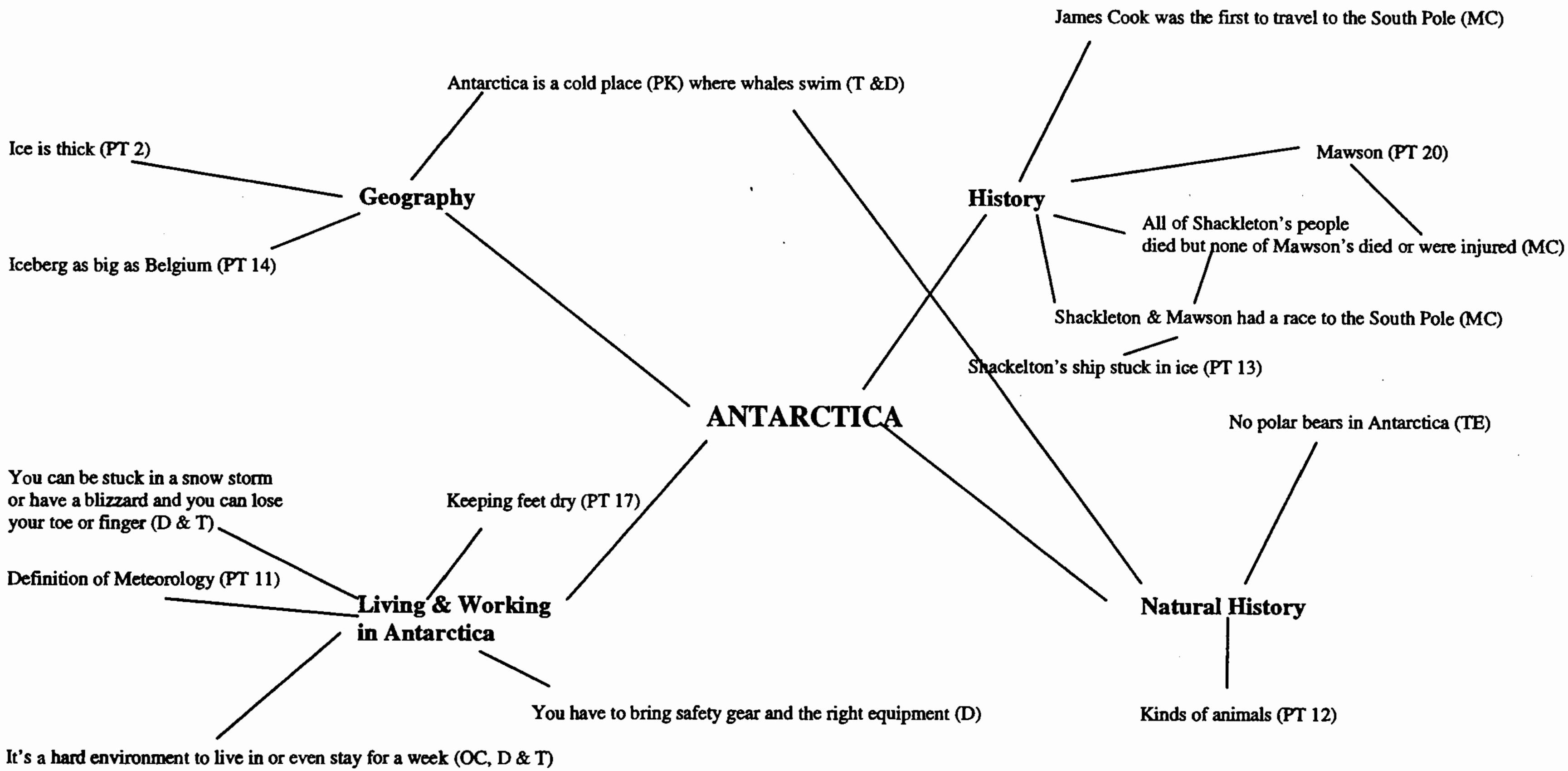
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 46: Alan's Post-Lesson Concept Map



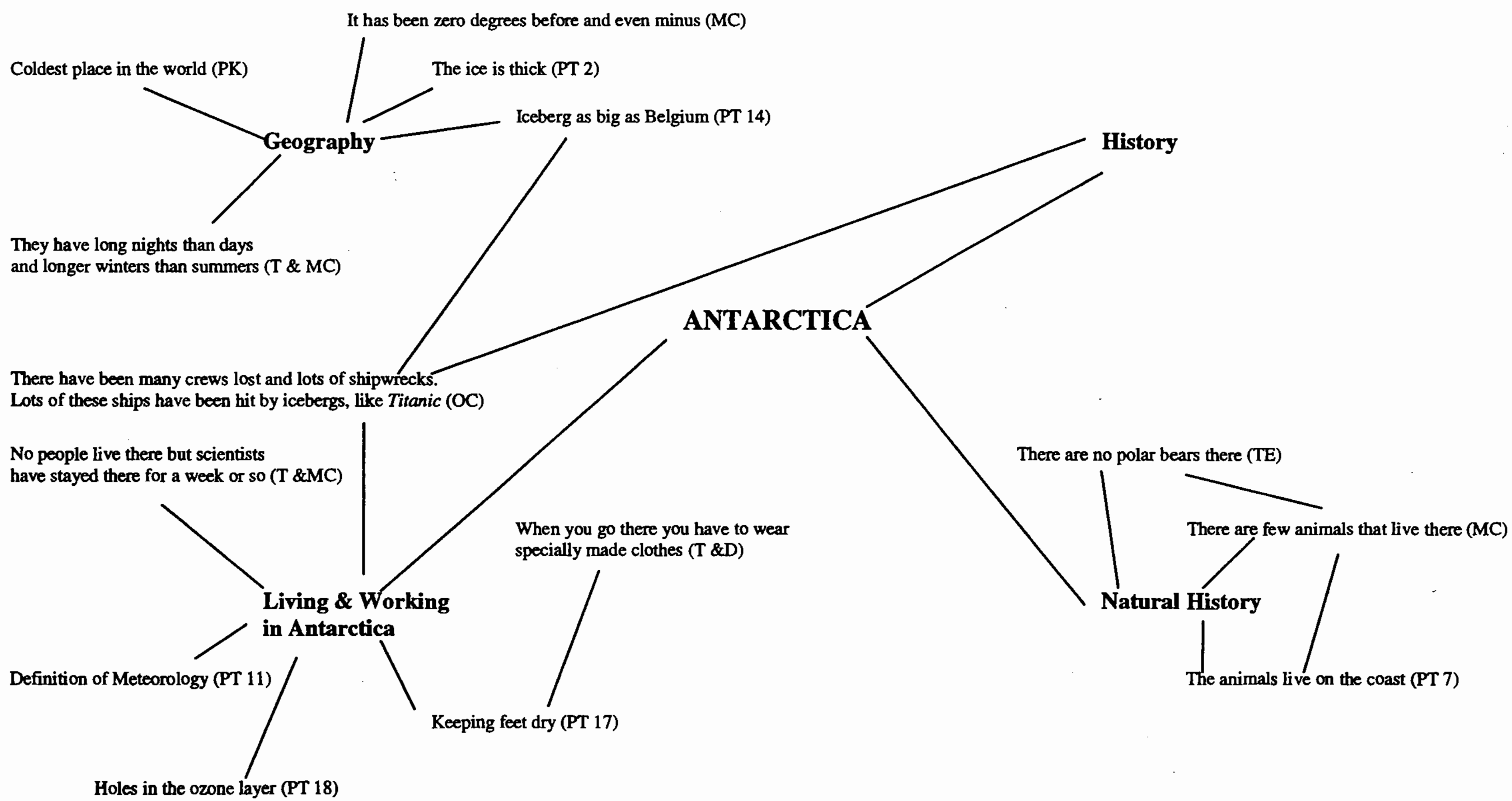
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 47: Alan's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 48: Alan's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Knowledge and concept development within the group

Although this group did not appear to function particularly effectively as a cooperative unit, relationships between discussion, prior knowledge and journal entries were discerned, providing some evidence of co-construction of knowledge in the group.

The general notion that Antarctica is a cold place was reported by all students in their first journal. Direct statements about the cold were included with related ideas such as Cara's entry " ...the snow might be light or heavy..." and "...under the snow there is freezing water...". Although Cara did not specifically mention the cold in her post-lesson journal, her entire entry concerned blizzards. She mentioned the cold or low temperatures again at three and twelve months. Alan also reported concepts related to the cold in his first journal. "Antarctica has lots of water and ice" and " ...coldest place on earth" (Figure 45). Alan omitted reference to the cold at the post-lesson journal but returned to it in the final two journals.

Concepts about the risks of frostbite and keeping feet dry "... you can get frozen bits as well" (Kirsten, twelve-month journal) were linked across all journal entries and discussion. The group's initial discussion about frostbite was an occasion when *all* their discussion was of the type proposing, negotiating and arguing (MAKITAB codes TS09-TS11; see Appendix H & I) with 80% coded as TS11. This lesson two exchange illustrates the group's involvement in this type of talk.

Aiden:	I've had frostbite before.
Alan:	(doesn't believe him) Oh yeah where?
Aiden:	I've been to Mt Buller.
Alan:	Yeah but where?
Aiden:	Mt Buller is...

Alan: Yeah I know but where did you have frostbite?

Aiden: Where do you think?...at the top of Mt Buller.

Alan: No but I mean like on hands, knees or what?

Aiden: Fingers and toes...

Alan: ...Let me have a look.

Cara: You didn't get them chopped off?

Aiden: That's because, that's because, that's because I had sweat bands on and then I put on the cold bands so they cool off.

Cara and Alan both exhibited prior knowledge of frostbite and were later able to correct Aiden's mis-construction. Discussion about frostbite occurred again in two other lessons and the students seemed to have elaborated the concept to include references to body parts. " You can get frozen bits as well" (Kirsten, twelve-month journal, Figure 44), " You can get frostbite there and lose a finger or nose" (Cara, three-month, journal, Figure 39) and clothing " When you go there you have to wear specially made clothes" (Alan, twelve-month journal, Figure 48).

All students in their pre-lesson journal reported concepts about penguins living in Antarctica and these consistently appeared thereafter. Kirsten incorporated penguins into a mis-construction related to the discussion about a team of scientists studying penguins in lesson four; " It only has penguins and only has about five or six people to study the penguins" (Kirsten, post-lesson journal, Figure 42). At three months (Figure 35), Aiden correctly mentioned one penguin species (the gentoo) and seemed to confuse *emperor* penguin with *king* penguin. At the same time (Figure 39), Cara stated that penguins *do* live there with reference to polar bears, " Polar bears don't live there". During the lessons, penguins received exposure through discussion and on the worksheets (pictures of penguins appear, Appendix J) and in lesson four penguins were discussed again.

TABLE 26

GROUP B1

MAKITAB ANALYSIS ON TASK TALK (TS CODES ONLY)

Codes	*lesson 1*	*lesson 2*	*lesson 3*	*lesson 4*	*lesson 5*	*Total Statements*	*%*
TS01			1		1	2	0.4
TS02	5	4	8	8	1	26	5.3
TS05	2	4	9	5	3	23	4.7
TS06				1	2	3	0.6
TS07			3			3	0.6
TS08	4	13	21	31	31	100	20.6
TS09	3	4	1	5		13	2.7
TS10	13	6	7	31	9	66	13.6
TS11	13	26	9	57	38	143	29.4
TS12		1	2	6	1	10	2.1
TS13				2	6	8	1.6
TS14	11	12	11	14		48	9.9
TS15			1	6	2	9	1.9
TS16	3	3	5	16	7	34	6.9
Lesson Totals	54	73	78	182	101		

A brief exposure to discussion about James Cook seemed to result in longer-term outcomes for the students. Only Aiden and Alan displayed prior knowledge of Cook through test scores but this knowledge was quickly elaborated, particularly by Alan (described above). The other group members had all retained some knowledge of

Cook by the final journal entry; " First man on Antarctica was Cook" (Kirsten, twelve-month), " Captain Cook was first to see Antarctica" (Cara, twelve-month) and " Cook first discovered Antarctica" (Aiden, twelve-month).

The summary of MAKITAB analysis on Table 26 suggests a group that at times produced satisfactory levels of higher order talk. A broad benchmark of TS08-TS11 codes revealed 66.3% of on-task talk in these categories. The group often engaged in lower order types of talk (coded TS08, 20.6%) but their higher order talk could also be productive. The last two lessons seemed more successful in this regard if levels of TS11 are taken as a benchmark. In lesson four, 31.3% of the talk was TS11 and in lesson five the figure was 37.6%. Lesson three did not prompt the group into these kinds of talk with only 11.5% of talk coded as TS11. Curiously, this was the lesson where James Cook was discussed, suggesting that factors other than in-depth discussion might have influenced the students' recall in this instance.

Although this group's talk seemed to a degree generally productive for all members and the tasks were completed, the non-inclusion of some students, particularly Kirsten remained of concern. Alan's leadership of the group was usually benevolent although some conflict was detected. The researcher was left to speculate that if Alan had managed to include the other group members more effectively, what academic gains could have been made? Should cooperative learning simply reinforce existing patterns of student participation or should it help bring about change?

5.6. Case study 4 (group B 2, school B)

Profile

This group consisted of two male and two female students, Cale, Max, Molly and Kate. Max, Molly and Kate were in year three (eight year olds) and Cale was in year two (seven years old) at the commencement of the study. Teacher data and observations indicated that the groups' highest achiever was Max. Kate was a middle achiever with particular strengths in Mathematics. Cale was a student likely to approach tasks with a serious intent and was anxious to participate. Molly was a middle academic achiever who displayed strong creative abilities in regular class activities. She seemed to lack confidence in social settings.

Group processes in the discussion

Table 27 indicates the dominant role played by Max and the very passive nature of Molly's contribution. Most of the discussion revolved around Max. He determined the group "culture" and usually controlled the situation. His attempts at control appeared driven by his motivation to complete the task. Cale attempted to contribute to the discussion but his relatively low status meant that Max usually ignored his efforts. Teacher data and observation suggested that Cale's low status was attributable to his lack of prior knowledge about the topic and age differentials. As a consequence of being ignored, Cale's on-task behaviour deteriorated and he became more disruptive to the group over the course of the lessons. This behaviour became a source of frustration for Max, causing him to threaten to leave the group in lesson two. He seemed more circumspect in the next lesson and this may have lead to less on-task talk in lesson three (see Table 28). Max did not appear happy to be a member of the group for the remainder of the lessons but his contribution rose to more like their usual levels in subsequent lessons.

TABLE 27

Group B 2 Summary of task related statements in group discussion (all lessons)

Student name	*Total on-task statements (off-task statements)*	*% on task (% off-task)*
Cale	125 (130)	22.48 (40.49)
Max	223 (41)	40.10 (12.77)
Kate	162 (83)	29.10 (25.86)
Molly	46 (67)	8.27 (14.33)

Under Max's leadership the group took turns in completing answers. His preferred way of working sometimes included checking and reviewing of answers (MAKITAB code TS15, see Appendices H & I) similarly to group B1. The following exchange indicates an awareness of some form of checking procedure suggested by Cale and approved by Max. The group did not carry out the procedure consistently.

Cale: After this do you want to check through the answers?

Max: OK we'll all get to check through the answer that we've done but that'll have ideas and that.

Max's contribution was very significant academically. He demonstrated greater prior knowledge and contributed the bulk of the ideas to the group. This partly explains his position of dominance. Despite his seemingly negative impact on Cale, Max provided the impetus for the group's treatment of the discussion questions. Max's knowledge also helped the group to stay focussed on useful discussion as illustrated by this exchange from lesson one.

Max:	Why do you think the ice is so thick in Antarctica? It tilts away from the sun in winter. Um... we should we could put something about summer as well...they might just...
Cale:	And it goes near the sun for summer.
Max:	No they get daytime all the time
Cale:	No...
Max:	...no in winter it goes away from the sun and it keeps on spinning that way but they get night time all the time. Night time twenty four hours...
Kate:	A day?
Max:	A night...
Kate:	...a day.
Max:	(understands) Yeah. So they don't get any light at all. And in summer they get light all the time.

TABLE 28

Group B2 task related and non-task related talk

Lesson number (total statements)	*Task related talk (%)*	*Non-task related talk (%)*
1 (166)	86	14
2 (177)	68	32
3 (190)	53	47
4 (187)	63	37
5 (157)	67	33
Means	67.4	32.6

When the group lost focus, usually as a result of a mis-construction by one of the group members, Max was able to use his prior knowledge to re-direct the discussion along more productive lines. Kate's contribution to this lesson one exchange could have created confusion for the students but Max and Cale helped to re-direct the group.

Max:	(on to question two now) So you get frostbite and it blinds you. Should we put the blizzard blinds you? Should we put the blizzard blinds you? Nah.
Cale:	Nah.
Kate:	No, no we don't...oh well. You get blizzard bite.
Cale:	It's meant to be frostbite though.
Kate:	No you can get...
Molly:	(looking at worksheet) ...you crossed out frost and you put it.
Kate:	After bite put "es".
Molly:	No, no, no no.
Kate:	Yes bite, blizzard bite.
Max:	No there's no such thing as blizzard bite it's only frostbite.

Although Table 28 suggests a group engaged in mostly task-related talk, these results could be misleading. Deeper analysis of the transcripts showed that the group did not work particularly cooperatively. MAKITAB analyses showed a high proportion of types of talk associated with good task engagement (TS08, TS11-13) but when one student dominates to the extent that Max did, benefits to others seemed problematic. Max's influence on Cale has already been described and the group dynamics seemed to have accentuated Molly's lack of social confidence. She appeared passive and despite good test scores, her journal data suggested a student who gained little from the lessons.

Group B2 individual case studies

Cale

Cale exhibited some knowledge of broad concepts about Antarctica in his pre-lesson journal (Figure 49). The general notion of the cold climate, "...it normally snows" and "...ice is always on the ground" seems to have been focussed onto the coldest temperature ever recorded. By the final journal, Cale was reporting this fact accurately.

Some of Cale's knowledge was sourced outside the study lessons. His post-lesson journal provides a good example of an integrated package of ideas drawn from outside experience.

> In the newspaper this week it says that Sorrento might flood and the army might need volunteers because Antarctica may have a hole in it after the year 2000 and a base stands right there. The hole might appear in the middle of Antarctica. Everyone has at least one year to evacuate.
>
> *(Cale, post-lesson journal)*

Cale's reference to Antarctic bases in the above extract continued into the three and twelve-month journals. The twelve-month journal entry (Figure 52) provides evidence of increasingly sophisticated conceptual development.

> There are three main bases there.
>
> The bases were named after explorers.
>
> *(Cale, twelve-month journal)*

A similar process of increasing sophistication was discerned in the three-month journal in statements relating to blizzards. Blizzard concepts were linked to the tunnel connecting the buildings in the lesson two worksheet (Appendix J). Cale produced an own construction in the twelve-month journal "...instead of cyclones and twisters in Antarctica they have blizzards" indicating he seemed to have linked several pieces of information from sources outside the lesson content into his own constructs. Despite his occasionally disruptive effect on the group, Cale's concept maps (Figures 49-52) reveal a student who appeared to have engaged to some degree with the lesson content. Table 29 indicates text provided the main source of knowledge for Cale. His attempts to contribute to discussion were often ignored and this may have led to Cale "switching off" during the discussion. His journal entries were typically brief but new own constructions and mis-constructions were still evolving at twelve months.

TABLE 29

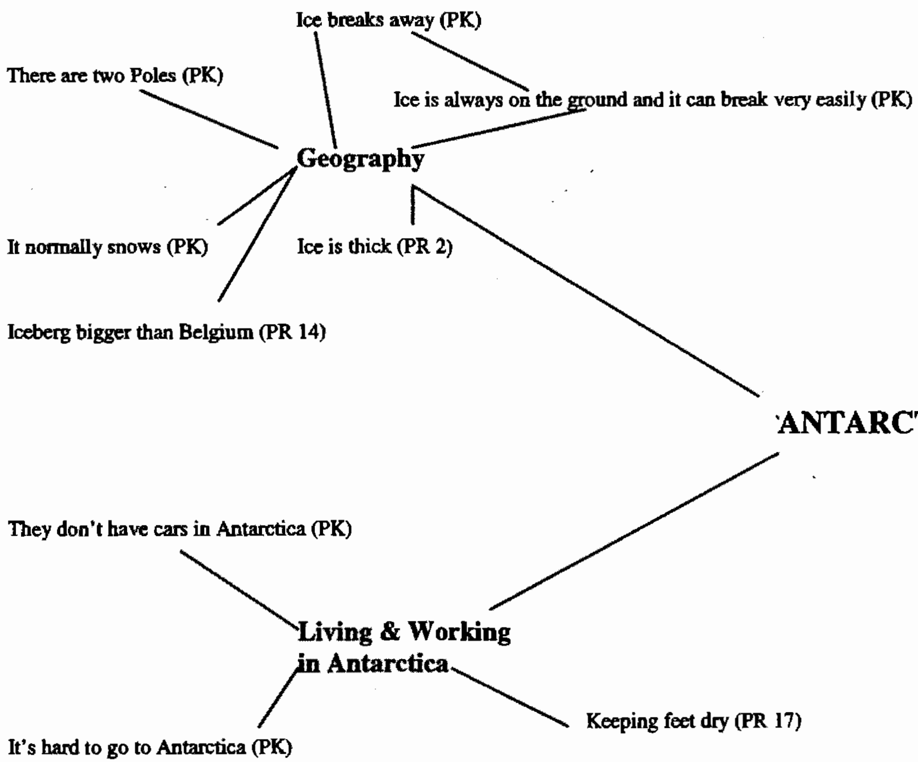
Distribution of journal codes and test scores

Group B 2-Cale

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	5	1				6
Test scores (%)	25		40	35	50	
Text		11	1	4	3	19
Discussion		3		4		3
Own constructions		2	1	1	2	6
Mis-constructions		5	1		1	7
Teacher effects		1		1		2
Affective statements				2		2

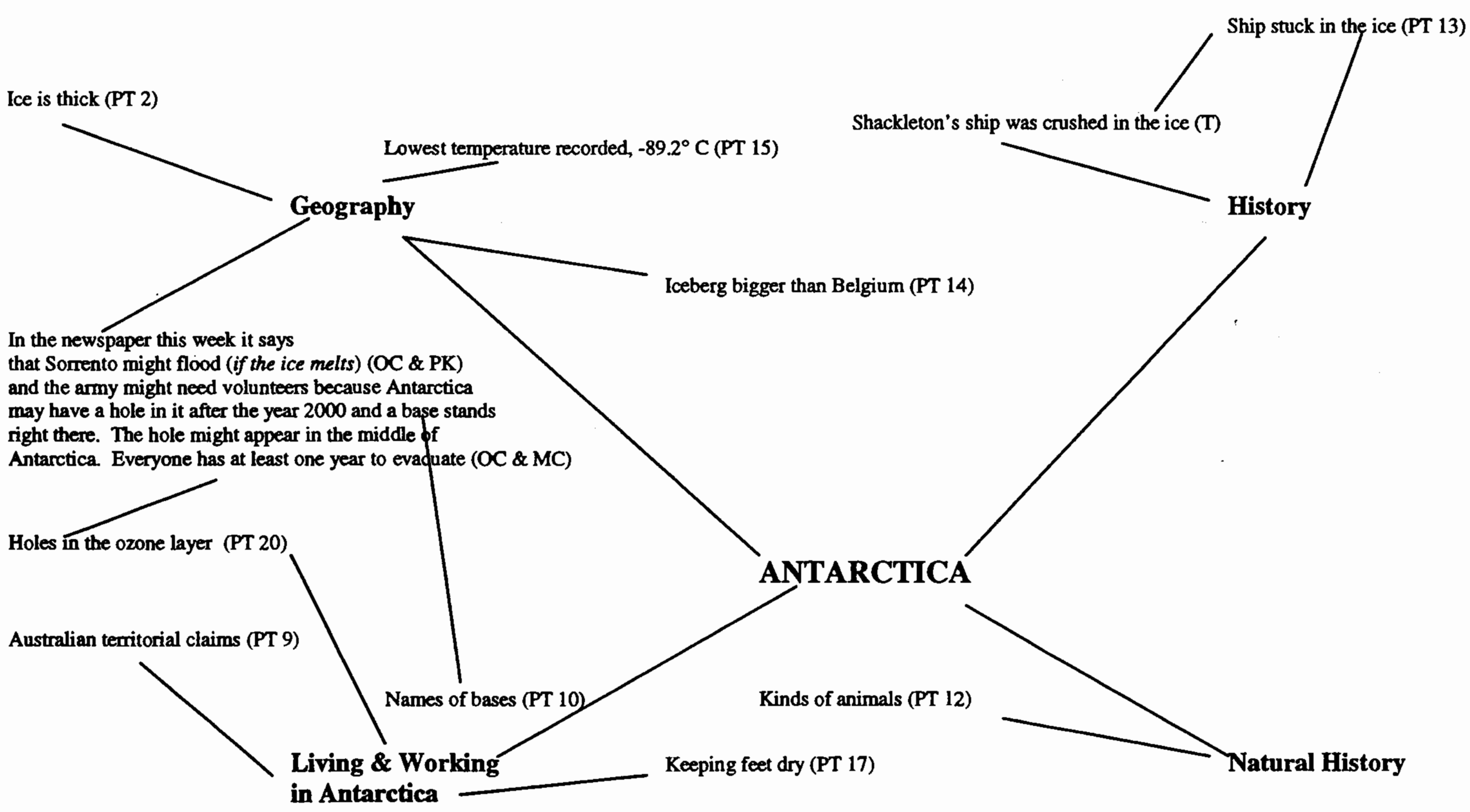
*includes three journal entries

Figure 49: Cale's Pre-Lesson Concept Map



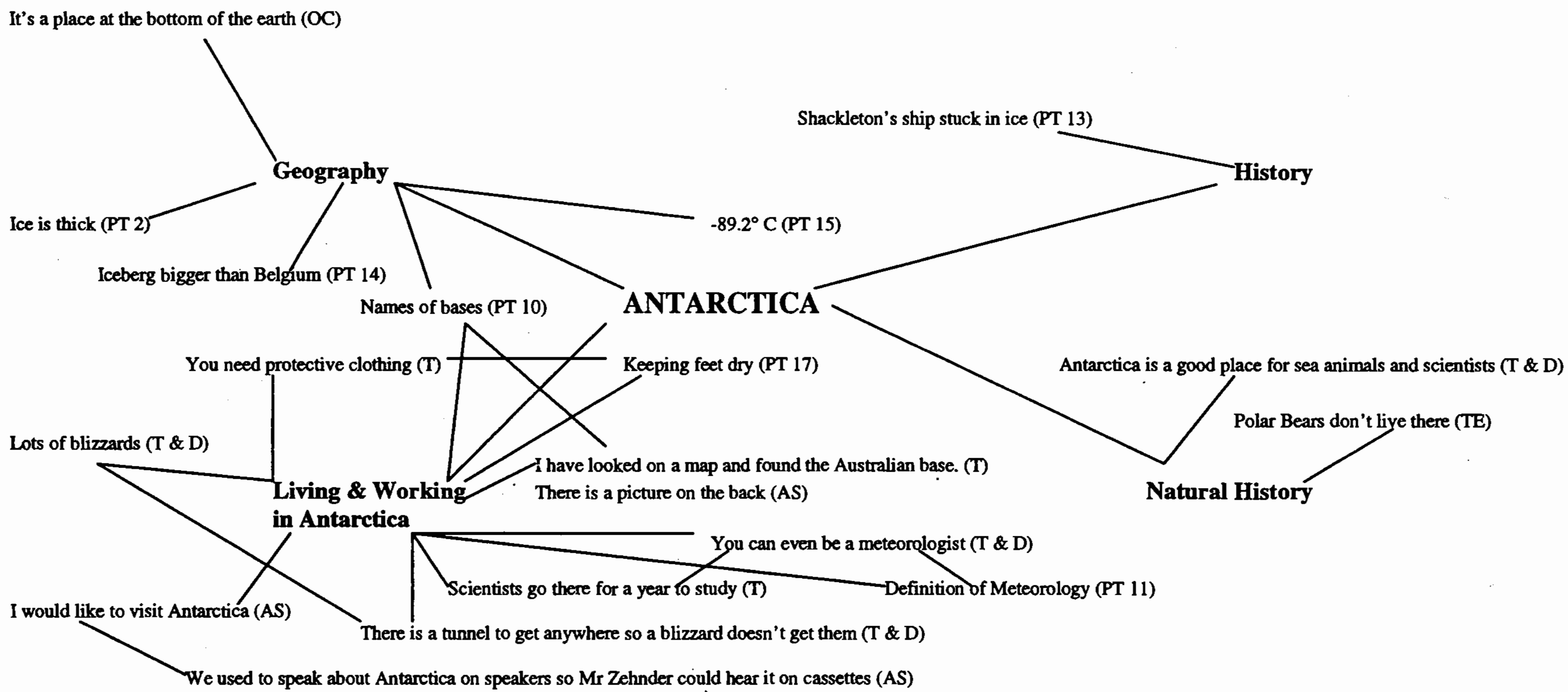
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 50: Cale's Post-Lesson Concept Map



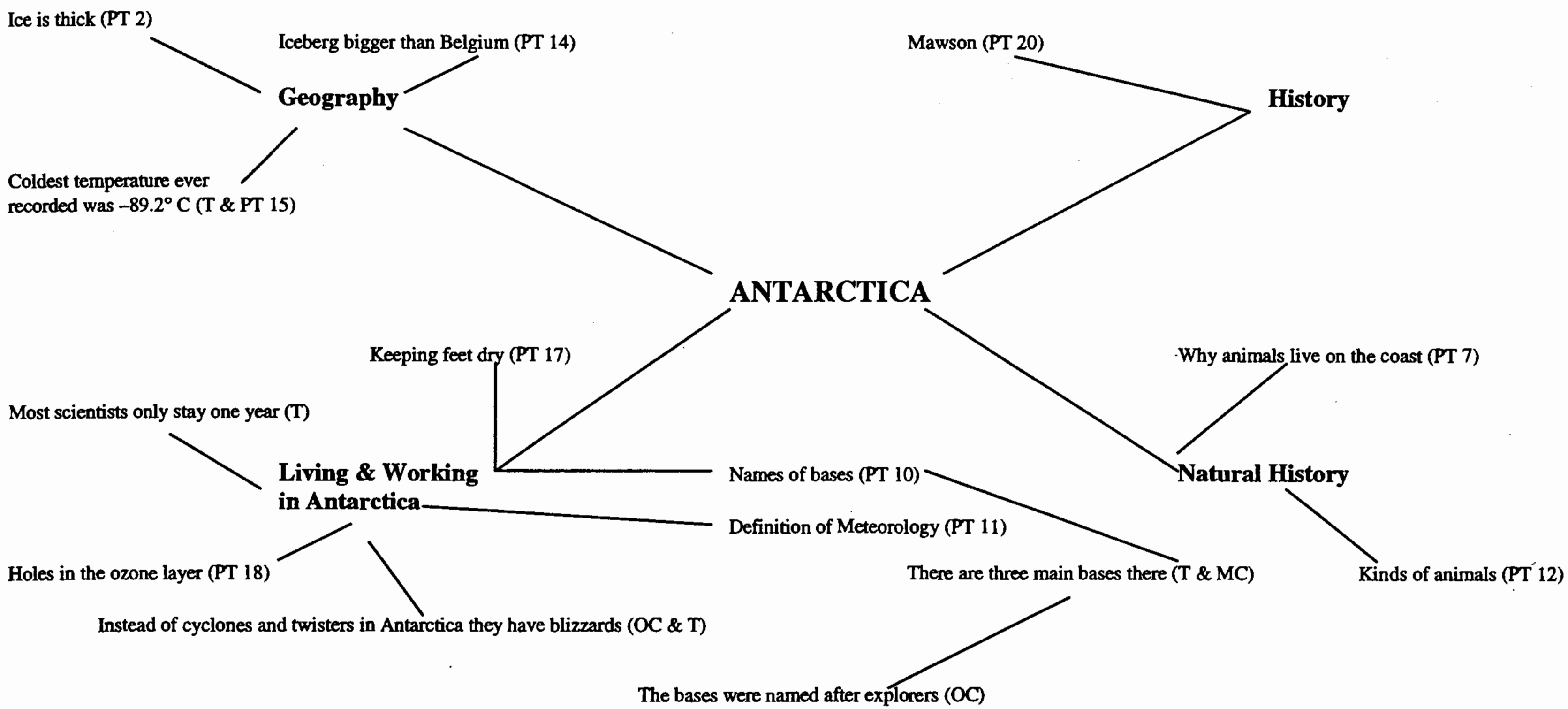
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 51: Cale's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 52: Cale's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Max

Max's contribution to the group culture is described above. Descriptions of this group's involvement with the classroom experiences in the study are written, to some extent, in Max's experience. He began with a broad prior knowledge of the topic and provided evidence of increasingly detailed conceptual development. His prior knowledge may have come in part from discussions with his father as indicated by this lesson one exchange.

Max: OK, OK. Why do you think the ice is so thick in Antarctica?

Kate: Because the world's away from the sun in winter

Max: Why not just... it tilts away from the sun. (writes answer)

Max: I know this.

Kate: Why?

Max: Because my dad stud... my dad and I studied this.

The concept that Antarctica is a continent of land covered with ice proved durable throughout all journal entries. The "cold place" concept was also consistent but seemed to narrow to the test item by the final post-test. However, related concepts about blizzards were elaborated in the three and twelve-month journals (Figures 55 & 56).

> If there are blizzards other scientists go out too. They hold a rope so they don't get lost because they can't see.
>
> Blizzards are formed when hard winds blow snow off very high mountain tops.
>
> Bases have to very strong or blizzards would blow them away.

(Max, three-month journal)

Blizzards caused by wind blowing snow off mountains and volcanoes.

Scientists travel in tunnels in the bases.

(Max, twelve-month journal)

Other evidence existed of Max's elaboration of concepts over time. His prior knowledge about Antarctic winters culminated in "...when it points away from the sun it's permanently night" (twelve-month journal). Information about the names of Australian Antarctic bases in the three-month journal (Figure 55) " ...Casey was a famous base there" became "...Mawson and Davis were famous explorers. Bases were named after them." after twelve months. Max responded correctly to the test item concerning the active volcano, Mt Erebus after exposure to the text from lesson one. By the final journal, this information had been elaborated into "...even though it is very cold there in still an active volcano".

Max appeared to gain more from text than discussion despite being the main contributor to group talk (see Table 30). The example below illustrates how he grappled with related ideas in an effort to form mental representations.

Whales have babies there.

(Max, three-month journal)

Whales come to migrate there.

(Max, twelve-month journal)

Max demonstrated good recall of information as indicated by each of his post-test scores and his concept maps (Figures 53-56). The test scores remained consistent over the study's duration. No journal data were available post-lesson but his concept maps at three and twelve-months suggested a student who had gained academically from the lessons. Despite his strong contribution to the discussion, Max's journal data revealed a student who seemed to work independently while acting as a member of the group. He did not appear to need the other group members.

TABLE 30

Distribution of journal codes and test scores

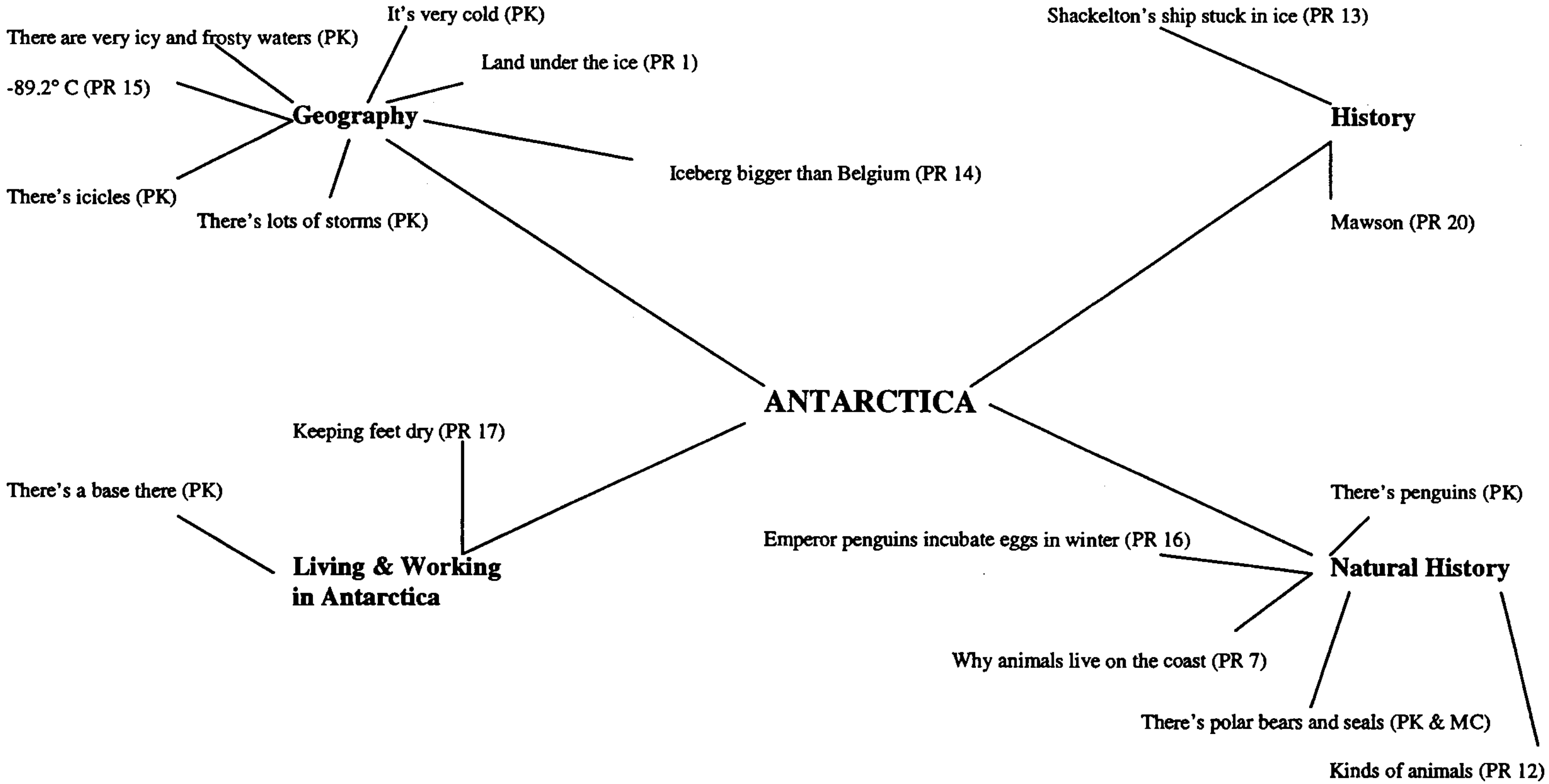
Group B 2-Max

	Pre lesson	*Mid lesson**	*Post lesson***	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	7	4		3	1	15
Test scores (%)	45		75	75	70	
Text		12		13	5	30
Discussion		2		3	1	6
Own constructions				2	1	3
Mis-constructions	1			1	2	4
Teacher effects				2		2
Affective statements						

*includes three journal entries

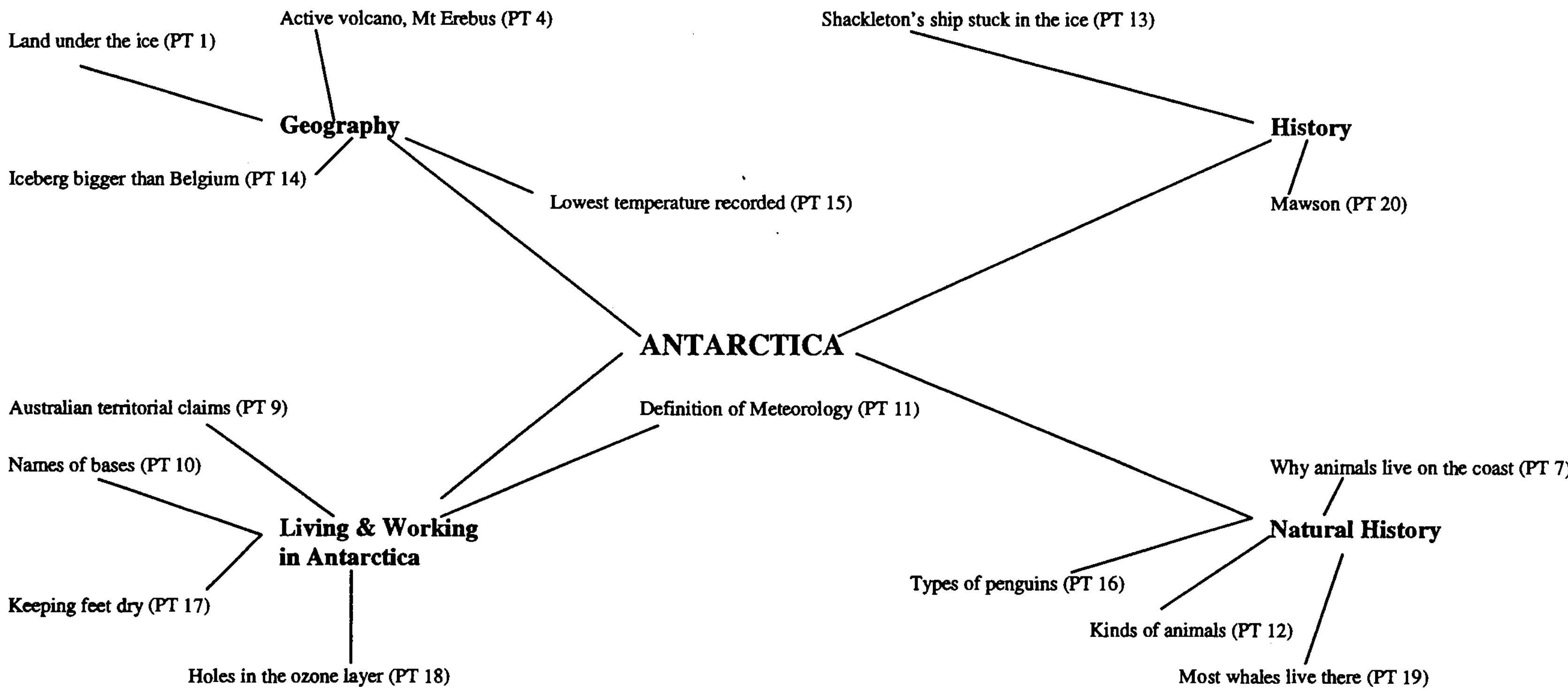
** no journal data available

Figure 53: Max's Pre-Lesson Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

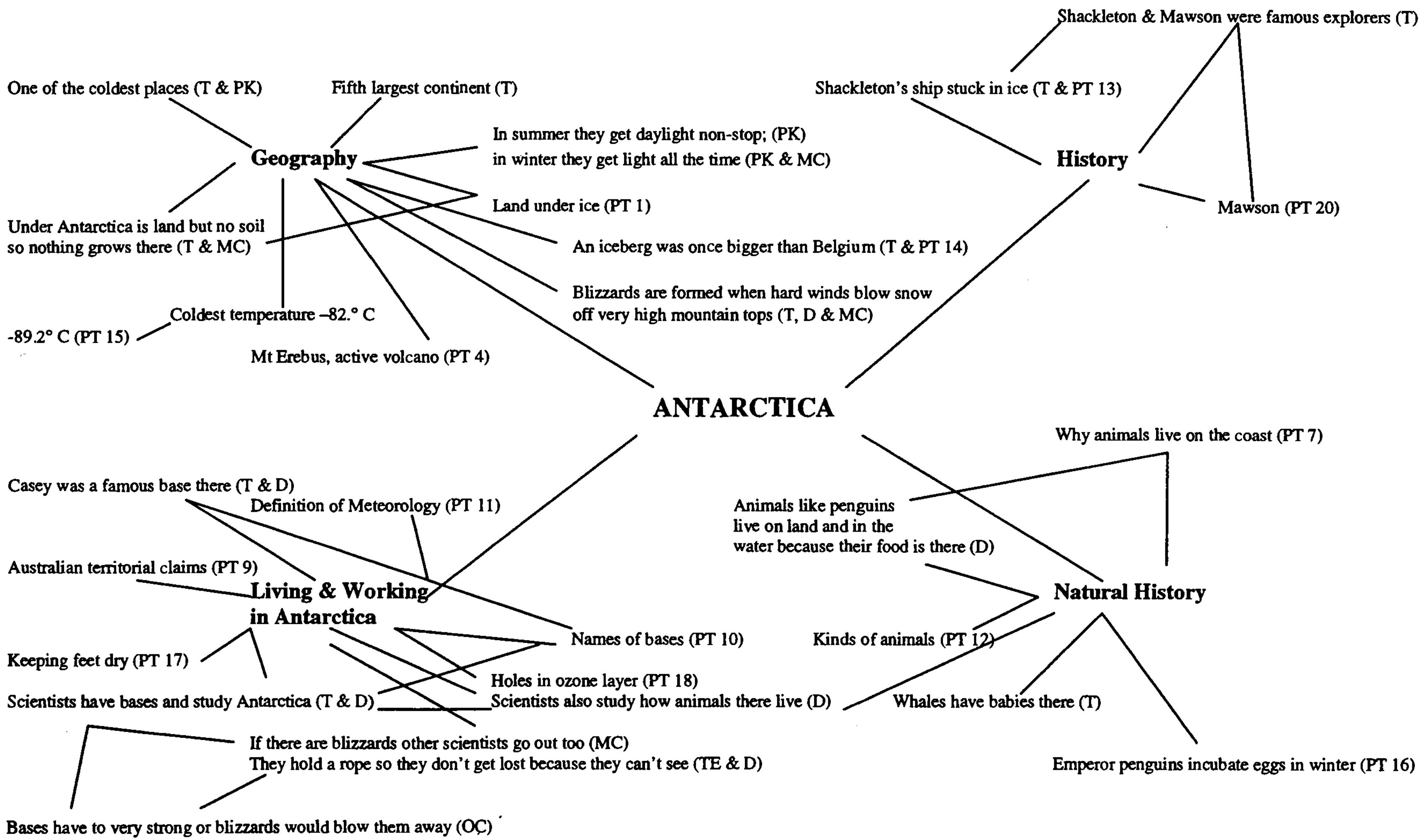
Figure 54: Max's Post-Lesson Concept Map



Note: No learning journal data available.

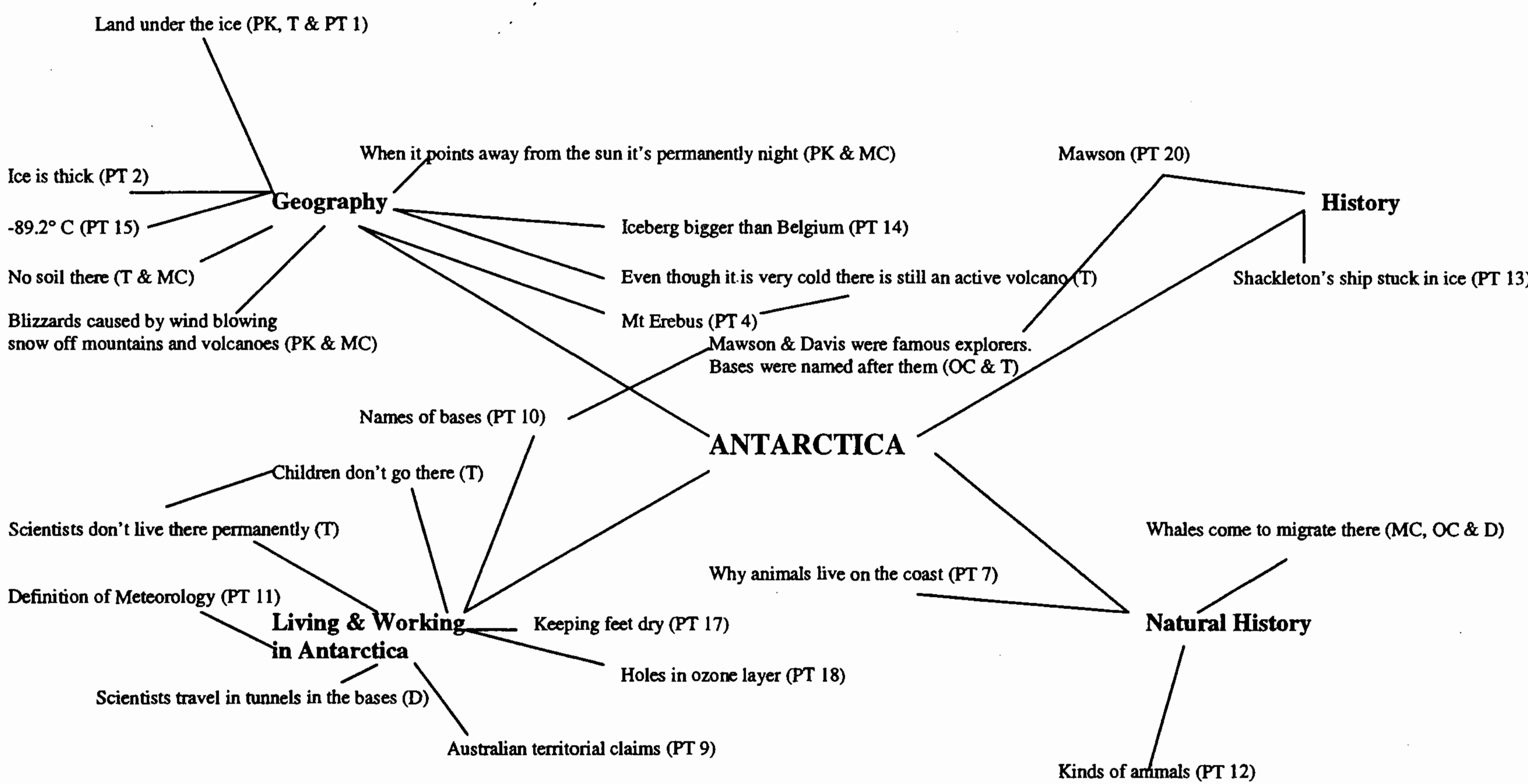
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 55: Max's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 56: Max's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Kate

Kate was not attending School B when prior knowledge data were collected. Her concept maps (Figures 57-59) revealed a student who seemed to have difficulty retaining information and concepts consistently over the three data collection points (see Table 31). Kate was a strong student in Mathematics but the relative brevity of her journal writings may also be attributed to her difficulties with English as described in the teacher data.

TABLE 31

Distribution of journal codes and test scores

Group B 2-Kate

	*Pre lesson***	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge						
Test scores (%)			65	40	55	
Text		10	3	2	4	19
Discussion		2		1	1	4
Own constructions		1		2		3
Mis-constructions		4	2	1	1	6
Teacher effects				1	1	2
Affective statements		1				

*includes three journal entries

**no data available

Despite her problems with English Kate was not deterred from making a contribution. Her references to explorers, Shackleton and Mawson, though inaccurate (eg. no base is named after Shackleton), suggested an attempt to come to terms with the information, including the spelling of the names.

Australian bases called Sakciten and Marson.

(Kate, post-lesson journal)

Shatcalten & Marson (*Shackleton & Mawson*) are explorers that were the first people to find Antarctica.

(Kate, three-month journal)

Kate's ideas about Antarctic wildlife developed further by the final journal; "...there are penguins; the types are adelie, emperor and more. There are birds, seals and shrimp." indicating a link to discussion. Kate provided other evidence of the influence of discussion and knowledgeable students such as Max in her final journal. This lesson one exchange appeared to have made a lasting impression on Kate.

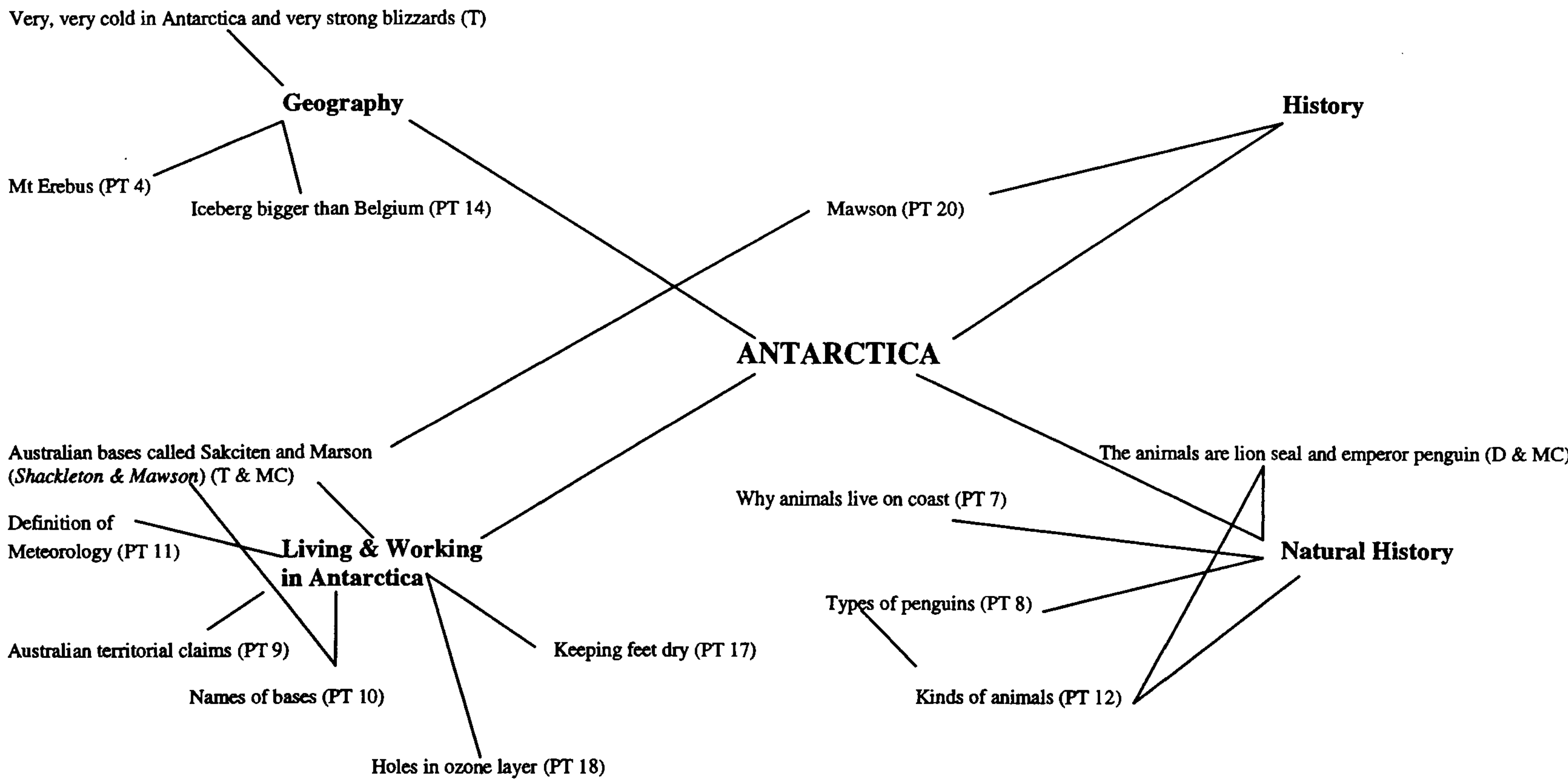
Max:	...no in winter it goes away from the sun and it keeps on spinning that way but they get night time all the time. Night time twenty four hours...
Kate:	A day?
Max:	A night.
Kate:	A day.

Kate recalled this exchange in her twelve-month journal as "...during the year it's dark and cold". Another link to discussion was the references to food in Kate's three-month journal, "...you can't live there for long because you can't find a lot of food..." (Figure 58) which seemed to originate in the following discussion from lesson one.

Kate:	And you wouldn't have like any food except for fish and there's hardly any fish in Antarctica.
Cale:	You wouldn't be able to cook the fish.
Max:	Yeah you wouldn't be able to cook the fish.
Kate:	Yeah and you would get sick of eating fish every single day.
Cale:	yeah and you would have to eat all the blood and that.
Max:	Yeah because if you eat it raw you will get bones and you might get food poisoning.
Kate:	Do you know what...and there's not...there wouldn't be so many holes.
Max:	What do you mean?
Kate:	Holes in the ground *(ice)* to catch them *(the fish).*
Max:	Anyway you wouldn't bring a saw or anything *(to cut the ice).*
Kate:	No.
Max:	It's three kilometres thick.

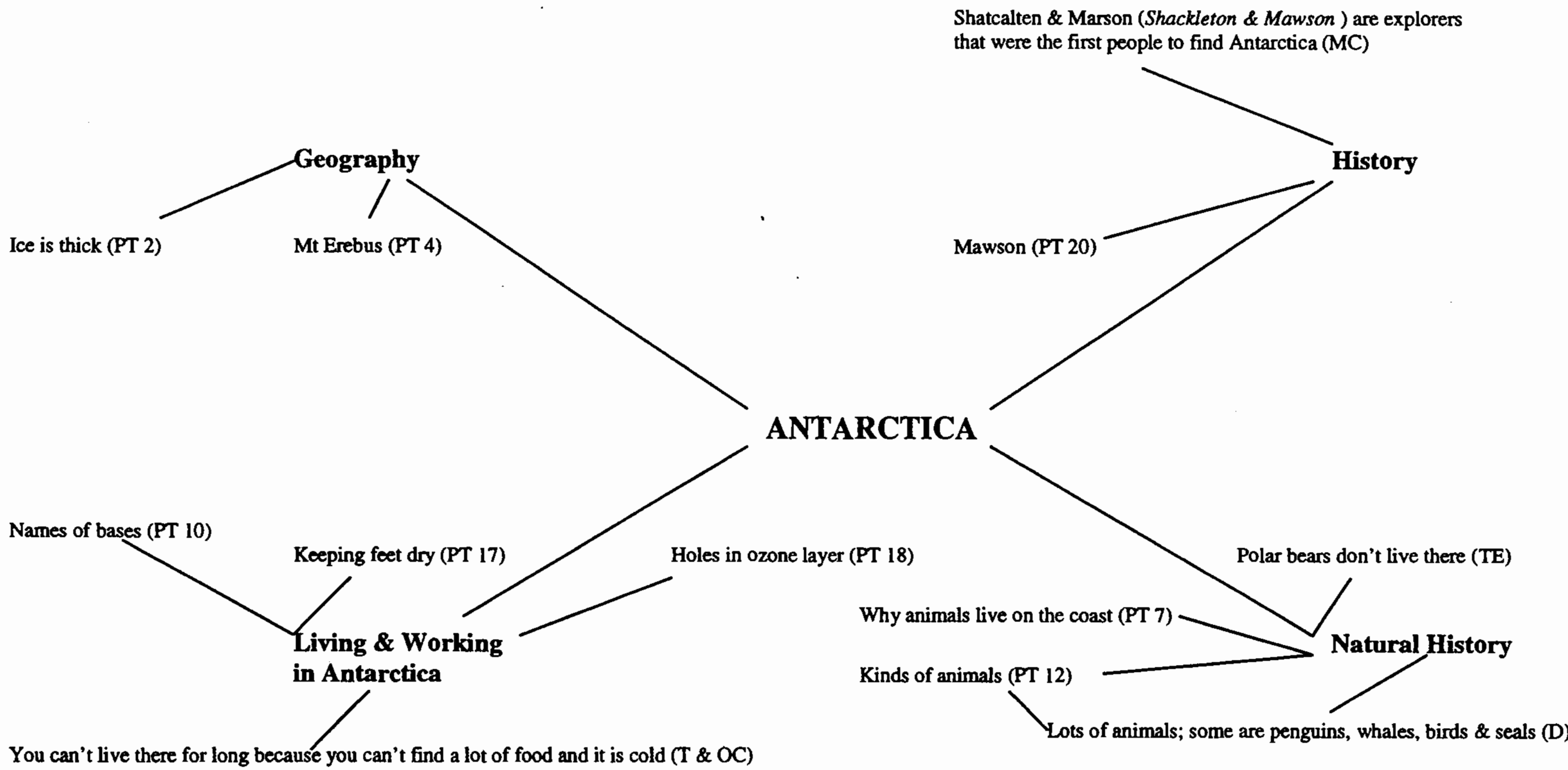
Kate's difficulties with English seemed to inhibit her journal writing and her test scores indicated a student who either experienced difficulty with the unit content or had not engaged with the lessons adequately. The former appears more likely in view of Kate's participation in discussion set against the dominance of Max.

Figure 57: Kate's Post-Lesson Concept Map



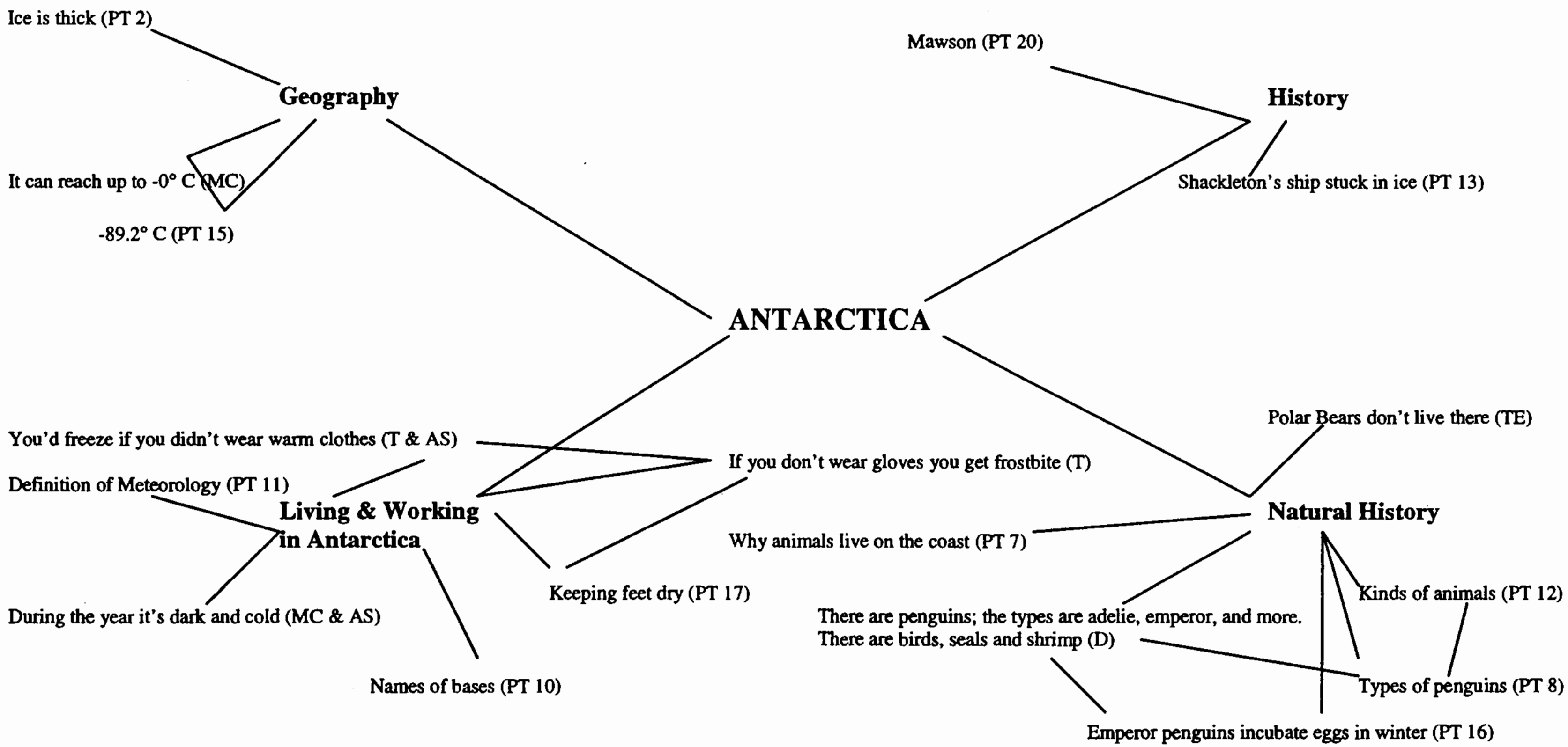
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 58: Kate's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 59: Kate's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

<u>Molly</u>

No pre-test and twelve-month data were available for this student. As described above, Molly was a very passive student in discussion. Her post-lesson and three-month test scores indicated she had learned from the lessons but her journals provided limited evidence. However, some instances were discerned where Molly had gained from the cooperative setting. Her statements about blizzards were one example of the influence of discussion on Molly's learning (Figures 61 & 62).

> There are blizzards which is a very bad snowstorm.
>
> *(Molly, post-lesson journal)*
>
> All the buildings are joined together because there might be a blizzard outside. The buildings are joined by a tunnel.
>
> *(Molly, three-month journal)*

In the following exchange from lesson one, Molly made no contribution but she appeared to have been listening actively because the blizzard concept was retained.

Max:	A blizzard is a very dangerous storm to be caught out in. Why? Give two reasons. Well one, it's so cold you can get frostbite.
Kate:	Yeah and two and two that's the ice hitting you and by hitting it is really hard.
Max:	Nah nah cos it's only snow but you can't see anything cos there's so much it's just like blinding.
Kate:	You don't have to write two.
Max:	Yes, you do. It says give at least two reasons, it says...

Cale: ...see, it says at least.

Max: What?

Cale: At least two...

Max: I know. Yes it does doesn't it Kate. Oh well so let's see. One it gives frostbite, write number one. One you get frostbite. So what would be the other one? It blinds you...

Kate: Hard to see...

Max: Nah right what do you mean?

Cale: The waves would get really hard and rough.

Max: There is no waves in Antarctica.

Cale: Yes there is. There's water under the ice.

Max: I know but there's not going to be...there's not going to be any surfers or anything there (group giggles). No we're talking about blizzards not the water. So two, it blinds you OK; write that.

The group's discussion about blizzards was related to the tunnel connecting buildings in lesson two. This discussion was recalled by Molly in the three-month journal.

> All the buildings are joined together because there might be a blizzard outside. The buildings are joined by a tunnel.
>
> *(Molly, three-month journal)*

The discussion about penguins in lesson four was also extensive due to the structure of the lesson. This may have assisted the development of Molly's concept about animals in the Antarctic, as indicated in the post-lesson journal (Figure 61).

> Many animals and dangers there.
>
> The animals that live there are emperor penguins, blue whales, seals.
>
> Careful of blue whales, that you don't bump into them.
>
> *(Molly, post-lesson journal)*

TABLE 32

Distribution of journal codes and test scores

Group B 2-Molly

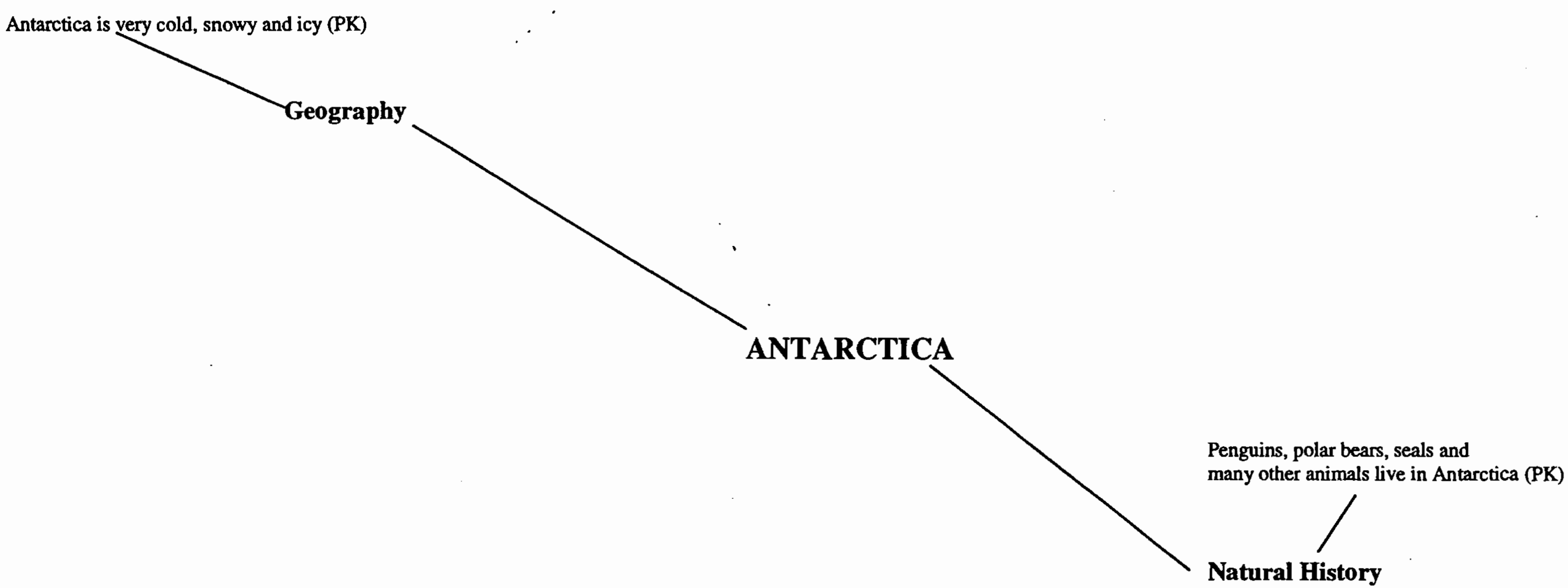
	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months***	*Totals*
Prior Knowledge	3	1				4
Test scores (%)	**		70	60		
Text		14	1	1		16
Discussion		3	3	2		8
Own constructions			2			
Mis-constructions		1		2		3
Teacher effects				1		1
Affective statements						

*includes three journal entries

** no data available

The available data for Molly (Figures 60-62, Table 32) suggest a student who had not engaged strongly with the lessons. According to teacher data, her passivity was more likely to be due to a lack of self-confidence in social settings rather than a lack of ability. Molly was regarded generally as an intelligent student. Further discussions with the teachers suggested that Max's assertiveness might have contributed to Molly's passivity. The combination of a lack of self-confidence and a dominant Max may have led to Molly's pronounced lack of involvement in the lessons.

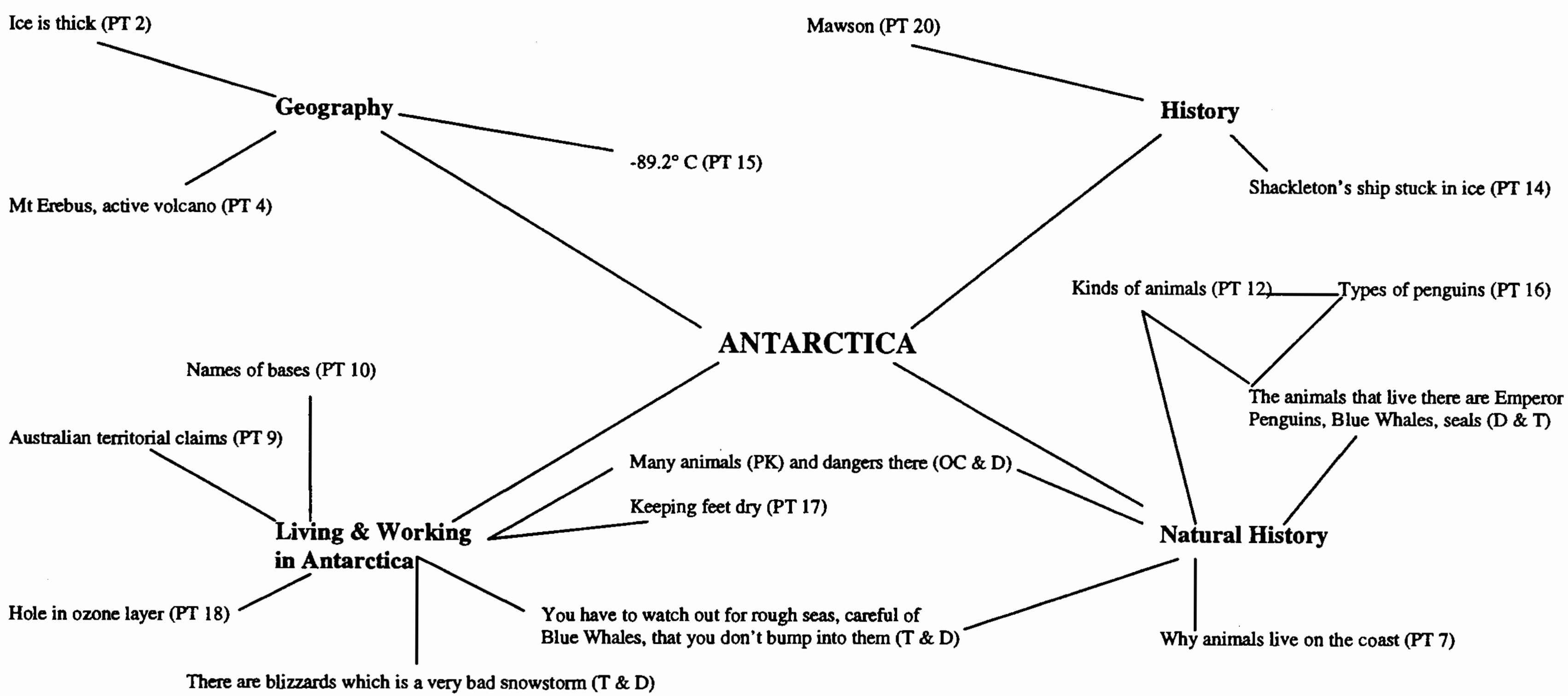
Figure 60: Molly's Pre-Lesson Concept Map



Note: No pre-test data available for this student.

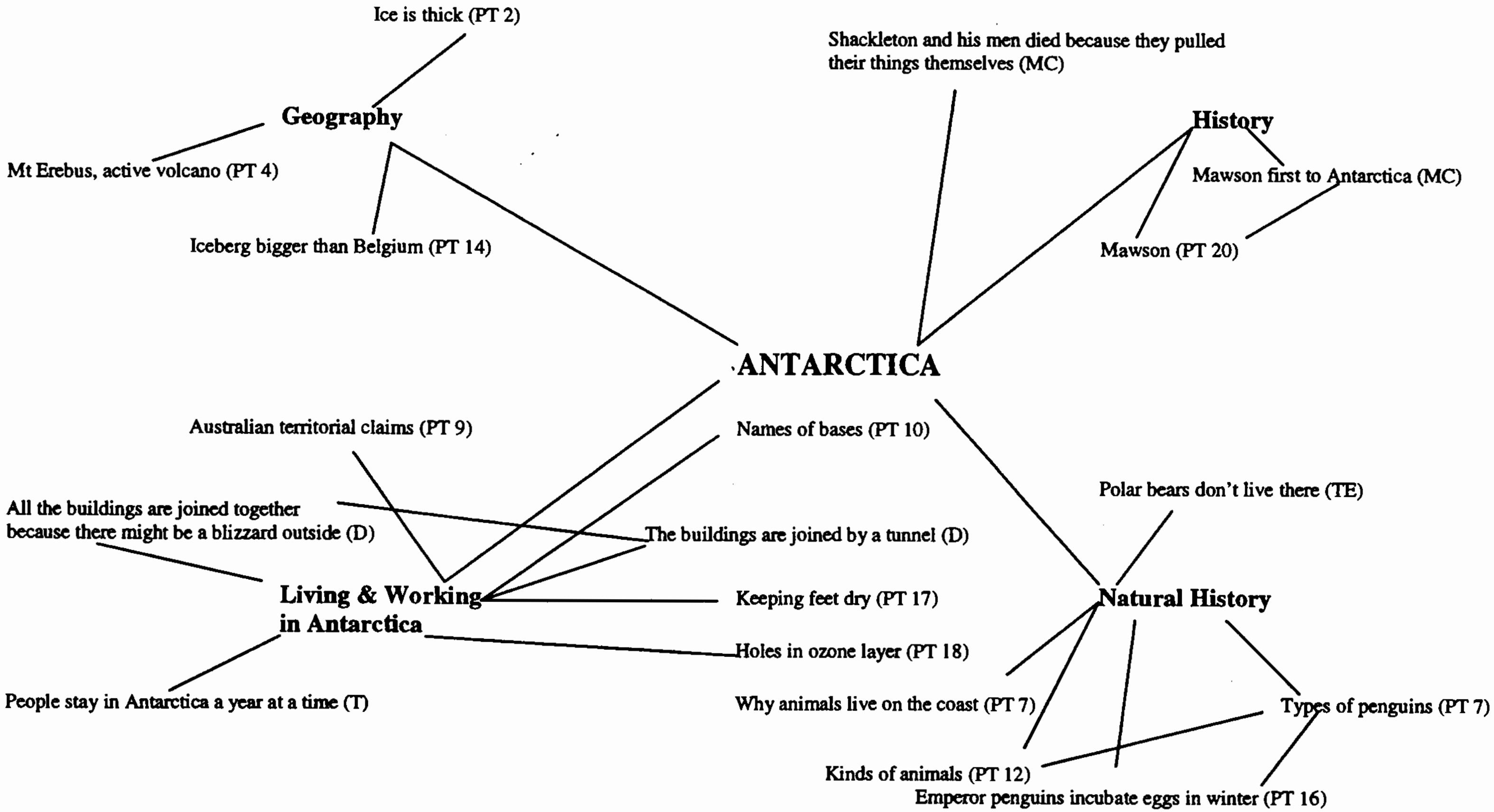
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 61: Molly's Post-Lesson Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 62: Molly's Three-Month Concept Map



Note: No twelve-month data available.

Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Knowledge and concept development within the group

Cross-referencing discussion and journal data provided some insights into the development of these students' concepts. The two concepts reported with consistency related to blizzards and general notions about the wildlife in Antarctica.

Blizzards received considerable attention in lesson one, featuring in 12.3% of all discussion in this lesson. All students except Kate specifically mentioned blizzards in their journals after three-months and Molly reported " ...there are blizzards which is very bad snowstorm" post-lesson. Cale and Max elaborated the concept in their three and twelve-month journals, including information about buildings and tunnels connecting them.

General concepts about Antarctic animals appeared consistently in all students' journals and test scores. Animals of various kinds were discussed at length in lesson four, receiving 43.9% of all discussion. This was not surprising given the structure of the lesson and was one occasion when the group engaged in in-depth types of discussion (MAKITAB codes TS09-TS11, see Appendix H & I). Discussion about blizzards and animals also appeared at other times, such as in lesson three when students were discussing possible hazards faced by Antarctic explorers. In this instance, blizzards and blue whales were combined.

Max: (*reads question three*) What kinds of dangers would Shackleton and his men have faced?

Cale: Blizzards...

Unknown student: seas...

Kate: ...just put blizzards and rough seas

Cale: Blizzards and...

Max: ...are you putting blizzards?

Kate: Blue whales and rough seas.

Cale: Blizzards, blue whales and rough seas.

The discussion above was brief but it appeared to establish a connection in the students' mental structures between the explorer Shackleton, blizzards and whales. Animals and blizzards had received considerable attention in discussion time and when Shackleton, blizzards and whales were discussed at the same moment, they appeared to become associated together. This was confirmed by analysis of journal data. This phenomenon is described further in the next chapter.

At first examination, Table 33 seems to indicate a group that engaged in satisfactory levels of task enhancing talk (described above). The benchmark of TS08 to TS11 MAKITAB codes represented 74.1% of on-task talk. This could be expected to produce better outcomes than those observed when comparing this figure, for example, to case study 1 (group A1) which produced 68.9% of their on-task talk in the same MAKITAB codes. However, group A1's talk was on-task an average of 90.4% of the time compared to group B2's 67.4% and given that Max dominated 40.1% of his group's on-task talk, this table may be misleading. Even a creditable 34.3% of the TS11 code did not guarantee gains in student outcomes, seeming to indicate that the quality of talk was not the only variable influencing student learning. Other variables influencing this group's performance may have been Kate's difficulties with English and Molly's passivity. The quality of talk issue may revolve around which student says what and when. If one student does *all* the TS11 talking, this could not be expected to benefit other students directly.

A comparison of TS08 and TS11 codes across all lessons reinforces the view that Max had withdrawn to some extent after the first two lessons because of the conflict described above. TS11 talk predominated while Max was motivated to lead the group but the TS08 talk became more prominent in the later lessons.

TABLE 33

GROUP B2

MAKITAB ANALYSIS ON TASK TALK (TS CODES ONLY)

Codes	*lesson 1*	*lesson 2*	*lesson 3*	*lesson 4*	*lesson 5*	*Total*	*%*
TS01		1		1		2	0.3
TS02	10	8	10	8	1	37	7.04
TS05	2	3	9	8		22	4.1
TS06		1	1			2	0.3
TS07							
TS08	12	18	20	43	34	127	24.2
TS09	5	5	1	1	12	24	4.6
TS10	15	20	11	3	9	58	11.0
TS11	51	47	24	24	34	180	34.3
TS12	7	3	2	5	1	18	3.4
TS13							
TS14	10	4	8	10	5	37	7.0
TS15	8					8	1.5
TS16	1	1		7	2	10	1.9
Lesson Totals	121	111	86	110	98		

5.7. Case study 5 (group B3, school B)

Profile

This group comprised two female and two male students; Rebecca, Hannah, Cody and Billy. Cody and Rebecca were in year three (eight year olds) while Hannah and Billy were in year two (seven year olds) at the commencement of the study. Twelve-month data were not available for Hannah and Cody due to absences. Teacher statements described Rebecca as an intelligent, articulate high achiever. The other students were generally middle achievers. Billy was prone to off-task behaviour and distracting other students. Hannah was typically reserved in regular class activities. Cody was particularly interested in Science and tended to read mostly non-fiction. When evaluating Hannah and Billy's performances in the lessons, their relatively young age must be considered. This has implications relating particularly to their prior knowledge and skills with reading and writing.

Group processes in the discussion

The group developed a working culture that involved individuals taking turns to answer the worksheet questions. They were oriented towards completing the task, rather than developing in-depth discussion of well thought-out answers. The notion of "finishing" the task appeared more important than thinking and talking carefully about their answers. This lesson three example is one of several similar exchanges.

Rebecca: You guys we're one of the only groups still going...

Billy: ...six groups are still going...

Rebecca: Well come on, just...we're one of the last.

Rebecca and Cody tended to dominate the discussion. This may be explained in part by age-related status differentials among the group's two younger members, Hannah and Billy. Table 34 indicates that the group member's contributions to discussion seemed to have split along age lines. That is, the two older children made approximately even contributions, as did the younger children.

TABLE 34

Group B 3 Summary of task related statements made in group discussion (all lessons)

Student name	*Total on-task statements (off-task statements)*	*% on-task (% off-task)*
Rebecca	183 (43)	32.68 (12.39)
Hannah	99 (91)	17.68 (26.22)
Cody	169 (119)	30.18 (34.29)
Billy	109 (94)	19.46 (27.08)

Rebecca was highly motivated to complete the task and tended to assume a leadership role. She appeared to like to be in command of the situation and became irritated when the group did not follow her lead. On one occasion in lesson two she challenged another student with "...Hannah, how come we always have to do what you say?".

Rebecca mimicked teacher-like statements when attempting to re-gain control of the group and she used the worksheet to maintain her position. In doing so she sometimes dismissed other children's contributions. In this lesson two exchange, Rebecca was focussed on completing the answer and disallowed Cody's effort.

Rebecca: Fix the machines...

Cody: *(insisting)* Animals...

Rebecca: No, it's too late we've already got fix the machines.

Rebecca contributed much of the substantive content to the discussion. She was the only group member who seemed prepared to discuss the questions in-depth and to question other students' responses as the following exchange indicates.

Rebecca: Electrocuted by snow?

Cody: Yeah. No you know how the water's so cold and you're in the water...

Rebecca: Can you think of another reason?

The group's younger members seemed unable to engage with the content and tended to go off task relatively easily. This may have related to issues of reading and writing skills and prior knowledge described above. As a result, Billy became disruptive at times and Hannah became generally passive. Billy's disruptive behaviour earned rebukes from Rebecca. No effort was made to include Hannah.

Rebecca's task motivation extended to protecting the group's answer from other groups. In one instance, she shouted at another group, "...shut up, you took our frostbite answer". The group's task motivation included a group pre-occupied with correct spelling.

Table 35 further indicates this group's motivation to complete tasks. For lessons four and five, talk was off-task mainly after task completion but for the sake of data reduction rules (see chapter four) all responses were coded. In lesson five, the student talk only went off task after the task was complete. The efficacy of this group's talk will be evaluated in the final section of this case study.

TABLE 35

Group B 3 task related and non-task related talk

Lesson number (total statements)	*Task related talk (%)*	*Non-task related talk (%)*
1 (165)	65	35
2 (193)	65	35
3 (289)	47	53
4 (168)	78	22
5 (92)	63	37 (after task completed)
Means	63.6	36.4

Group B 3 individual case studies

Rebecca

Rebecca's pre-lesson journal indicated a broad understanding of concepts about Antarctica. The following example was a collection of general concepts about Antarctica known by Rebecca before the lessons but not elaborated in later journals.

> Penguins, seals, blizzards, icy waters, icebergs and no polar bears. Lots of penguins and seals and freezing conditions. Lots of blizzards. Deep dark waters.
>
> *(Rebecca, pre-lesson journal)*

Rebecca's remaining journals revealed a student with good recall, particularly of information gained from text (see Table 36). Some key writings were related to discussion but most of her knowledge seemed to have been gained from reading lesson texts. In several cases Rebecca's journal writings were a combination of several pieces of information into one integrated statement.

> Robert Scott led his team of explorers through Antarctica in a race to the South Pole. They tried to pull the sleds themselves and started to sweat and the sweat froze and they probably died from frostbite.

TABLE 36

Distribution of journal codes and test scores

Group B 3-Rebecca

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	9			1		10
Test scores (%)	45		90	80	85	
Text		19	11	10	8	48
Discussion		4	2		2	8
Own constructions		1	1		1	3
Mis-constructions			1		1	2
Teacher effects						
Affective statements		2				2

*include three journal entries

Rebecca's Robert Scott entry was linked to a statement about Amundsen reaching the South Pole first and over time the various pieces of information were re-organized into a more succinct statement.

Amundsen & Scott had a race to the South Pole. Amundsen reached there first while Scott's men died from the cold.

(Rebecca, twelve-month journal)

Rebecca's ability to recall information obtained from text was evident in the above example because the discussion about Scott and Amundsen was limited to the brief comments below from lesson three.

Cody:	Why do you think Scott's team died but Amundsen's lived. Give two reasons.
Billy:	OK...
Hannah:	What does it say anyway? (indistinct) It says...
Billy:	...Hayley said it
Hannah:	Aaaannnarctic...
Cody:	Because Amundsen was saved by the...
Rebecca:	...What do you think? Amundsen's men took dogs and Scott's team...Annie, we're trying to keep this seriously (speaking to a member of another group).
Cody:	Amundsen's men took dogs.
Hannah:	And Scott's men tried to pull the sleds themselves.

Similarly, specific discussions about Cook were brief but the concept that Cook had circumnavigated Antarctica was well established in Rebecca. A capacity to learn direct from text was further evident in her recall that the first landings in Antarctica were by sealers. This was not discussed at any time during the lessons (Appendix J) and Rebecca was the only study student to recall this piece of information.

The group amalgamated the discussion of the third (Shackleton's problems) and fourth question (dangers explorers face today) in lesson three (Appendix J) into a general discussion about the dangers in Antarctica. This was interspersed with off-task talk, talk hampered by a lack of prior knowledge and talk geared to completing the task as quickly as possible. Despite these potential difficulties, Rebecca recalled the facts about Shackleton's ship becoming stuck in the ice and the subsequent sea voyage to safety in the post-lesson, three-month and twelve-month journal. Note the evolution of the open boat voyage across dangerous seas→a rough journey they all survived→sail back in a raft.

> Shackleton's ship got stuck in the ice and he had to lead his men through an open boat voyage across dangerous seas. Luckily, none of his men died.
> *(Rebecca, post-lesson journal)*
>
> Shackleton's ship stuck in ice. A rough journey, they all survived
> *(Rebecca, three-month journal)*
>
> Shackleton's ship got stuck in the ice and they had to sail back in a raft.
> *(Rebecca, twelve-month journal)*

The group's discussion for question two, lesson four (Appendix J) was also potentially unproductive. Cody attempted a solution and Rebecca appeared to grapple with the concept while the other group members seemed to make little progress with the question.

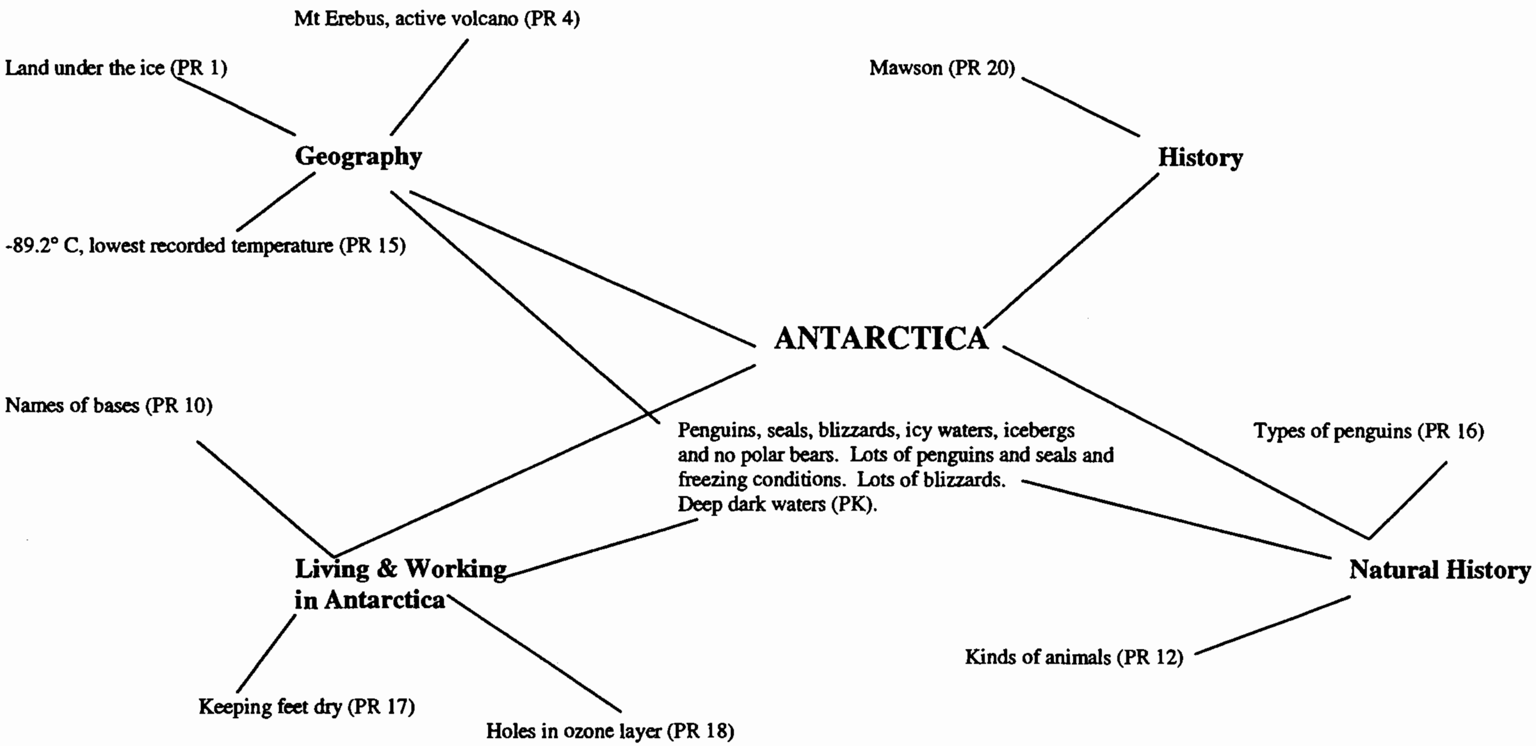
Cody:	Why do you think the animals live in or near the sea? *(reading question)* ...because they're attracted to the sea? *(Billy giggles)*
Rebecca:	*(sounds annoyed)* They are not attracted to the sea. You are just being silly.
Cody:	I'm not.
Billy:	*(to Rebecca) You're* being silly...
Cody:	I am trying to figure something out...
Hannah:	Because they want to float?
Cody:	No cos' they all can swim...
Rebecca:	Because they can't fly.
Hannah:	Maybe...
Rebecca:	...but why would they be near the sea if they couldn't fly. They could be in the middle of Antarctica. They could be...they could be living permanently in the ocean if they couldn't fly.

By Rebecca's twelve-month journal she had produced a satisfactory solution to the question.

> No animals live inland. They live on the coast because there is no food inland, it all lives in the sea.
>
> *(Rebecca, twelve-month journal)*

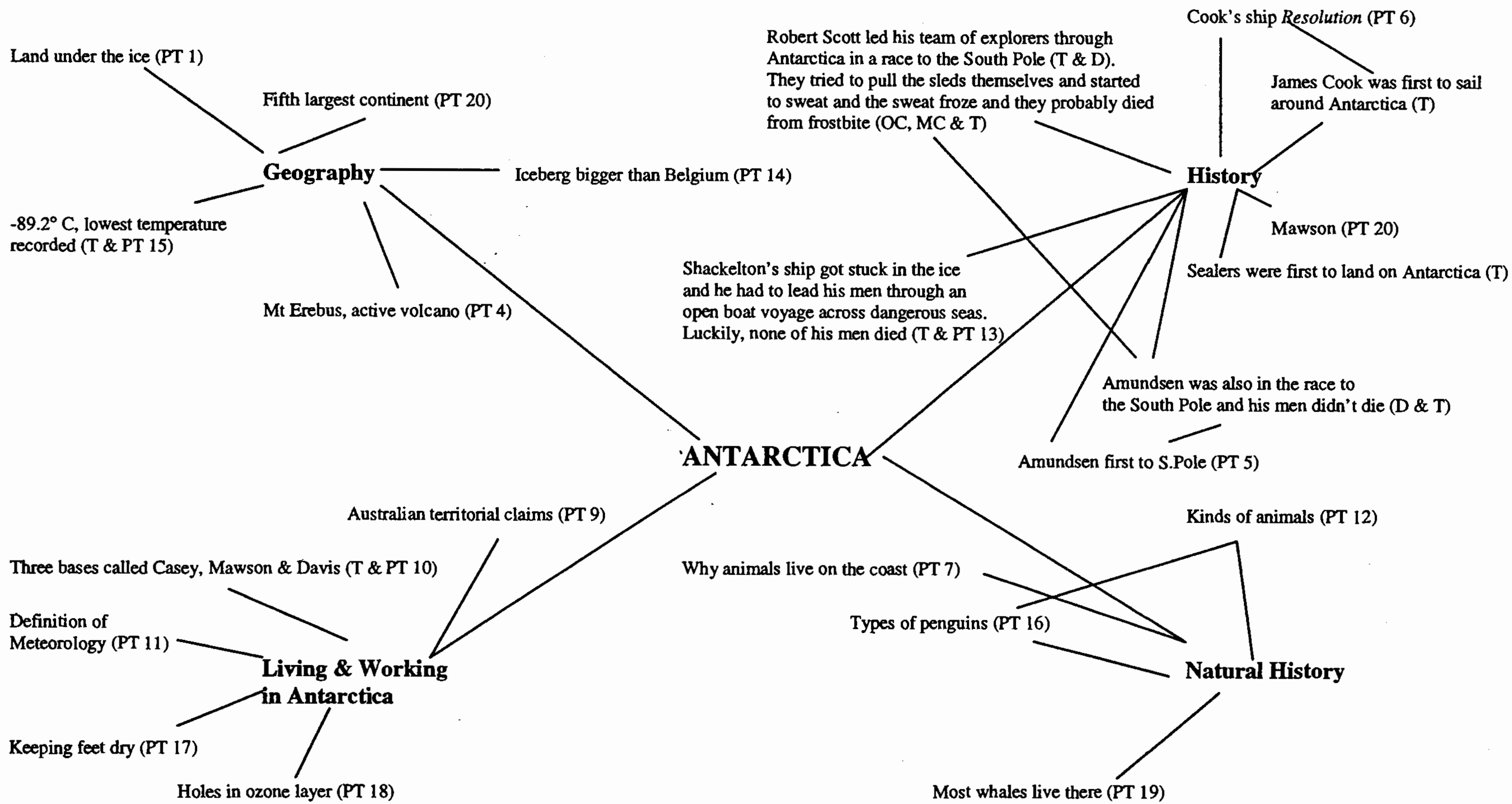
Rebecca's concept maps (Figures 63-66) confirm teacher and observational data that she was an academically able, highly motivated student. She demonstrated strong writing and reading skills during the lessons and at data collection points. Although Rebecca gained from the subject matter presented in the lessons, little evidence could be discerned that she had gained from the cooperative setting. These issues will be elaborated in the final section of this case study.

Figure 63: Rebecca's Pre-Lesson Concept Map



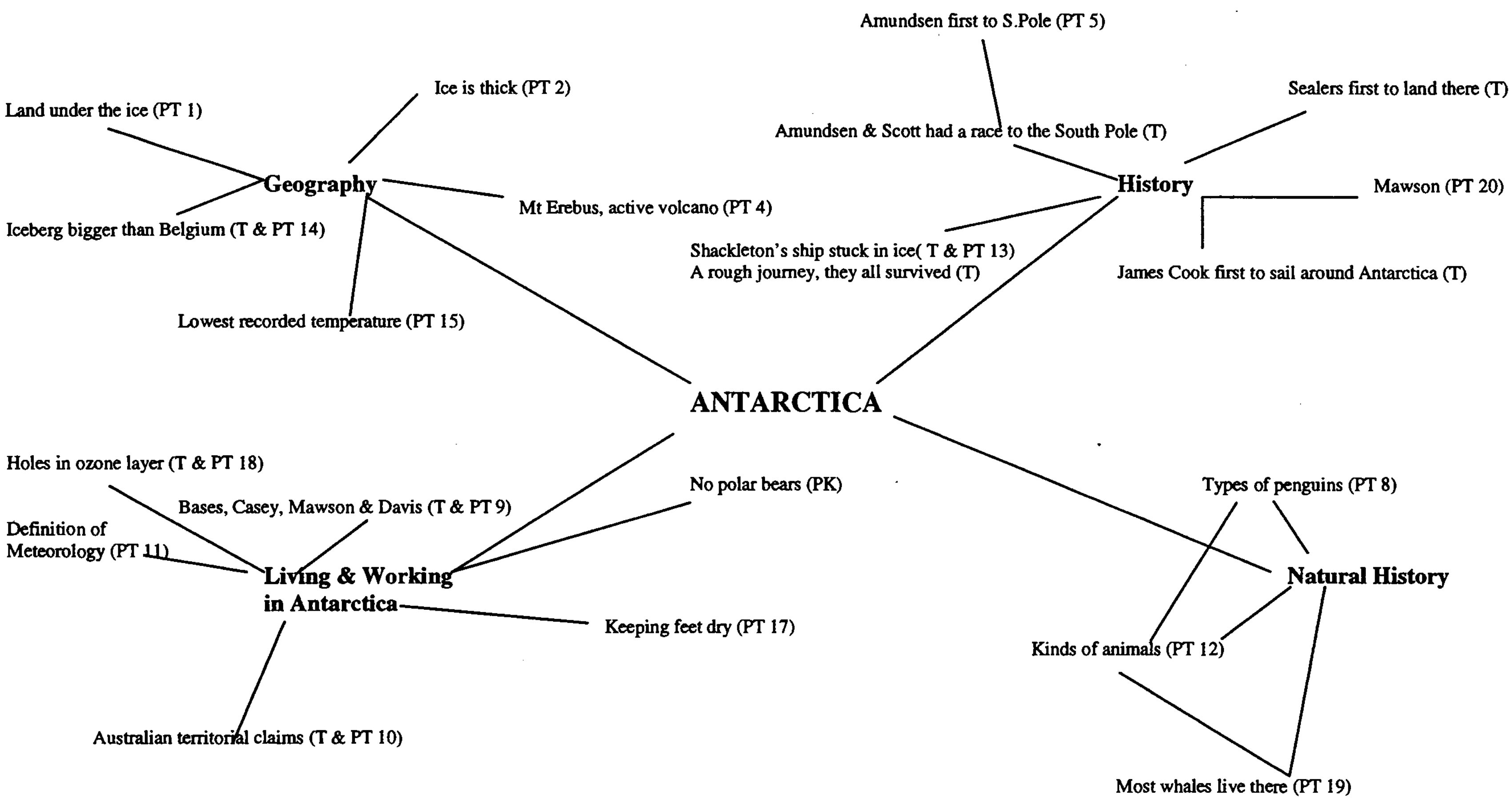
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 64: Rebecca's Post-Lesson Concept Map



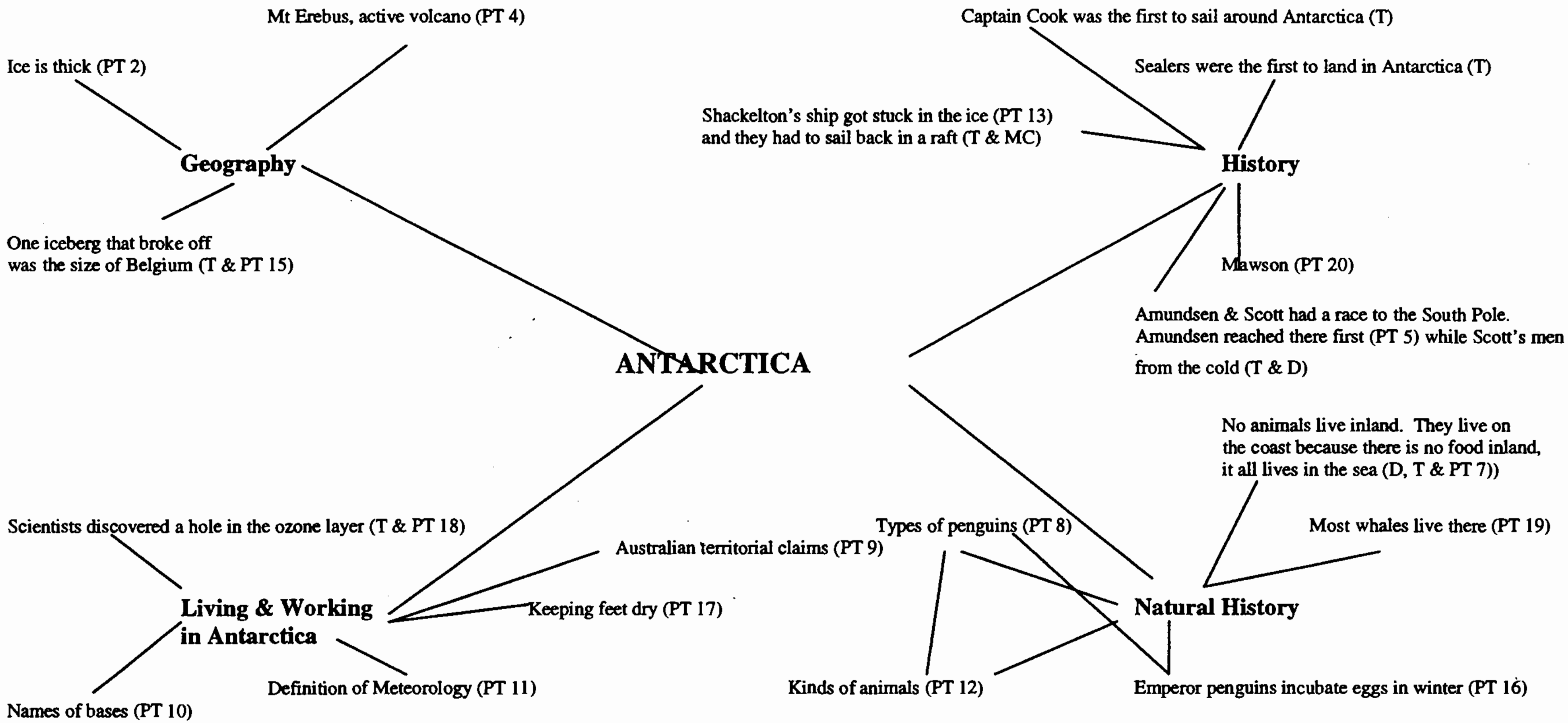
Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 65: Rebecca's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 66: Rebecca's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Hannah

No twelve-month data were available for this student. Hannah lacked prior knowledge of Antarctica as revealed by her concept maps (Figure 67). The four items she scored correct on the pre-test may have been partly attributed to guesses. However two concepts were developed as a result of the lesson experiences. Test scores indicated that Hannah might have had a general idea that animals live in Antarctica. This developed later into journal statements. Her final journal indicated that the whole class intervention to correct the polar bears mis-construction was effective for her.

> There are animals who live there and they are all kinds of whales, birds and wolfs to pull maybe a sleigh.
>
> *(Hannah, post-lesson journal)*
>
> There are lots of animals there; no polar bears, sealions and maybe whales.
>
> *(Hannah, three-month journal)*

The general notion that Antarctica is a cold place involved a focus onto specific temperatures, "...coldest temperature is 8.9° C" (post-lesson journal) and may have been linked to discussions and journal entries about blizzards "...there is a storm called a blizzard" (Figure 68) and "...they even have blizzards" (Figure 69). A further link (Figure 69) was discerned between discussions about tunnels joining buildings in lesson two and Hannah's blizzard/cold place concepts.

> They have lots of buildings and tunnels there.
>
> They even have blizzards there.
>
> *(Hannah, three-month journal)*

Hannah's responses may seem limited compared to students such as Rebecca but they should be evaluated in an age-appropriate context. Her post-test scores indicated that she had learned some of the material presented in the lessons. She produced a higher number of affective statements than most students, especially in her mid-lesson journals (see Table 37), which may have also been related to her developmental level. Knowledge and concepts appeared to continue evolving for Hannah as indicated by her improved three-month test score and the generation of new mis-constructions. No twelve-month data were available for Hannah so further analysis of her conceptual development was not possible.

TABLE 37

Distribution of journal codes and test scores

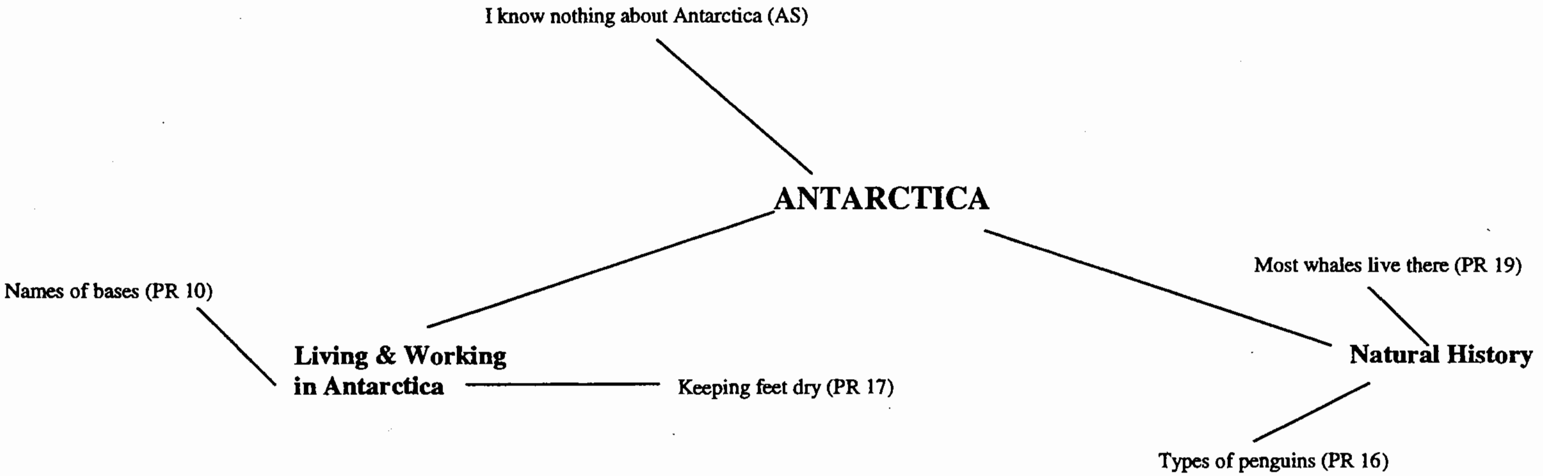
Group B 3-Hannah

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months***	*Totals*
Prior Knowledge						
Test scores (%)	20		45	60		
Text		8	6	2		16
Discussion		1	1	2		4
Own constructions		3	1	1		5
Mis-constructions		1	1	2		4
Teacher effects				2		2
Affective statements	1	7				8

*includes three journal entries

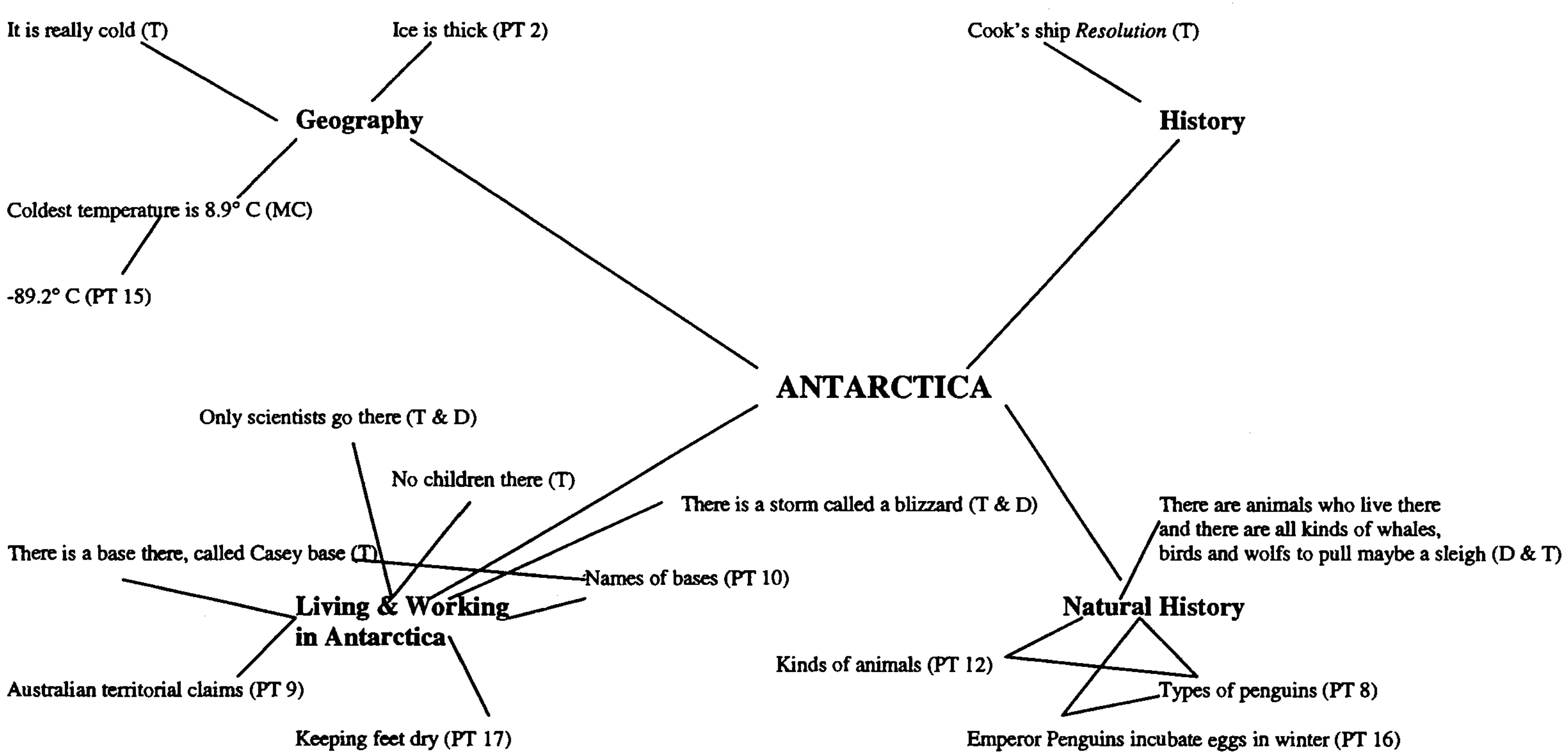
** no twelve month data available

Figure 67: Hannah's Pre-Lesson Concept Map



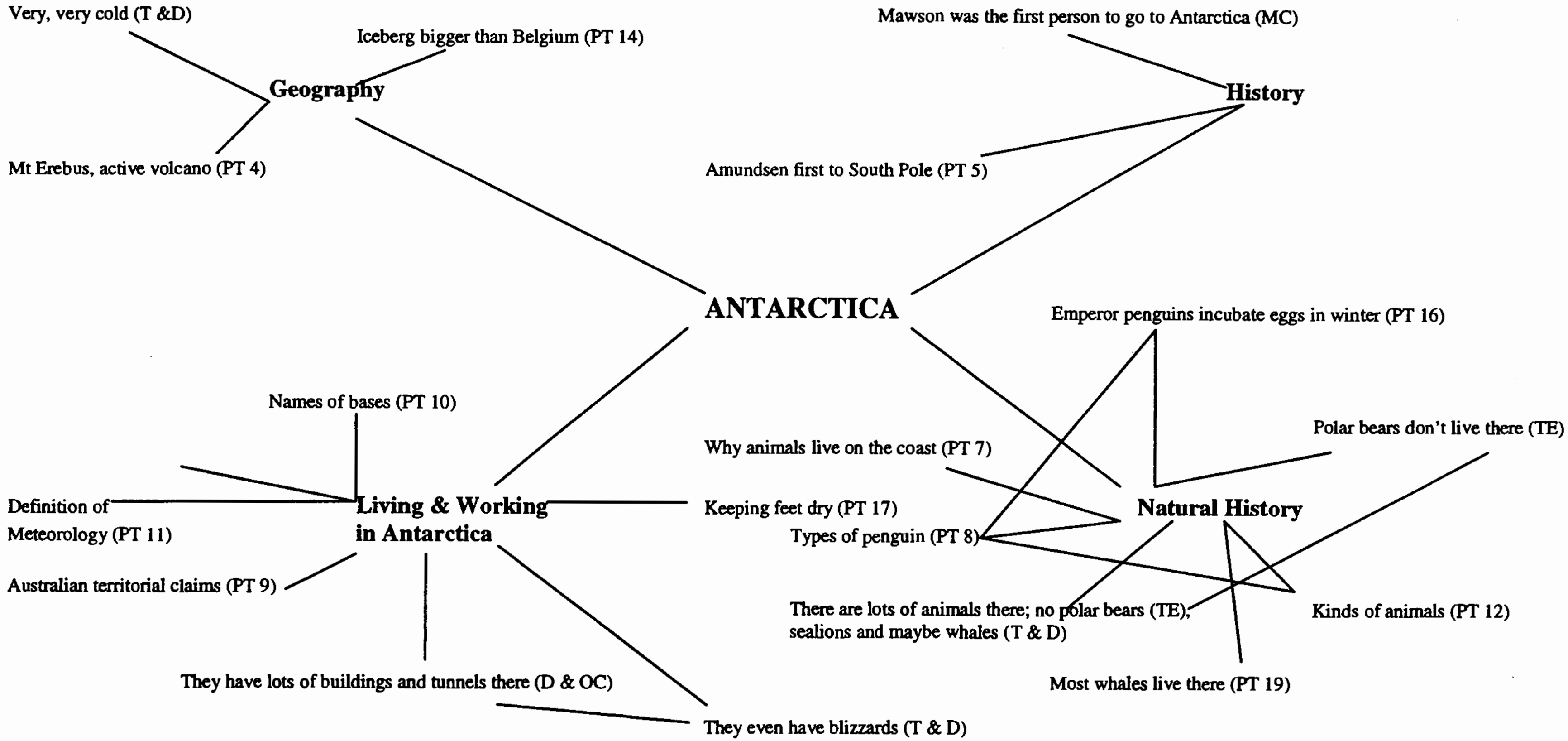
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 68: Hannah's Post-Lesson Concept Map



Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 69: Hannah's Three-Month Concept Map



Note: No twelve month data available for this student

Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Cody

Cody was not available for data collection at twelve months. His concept maps (Figures 70-72) suggest a student who had engaged with the lesson content to some degree. The lack of twelve-month data inhibited an analysis of the long-term impact on Cody's learning of the cooperative setting. Although Cody made 30.2% of all on-task statements (see Table 34) in the group's discussions he also made 34.3% of all off-task statements suggesting that his attention was not consistently to the task. This may have affected his performance which, according to teacher data, was below expectations. Table 38 indicates a student who made modest gains from the lessons. In common with his fellow group members, Cody seemed to learn best from reading the lesson text.

TABLE 38

Distribution of journal codes and test scores

Group B 3-Cody

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months***	*Totals*
Prior Knowledge	4					4
Test scores (%)	20		45	65		
Text		7	3			10
Discussion		1		2		3
Own constructions		1	1	1		3
Mis-constructions	1	1	1	2		5
Teacher effects						
Affective statements				1		1

*includes three journal entries

Cody began with a general concept of the cold conditions in Antarctica and this remained consistent across all journal entries. In the post-lesson journal Cody developed this concept into two statements and followed with a third in his three-month journal (Figures 71 & 72).

Very cold; can get to -89° C.

It's the coldest continent.

(Cody, post-lesson journal)

The weather can get to -29° C a day.

(Cody, three-month journal)

Similarly, concepts about the first Antarctic explorers seemed durable, particularly at the post-lesson journal (Figure71). Cody's knowledge about animals in Antarctica seemed to narrow the focus to penguins by the three-month journal. This was also indicated by the post-tests.

Adelie and Emperor Penguins live there because they can handle the cold weather.

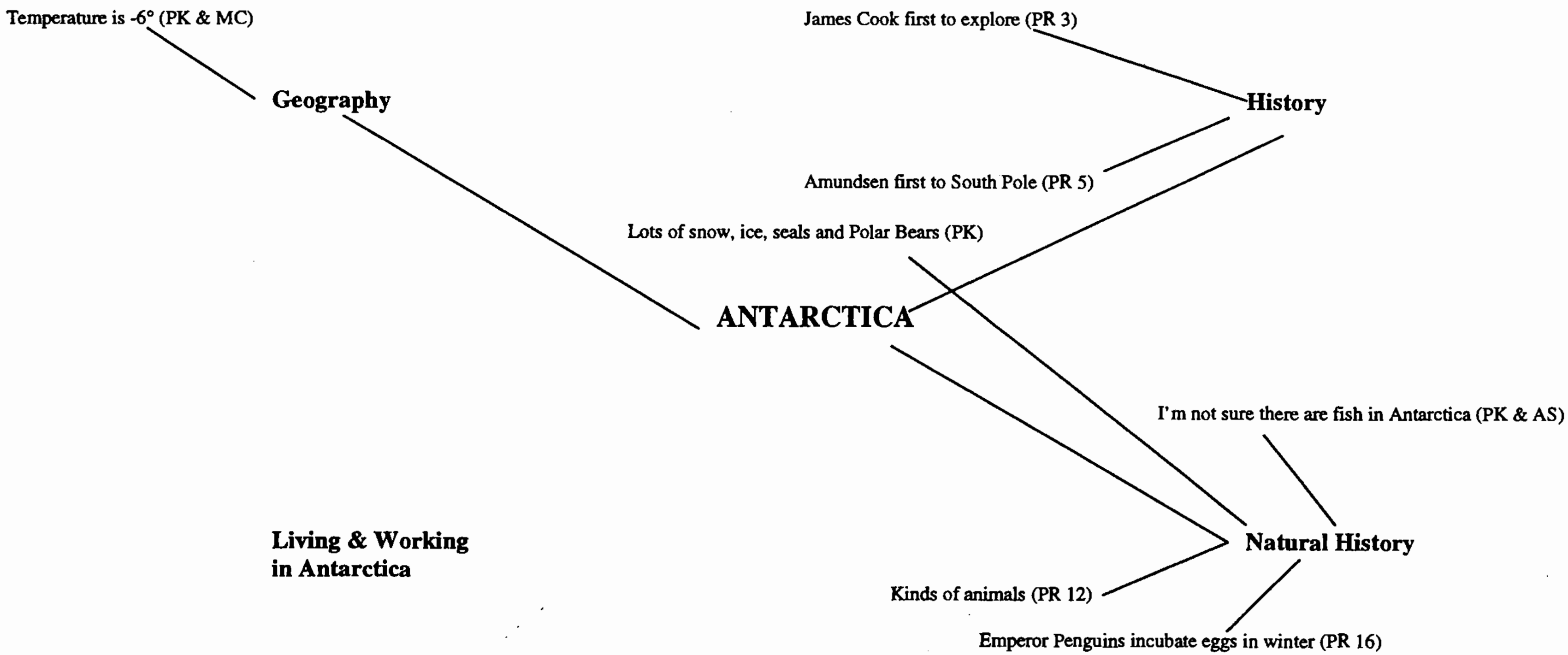
My favourite animals are the Evner (*Emperor*) Penguin and the Killer Whale.

(Cody, three-month journal)

Cody appeared to already have some knowledge of early Antarctic explorers as indicated by his correct test responses to questions three and five (see Appendix J). He developed his knowledge from lesson three into a post-lesson journal entry, "first explorers were Amundsen, Scott, James Cook" and the fact about Amundsen was also answered correctly in the three-month post-test.

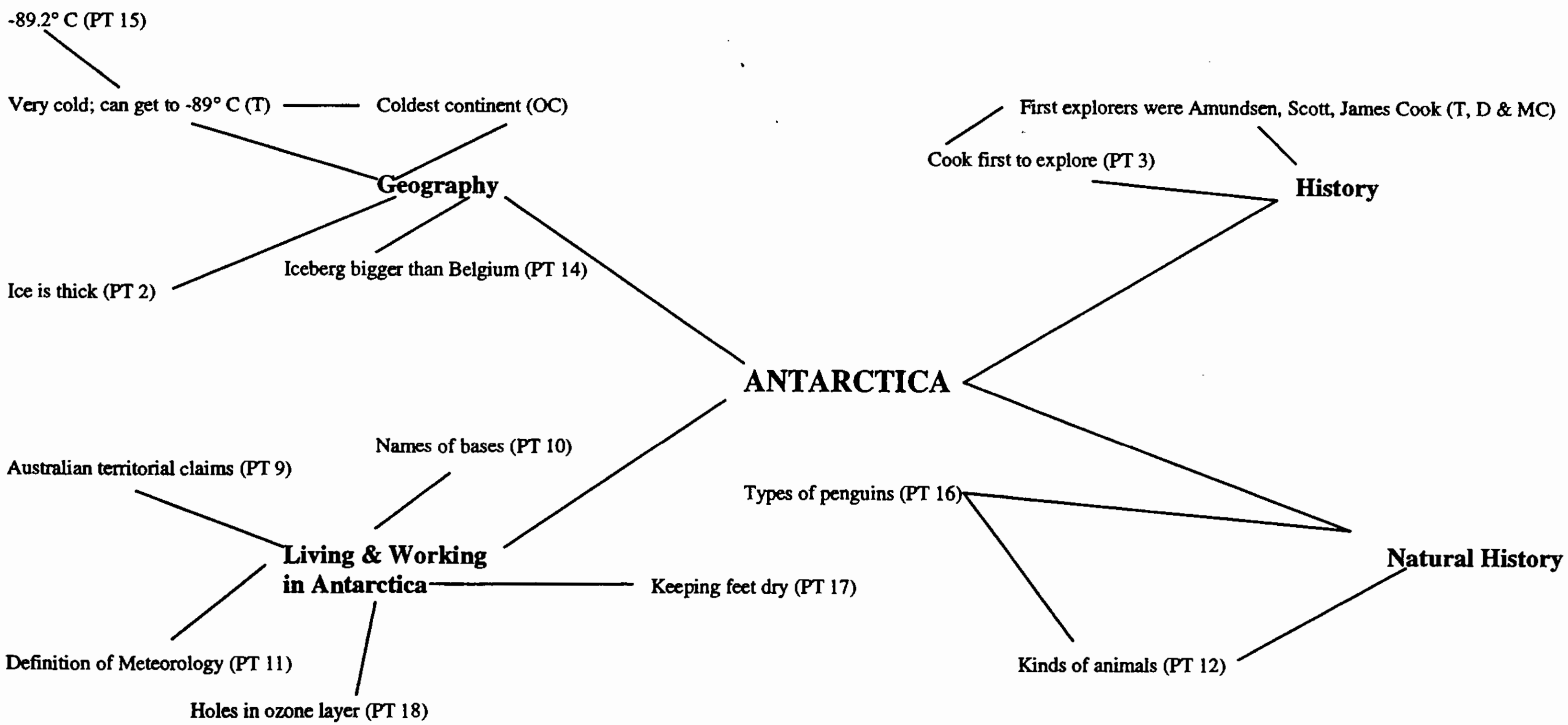
Cody's three-month journal entry about the South Pole provided an example of how individuals can mis-construct information without any influence of the group when he wrote, "Antarctica has one of the most popular states called the South Pole". No discussion was connected to this journal entry.

Figure 70: Cody's Pre-Lesson Concept Map



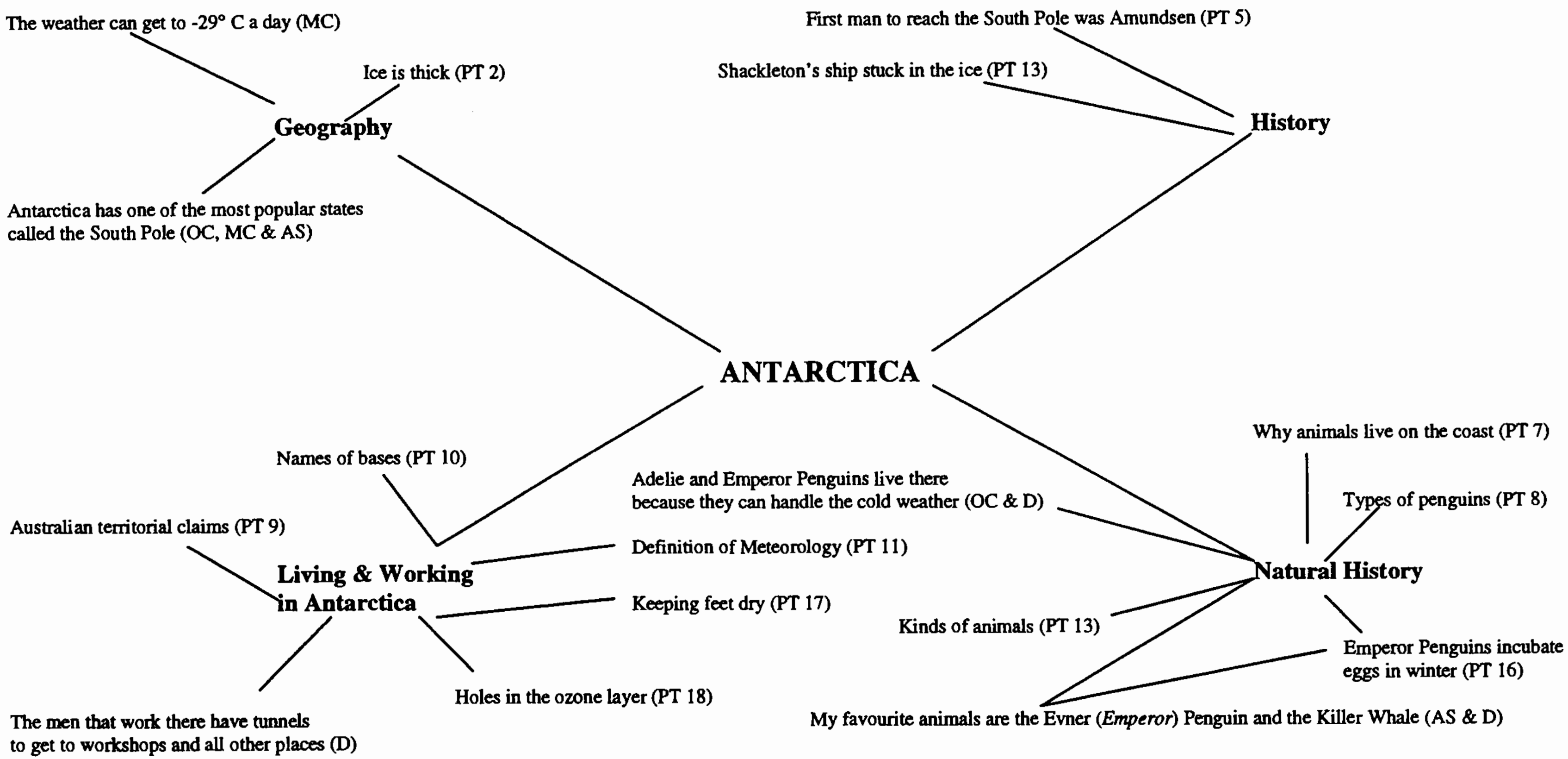
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 71: Cody's Post-Lesson Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 72: Cody's Three -Month Concept Map



Note: No twelve-month data available for this student

Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Billy

Billy seemed to interpret the journal requirements with a preference for linking several ideas into one larger statement. His pre-lesson journal provided an indication of this approach and he continued to do this until the three-month journal (Figures 73-75).

> Very cold place, penguins are there and there are icebergs and polar bears there; lots and lots of snow and a couple of igloos.
>
> *(Billy, pre-lesson journal)*
>
> No children are allowed to go there. Scientists are not allowed to bring their families.
>
> *(Billy, post-lesson journal)*
>
> Penguins, seals, icebergs, avalanches, blizzards, no whales, lots of water, no sharks, warm clothes, no houses, no fish, no children, no whales.
>
> *(Billy, three-month journal)*

By the twelve-month journal, Billy could provide more discreet statements, although several were related to each other. Unlike most other students he began his final journal with an introductory affective statement (see Table 39), " Antarctica is a fascinating place" and included several statements which could be tracked from the journal statement above.

> Blizzards, icebergs.
>
> Some blizzards can blow down a house.
>
> You need special clothing.
>
> Frostbite sometimes kills people.

Emperor penguin is the biggest penguin.

Penguins are there.

(Billy, twelve-month journal)

Billy's use of an introductory statement seemed to be related to his developmental level. These kinds of statements, like Hannah's affective statements, were more common among younger children who seemed to interpret writing tasks in terms of narrative forms.

TABLE 39

Distribution of journal codes and test scores

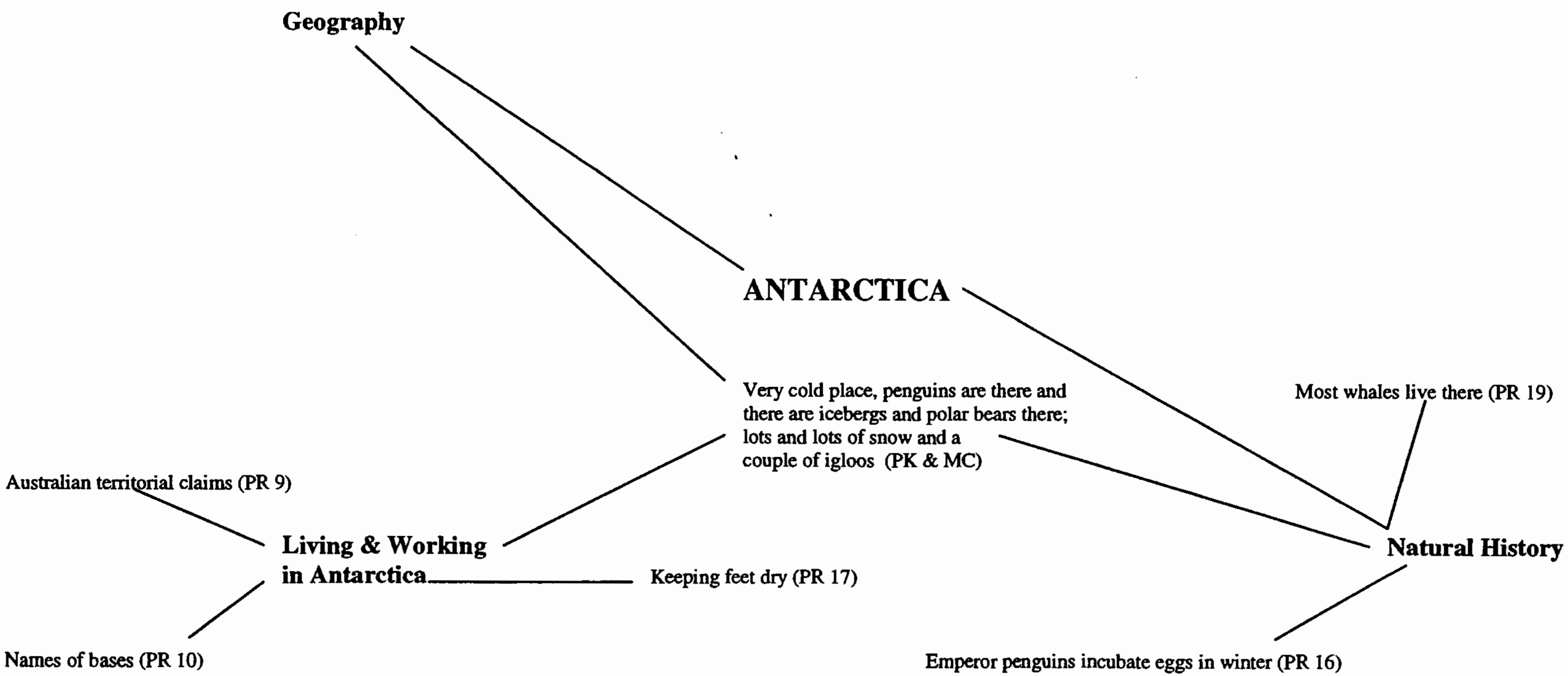
Group B3-Billy

	Pre lesson	*Mid lesson**	*Post lesson*	*Three months*	*Twelve months*	*Totals*
Prior Knowledge	5	2	2	2	2	13
Test scores (%)	25		45	45	35	
Text		7	2	3	4	16
Discussion		1		1		2
Own constructions		3		1	1	5
Mis-constructions	2	5	1	3		11
Teacher effects		2			1	3
Affective statements		1			1	2

*includes three journal entries

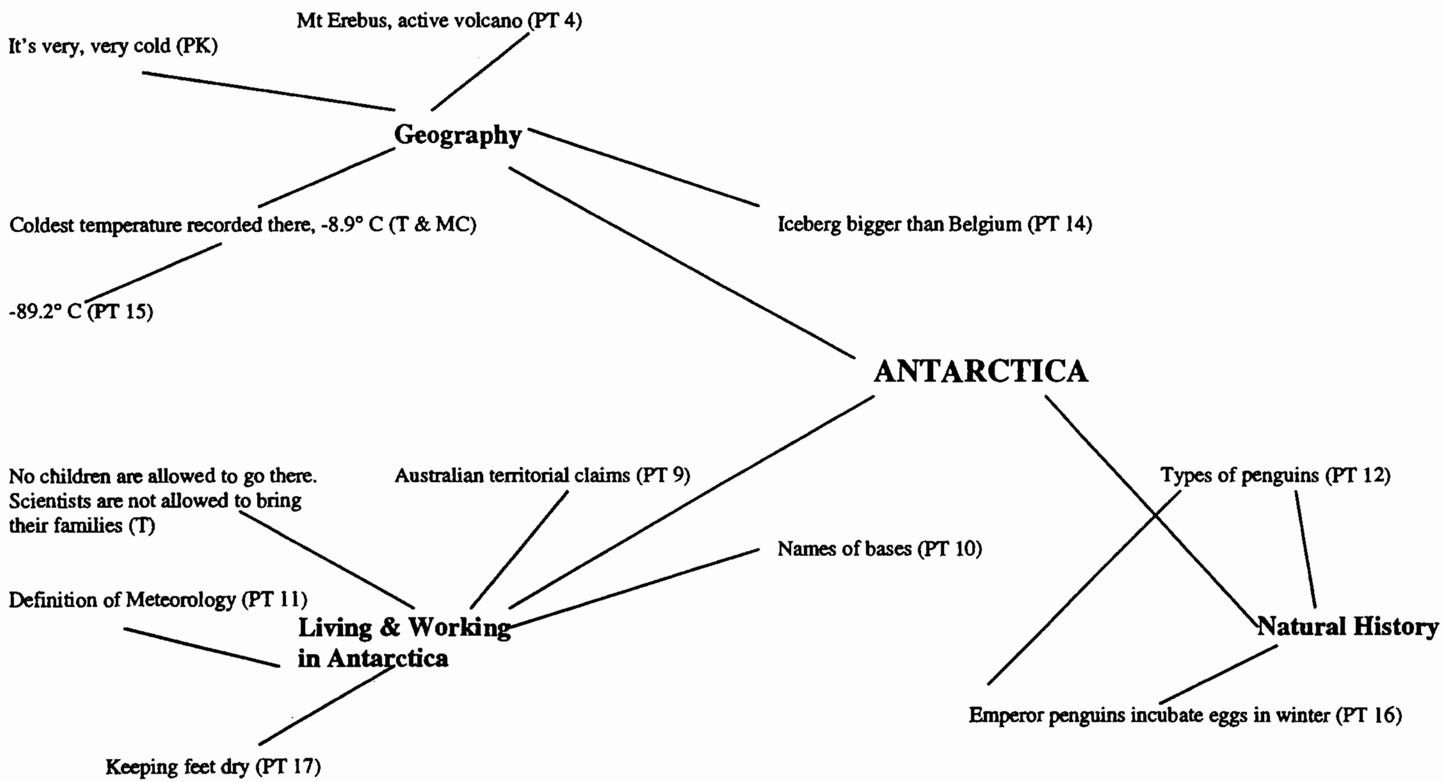
Table 39 suggests a student who was grappling with the unit content. He scored poorly in the post-tests and produced an overall high level of mis-constructions. Billy was the group's most disruptive student. He made 19.5% of on-task statements in the group and 27.1% of off-task statements. According to teacher data, Billy's classroom behaviour was typically disruptive. His relative youth may have also contributed to a lack of attention to the task. Billy's behaviour inhibited his contribution to the group and seemed to impact on his long-term learning outcomes.

Figure 73: Billy's Pre-Lesson Concept Map



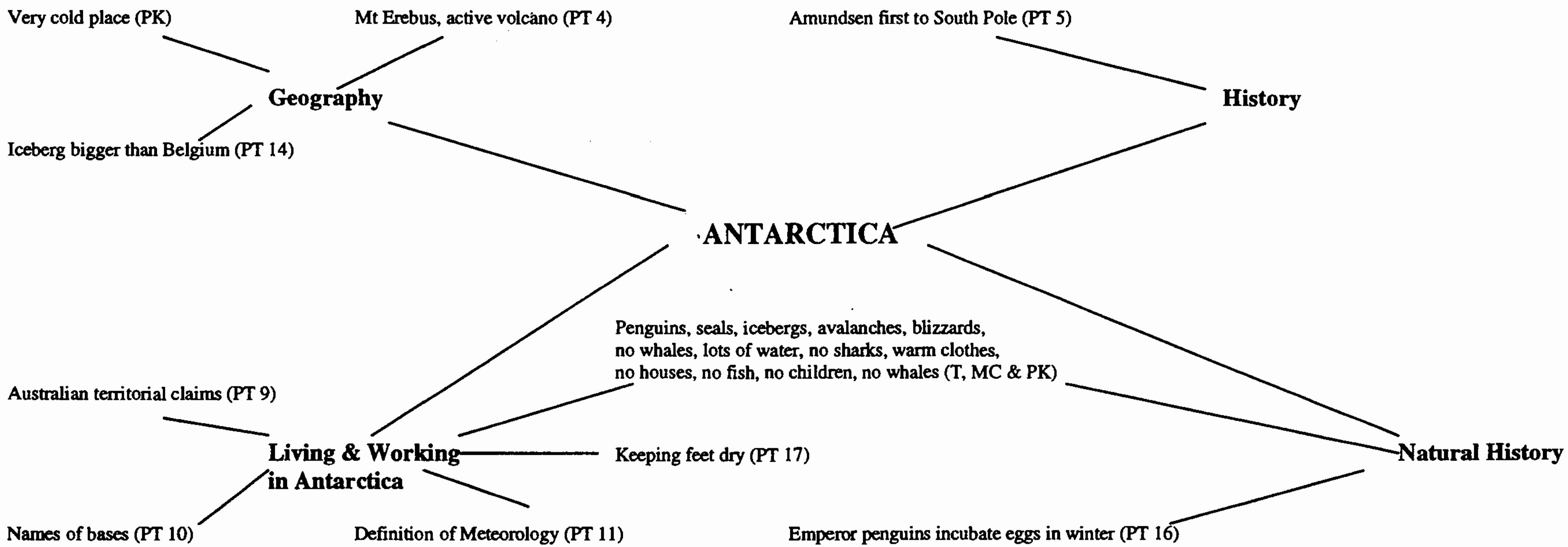
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 74: Billy's Post-Lesson Concept Map



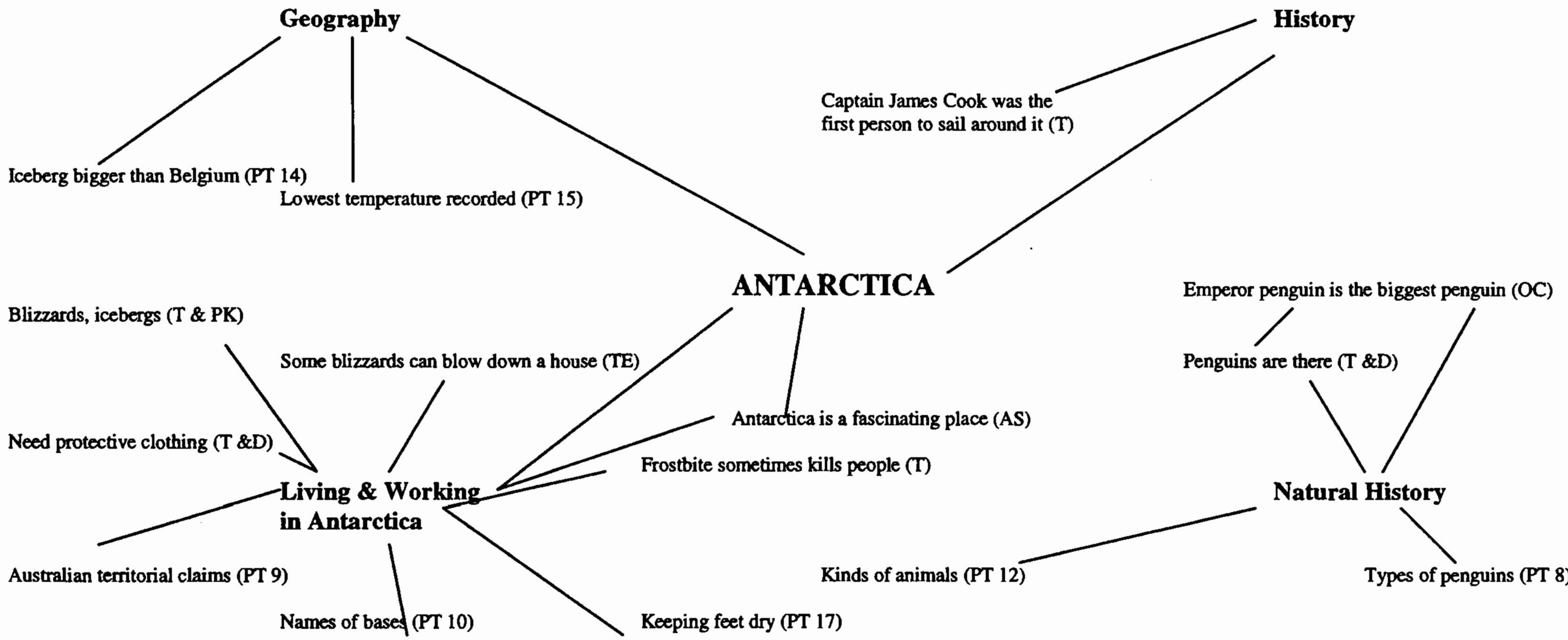
Key : PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 75: Billy's Three-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Figure 76: Billy's Twelve-Month Concept Map



Key: PK: prior knowledge; PR: pre test; PT: post test; T: text; OC: own constructions; D: discussion; TE: teacher effects; MC: misconstructions; AS: affective statement

Knowledge and concept development within the group

Analysis was hampered by the absence of twelve-month data for two group members but as was described above, very little actual cooperative discussion was discerned among this group. Although they seemed to remain generally on-task their talk did not produce the academic gains found with other groups. The academic gains made by Rebecca were mostly her own achievement. Cross-analysis of the group's concept maps indicated few strong conceptual links across members. Journal responses appeared unpredictable and erratic.

The focus on task completion lead to relatively high proportions of talk coded TS08 (34.9%, see Table 40) using the MAKITAB instrument (see Appendices H & I). As was described in the previous case studies, these kinds of talk represent lower order responses. By contrast, talk coded as TS11, higher order talk, comprised only 25.2% of all on task talk. When considered as part of *all* talk during the lessons, only 11.6% of this group's talk was of the TS11 variety, even allowing for the off task talk found in lesson five where the students remained on-task until the worksheet had been completed. The group directed its efforts towards completing the worksheet and was not typically concerned with exploring ideas. They read the requirements for the worksheet and often wrote the first answer proposed, usually offered by Rebecca, with minimal discussion.

This group "culture" appeared to impact significantly on the group's academic outcomes. The group had only engaged in limited cooperative discussion and had produced lower levels of higher order talk than were found in the other groups. Responding routinely to discussion questions may appear to be on-task but these kinds of talk did not seem to enhance the students' learning. This finding is discussed further in the next chapter.

TABLE 40

GROUP B3

MAKITAB ANALYSIS ON TASK TALK (TS CODES ONLY)

Codes	*lesson 1*	*lesson 2*	*lesson 3*	*lesson 4*	*lesson 5*	*Total*	*%*
TS01	3		4			7	0.01
TS02	8	10	7	6		31	7.5
TS05	3	1	5	2	1	12	2.8
TS06							
TS07							
TS08	23	27	34	45	16	145	34.9
TS09	4	6	4	3		17	4.1
TS10	8	7	2	11	2	30	7.2
TS11	14	19	37	19	16	105	25.2
TS12		4	1	7	1	13	3.1
TS13				1	2	3	0.7
TS14	4	17	7	1	2	31	7.5
TS15	3				2	5	1.2
TS16		6	4	7	3	20	4.8
Lesson Totals	70	97	105	102	45		

5.8. Chapter summary

This chapter presented the results of the research in the form of general findings that allowed for a detailed micro-analysis of the data. The analysis led to individual and group case studies. Each case study involved group profiles, descriptions of group processes influential in the cooperative settings, individual case studies based around concept maps from student data and descriptions of group influences on student learning.

CHAPTER SIX

RESULTS OF A CROSS CASE ANALYSIS OF THE FIVE CASE STUDY GROUPS

6.1. Overview

The results of a cross case analysis of the five study groups are reported in this chapter, indicating similarities and differences between the groups. The research questions provide the framework for reporting these findings. The chapter concludes with a section that establishes the basis for discussion and conclusions in the final chapter.

6.2. Introduction

The cross-case analysis began with an examination of the observational data and data collected from discussions with the study teachers. These findings provided a general background to the classroom settings described in the study. Observational data indicated that the effects of the study in both schools went beyond the data collected in tests, journals and discussion transcripts. These effects included the continued use of small groups, naming groups after Antarctic explorers, improved pro-social skills and an impact on student selections of research topics and library books. Anecdotal evidence also existed of a heightened awareness among students of issues related to Antarctica.

The emphasis on the total classroom context in the above analyses provided the stimulus for the development of an organizing structure in the more "fine-grained" cross-case analysis that was to follow. The application of analytic induction methods in this study (see chapter four) necessitated analysis grounded in the data.

The previous chapter presented individual case studies and related the individual students to case studies of each group. The analyses in this chapter were based upon an organizing framework derived from the data (Figure 77) and are intended to compare and contrast findings across all groups in order to generate assertions for elaboration in the final chapter.

The major general finding of the cross-case analysis was the strong linkage between student outcomes, teacher cognitive intent, student discussion and contextual factors. This connection related to research question three and became the central structure of the model (Figure 77). The teacher's intended cognitive outcomes and their influence on the task structure were depicted in the model as factors related to teacher cognitive intent.

Contextual factors emerged as particularly significant. In the model (Figure 77), the contextual factors revealed in the data are shown and are also depicted as impacting directly upon the quality and quantity of student talk. As the lessons proceeded it was noted that some students had begun applying their newly acquired knowledge in the new situations and this in turn became a factor that enhanced student discussion. New knowledge widened the group's available knowledge base. This was most noticeable in lessons four and five where particular opportunities to apply knowledge were presented to the students.

The model (Figure 77) became the basis for investigating and discussing each of the research questions while providing an over-arching structure for the chapter. A further delineation of the nature of quality talk and the nature and important influence of contextual factors are the main discussion foci for the discussion below.

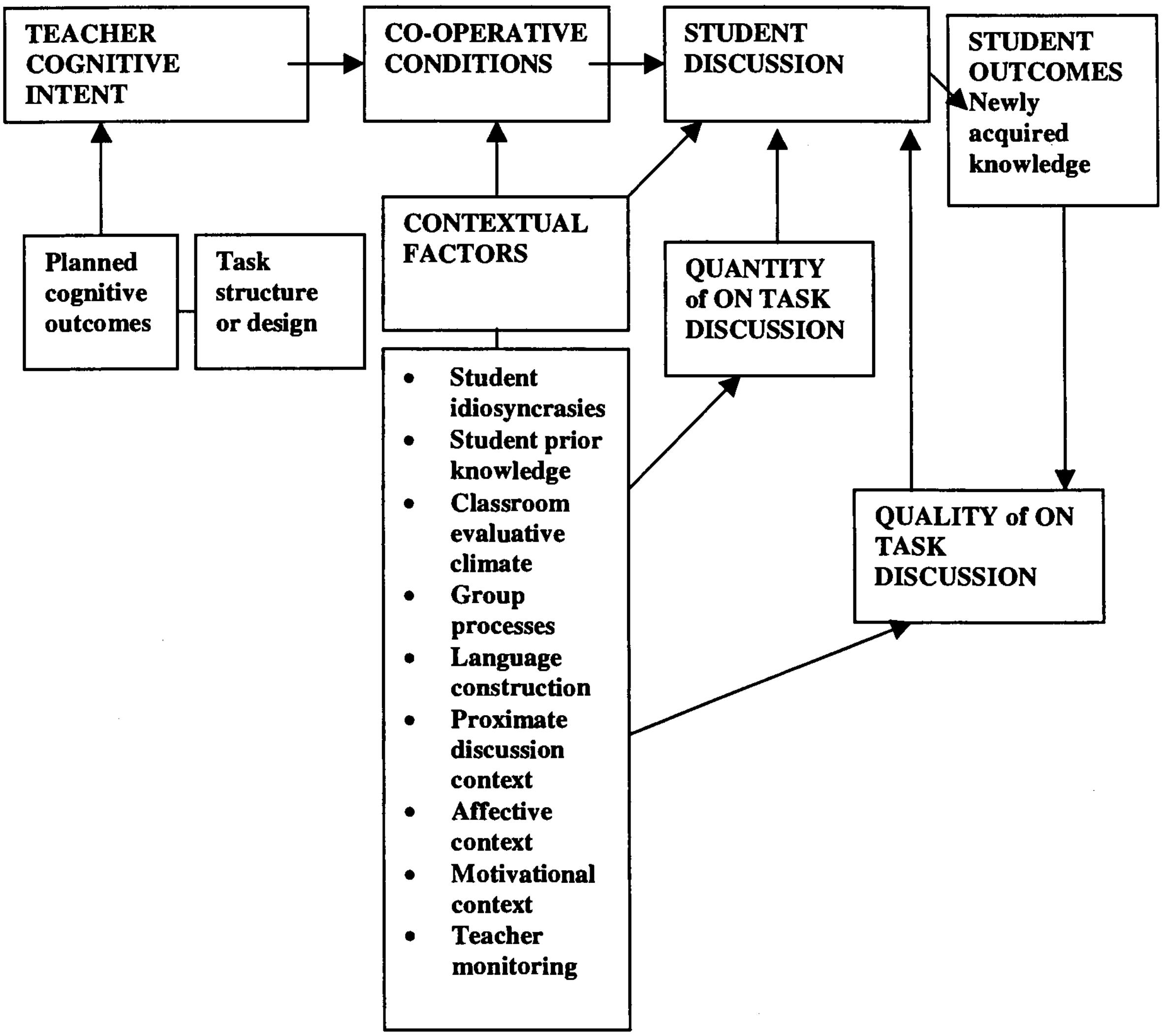


Figure 77: Model of Cross Case Analysis

6.3. Re-statement of research questions

The research questions were based upon two general avenues of inquiry; (a) the means whereby student learning and cognition occur under cooperative learning conditions and (b) the role of the group setting in determining individual and social construction of knowledge. Each broad question involved subsidiary questions.

1. What processes produce knowledge construction under cooperative conditions?

   1.1. What evidence of co-construction of knowledge can be discerned?

1.2. To what do specific types of discussion lead to co-construction of knowledge?

2. What conditions or factors mediate student learning and cognition in small groups?

2.1. What is the role of prior knowledge in group discussion and knowledge co-construction?

2.2. What classroom contextual factors influence discussion and knowledge co-construction?

3. What connection can be discerned between teacher cognitive intent, cooperative conditions, student discussion and student outcomes?

3.1. How do group processes mediate teacher cognitive intent?

3.2. How does student discussion mediate teacher cognitive intent?

3.3. What individual student characteristics influence teacher cognitive intent?

6.4. The role of contextual factors in discussion and student outcomes

This research found evidence of both individual and social construction of knowledge with the overall context of student discussion emerging as a dominant factor. Context appeared to exert a profound influence on the two main lines of inquiry of this study, namely the means whereby student learning and cognition occur under cooperative conditions and the role of the group in individual and social construction of knowledge (research questions 1 and 2). Some contextual factors were present as student antecedents before the lessons. Of these, student idiosyncrasies and prior knowledge appeared particularly prominent. Other contextual factors were determined by the teacher, through the task structure or the evaluative climate or by the creation of discussion contexts. Still further factors emanated from the affective domain. The various contextual factors are discussed in the section below.

Another significant contextual factor that appeared to influence knowledge construction was the specific content of discussion at given moments in the discussion. This kind of discussion context is termed *proximate discussion context* by the researcher and is described further in section 6.5. because of its influence on knowledge construction.

<u>The idiosyncratic nature of the students' learning</u>

Individual meanings were drawn from classroom experience on two levels. Early analysis suggested that student learning from the lessons had been highly individual and idiosyncratic but further investigation revealed that social construction of knowledge had also occurred widely. Just as individuals had displayed idiosyncrasies, groups seemed to develop idiosyncratically. Not only did the group experience in general help to shape the meanings of the group members but each group also shaped different meanings when compared to each other group. Individual antecedents emerged as a powerful influence on the development of the group despite the students' similar classroom experiences. Involvement as a member of a group and involvement in a particular group combined with individual characteristics to produce some of the most significant contextual factors mediating student outcomes.

Allowing for differences between the two study schools and the student participants, the students had all been exposed to similar learning experiences and consequently, commonalities were anticipated with the material the students learned. However the various analyses of the data yielded an unexpected unique, idiosyncratic nature to each students' learning. This finding confirms work by Nuthall & Alton-Lee (1993). Observations during data collection noted the students' learning as *individualistic*, *idiosyncratic, unpredictable*, even *volatile*. These observations were confirmed by analysis. All students demonstrated that they had learned from the unit but the wide variations in the content of student journals were not expected.

The degree of unpredictability was noted first in the students' test results. Consistent short term learning was indicated by the post-test scores because all students improved their test score from pre-test to post-lesson test. Not surprisingly, several students had forgotten some of this knowledge after three months and more again after twelve months. However, some students' test scores actually improved after twelve months (David, Kirsten, Cale, Kate & Rebecca) and others remained almost stable.

Journal data revealed the transformation by the students of information into new mental structures. The manner and degree of these transformations appeared highly individual, with students seeming to grapple with the new material. The researcher had conjectured that own constructions and mis-constructions would remain relatively stable but this was not the case. Most students produced *new* own constructions and mis-constructions at each journal writing session. Own constructions included in one learning journal were usually not repeated later, seemingly produced in an on-going flow that was not replicated and seemed unrelated to their most recent attempts.

A similar pattern was discerned with student mis-constructions. Mis-constructions were usually as unique to the individual as were their own constructions. Once "mis-constructed", the erroneous idea tended to be discarded. Occasionally these constructions were more long term, including in some cases, mis-constructed *prior knowledge*. When Paul wrote in his pre-lesson learning journal; " ...lots of people die in Antarctica" this entry was not repeated again until the twelve-month interval.

The other learning journal categories, like the test results, seemed unpredictable. Items recalled for one journal were often forgotten later. Sometimes items recalled immediately after lessons were not recalled at three months and then recalled again at twelve months. Students' own constructions revealed a similar pattern. Recall of prior knowledge also appeared idiosyncratic. When Joel wrote about hypothermia in his pre-lesson journal "people can die of Hypothermia easily if they don't wear the right clothing" he did not elaborate on the idea in later journals. Although some consistencies in knowledge retained were found across group members, particularly when related to student discussion, the precise mechanisms that initiated their recall remained problematic.

Further evidence of individual knowledge construction was where some students recalled material not remembered by the other participants. The lessons were structured with definite teacher cognitive intent indicated in part by the selection of discussion questions. The discussion questions did not deal with all the information presented in the lesson texts (Appendix J) so that it was possible to distinguish between knowledge gained from text and discussion and knowledge transmitted direct from text. One example of knowledge transmitted, virtually unchanged, from text was Rebecca's repeated reporting that sealers were the first people to actually make landfall in Antarctica (Figures 64-66). This fact was only mentioned (see Appendix J) in the lesson three text and nowhere else but it seemed to attract Rebecca's attention because she cited it in all journals. Whether this was a function of her interests, curiosity or undetermined contextual factors remained problematic but it illustrates the direct transfer of knowledge from text and the individual students' reaction to the same classroom experiences.

Not surprisingly, the idiosyncratic, individual knowledge construction seemed influenced by the curiosity and interests of students. This *affective context* emerged as an important factor in student learning. Evidence was found of the contribution to student idiosyncrasies made by several affective components. Students seemed to recall general themes in their journals, suggesting particular interests. For example, some students recalled more in the history theme and less in other themes. Most students showed some recall of information about Antarctic wildlife and certain information appeared to have engaged their attention, particularly when an element of danger or emotional response was present. Recall of information about blizzards and frostbite was common. Observation and discussion with participants noted the wide appeal of these topics. An example of the emotional element was evident with the two school A groups, which had lengthy (erroneous) discussions about Scott's team trying to survive by eating their sled dogs. This discussion produced an observed emotional response in the students. They subsequently displayed good recall of information related to Scott in their journals and test scores.

Although discussion influenced student learning in unique ways, classroom events tended to draw individual meanings closer together. Social construction of knowledge occurred consistently among the groups but individuals evolved their own mental representations over time. Idiosyncratic groups were created because of the interaction between individual antecedents, contextual factors and classroom events. These factors in turn shaped the nature of the discussion and combined to produce a social milieu for the development of unique group social constructs.

The role of prior knowledge

Prior knowledge was seen as a highly significant aspect of student idiosyncrasies. Again confirming work by Nuthall & Alton-Lee (1993), prior knowledge was identified early in the analysis as another significant contextual factor in the students' discussion and learning. The nature of the student discussion, the particular group emphasis and the eventual outcomes were mediated strongly by prior knowledge. Groups possessing less collective prior knowledge were not able to engage as actively in the task and tended to go off task more readily. They tended to develop a group culture geared to completing the task with minimal quality talk if they had little prior knowledge on which to build. A lack of prior knowledge also led to irrelevant, unproductive or off task discussion that had a minimal positive impact on students' learning. The following exchange from group A1, lesson one, illustrates how a lack of prior knowledge hampered discussion.

Kirsten:	What kinds of dangers would Antarctic explorers face today? OK what kinds of dangers would an Antarctic explorer face today?

Group goes off task for a moment.

Alan:	What was the question again?
Cara:	Arh, here I'll show you

Group reads question again.

Kirsten:	An eight...whale attack
Cara:	Eight whale?
Alan:	A blue whale attack?
Cara:	No, but we already had a blue whale...
Kirsten:	...a humpback whale and a blue whale...
Cara:	OK a humpback whale and a blue whale.

Contrastingly, knowledgeable students helped create knowledgeable groups and led their peers into enhanced learning outcomes. All groups represented small learning "communities", each with a unique pool of knowledge which could be accessed to create shared meanings. Shared meanings seemed to be interpreted individually by the group members but prior knowledge remained a decisive factor in the group's overall context. The role of prior knowledge was also evident in the quality of student talk. Students possessing accurate prior knowledge were not only able to contribute more but were also able to enhance the overall quality of the discussion. Quality discussion is described further in the next section.

Not surprisingly, individual differences impacted on the various contributions to shared meanings made by each student. Paul (group A2) was a very knowledgeable student and would contribute but not generally become involved in an in-depth type discussion. His fellow group member, David, was also knowledgeable and was keen to "tease out' ideas as described previously (see chapter five). A connection between *prior knowledge, quality discussion and longer-term learning* was discerned. If the group members possessed good prior knowledge between them, quality discussion seemed more likely and these ideas and information were more likely to be recalled later in learning journals.

Clark (group A1) was a knowledgeable student who made strong contributions to the group task. Clark's lesson two statement about meteorologists, "Or a meteorologist, cos there's a weather hut...a meteorologist...a guy who studies the weather" seemed to have far-reaching consequences. His *language knowledge*, of the correct technical term, influenced the group's conceptual development. Although weather and climate were mentioned frequently his offering was the first specific mention of the term meteorologist within the group. It was referred to again on several occasions, including in lesson five where application of knowledge was required and seemed to provide additional layers to the group's understandings. Use of the term meteorologist did not occur in any other groups' journals. The group A1 students consistently scored the relevant test item correct and rich long-term outcomes for Clark's group were detected in their journals. These outcomes seemed to result from the focussing of discussion on meteorologists and scientific research generally, initiated by Clark's prior knowledge. The relevant journal examples are listed below in order to illustrate the effect of Clark's prior knowledge.

> Some of the jobs are cook, meteorologist, nurse, engineer, mechanic, scientist and maybe biologist.
>
> To go there you have to be fit and experienced in certain jobs.
>
> *(Clark, post-lesson journal)*
>
> Only scientists and workers visit Antarctica.
>
> The balloon launching pad records the climate.
>
> *(Clark, three-month journal)*
>
> Some workers that are taken there are chef, scientists, meteorologist, doctor & nurse.
>
> They use weather balloons to record the climate.
>
> *(Clark, twelve-month journal)*
>
> They have a piece of string and on the end is an object, usually a camera. They launch the balloon in the air with a gas called Helium. The balloon keeps expanding while the camera keeps taking photos.
>
> There's a balloon launching pad in Antarctica.
>
> *(Abi, post-lesson journal)*
>
> Some of the jobs you can get there are doctor, meteorologist, scientist, radio-man, mechanic and nurse.

They have scientific research bases and to get around there's tunnels and ropes joining them up.

(Abi, three-month journal)

There are data bases there.

(Abi, twelve-month journal)

They send up balloons with lots of instruments to detect weather.

People have to have the right skills to go there.

(Joel, post-lesson journal)

They use weather balloons to get the weather.

(Joel, twelve-month journal)

Idiosyncrasies were again evident in the examples above such as Abi's reference to Helium from her prior knowledge. She had also mis-constructed ideas about bases at twelve months, providing evidence that the students had interpreted meanings in unique ways within an over-arching, co-constructed meaning derived from the discussion.

Deliberately activating prior knowledge was trialed at School A (see chapter four). These groups were asked to discuss what they had learned in the previous lessons before beginning each new discussion tasks (Mevarech, 1996). The two school A groups' pre-task discussion appeared to help engage their prior knowledge. These discussions tended to become cursory in each of the lessons but despite their brevity some gains were discerned as this example from group A2 indicates.

David: In the last lessons we learnt that there were tunnels joining all the buildings together

Paul: And about the weather balloons that are used to find out the weather...we learnt about what people work in Antarctica. What jobs they do...

Rianne: ...and we learnt that no one could survive there

Melanie: And you had to make a tunnel to get from different places

The ideas discussed in the above exchange seemed to be retained over the duration of the study, possibly due to time intervals and repeated engagement with the subject matter as described by Nuthall and Alton-Lee (1993). The information about connecting tunnels was included in learning journals of all group A2 members at differing times. *Weather* balloons were not mentioned in the lesson text but the idea was generated from Paul's prior knowledge, " that's the science hut...or it could be just a weather balloon" (lesson two) and was recalled variously by group members. The weather balloon example illustrates further the important role individuals play if they are able to apply knowledge gained from elsewhere.

Students were sometimes conscious of the source of their prior knowledge. Some School A students displayed meta-cognitive awareness in their discussions, even mentioning prior knowledge explicitly as in the group A1, lesson three exchange below.

Clark: OK Cook's ship was sailing like the one in the picture. Would exploring Antarctica have been harder for Cook?

Joel: Do we have any previous knowledge for that?

Clark: Not really.

Another example of student awareness of prior knowledge origins was Max (group B2) when he described his father as a source in this lesson one exchange.

Max: Why not just... it tilts away from the sun

(group writing answer)

Max: I know this

Kate: Why?

Max: Because my dad stud...my dad and I studied this...

Abi (group A1) prefaced one of her three-month journal (Figure11) entries with "learnt somewhere else" and Cale (group B2) quoted his source in this post-lesson journal entry (Figure 50). A newspaper article had outlined the possible effects of rising sea levels due to global warming and Cale version of the ideas expressed is quoted below.

> In the newspaper this week it says that Sorrento might flood and the army might need volunteers because Antarctica may have a hole in it after the year 2000 and a base stands right there. The hole might appear in the middle of Antarctica. Everyone has at least one year to evacuate.
>
> *(Cale, post-lesson journal)*

In addition to the influences on discussion, prior knowledge appeared to create a kind of "multiplier effect" on knowledge retained. Knowledgeable students not only gained more from discussion but also contributed more and their longer term retention seemed enhanced. Students such as Max and Rebecca (School B) and David, Paul, Abi, Joel and Clark (School A) began with prior knowledge which seemed to act as building blocks for subsequent learning. David in particular was able to generate a high proportion of *own constructions* at the twelve-month learning journal. These constructions were typically richer and more sophisticated than those of his peers and he seemed to draw on knowledge gained from other sources to produce his own constructions. David also maintained high scores in all post-tests and produced relatively few *mis-constructions.* By contrast, some other students began with less prior knowledge, were less active in discussion and retained less information in the long term.

Not all statements derived from prior knowledge was necessarily accepted or applied by the group, suggesting other variables may have been involved in student recall. Evidence was found where the group overlooked specific student prior knowledge that may have been useful. Sometimes, discussion like the following group A2 (lesson four) exchange, produced conceptual development but Paul's prior knowledge (sea is warmer than the ice) offering seemed to be forgotten by most group members, including Paul.

David & Rianne (together, reading aloud): OK why do you think the animals live in or near the sea?

David:(speaking over Rianne who is also trying to speak) Maybe because their natural diets are around the sea...

Rianne: ...fish and prawns.

Paul: ...or the sea's warmer than the ice.

David: Yeah and um some of them are like part.....

Rianne: ...sea birds...

David: ...sea animals and part land animals

Paul: Amphibians.

David: Yeah they can't go too far from the sea.

Paul: So we'll just write um

David: That's where their natural diet is...

Paul: And it's warmer.

Paul later repeated his assertion that the sea was warmer but the group focussed their answer on David's explanation. Although the group recalled concepts related to animals living near the coast, the fact that the sea is warmer than the ice was forgotten. On this occasion, Paul's information could have added to the group's understandings but did not receive sufficient attention to be included in the group answer and subsequent journals. David was the only student to use Paul's statement when he wrote the following mis-construction (people *do* dive in Antarctica) in his three-month journal:

> People can't dive in Antarctic waters because it is just slightly warmer than the land.
>
> *(David, three-month journal).*

Evidence was found of *inaccurate or incorrect* prior knowledge leading to irrelevant and confusing discussion. If a student contributed incorrect information the consequences could be quite disruptive to quality discussion and the eventual understandings of the group members. Inaccuracies were likely to produce mis-constructions in learning journals and when the group combined to mis-construct information during discussion, the mis-constructions were sometimes retained long-term by some group members. This exchange from group B1, lesson three was preceded in other lessons by several erroneous statements by Aiden about polar bears in Antarctica, "I think that they might be studying polar bears", "And the answer was I think they might be studying polar bears because they have too much fur". This was a common mis-conception among School B students. Aiden's incorrect prior knowledge was not challenged by the group and was accepted as a suitable answer. The exchange below illustrates how inaccurate prior knowledge could have a detrimental effect on student learning.

Cara:	The sea cos it was a dangerous sea. Sharks. A shark attack
Alan:	A polar bear?
Cara:	Yeah. A shark and polar bear attack.
Alan:	A polar bear and maybe a shark...
Kirsten:	But there's no sharks up there (*in Antarctica*).
Alan:	(adamant) Yes there are!
Cara:	Blue whales...
Alan:	Polar bear and maybe a blue whale.

These kinds of mis-constructions strongly mediated the teachers' cognitive intent. This piece of mis-information proved so durable that whole class teacher intervention was required in order to correct it, providing an example of the important teachers' role in cooperative learning.

<u>The role of the teacher in creating context</u>

This research found that the teacher had a significant role to play in the creation of the context in which discussion and knowledge construction occurred. The teacher does not necessarily play a passive role in small group cooperative learning (Meloth & Deering, 1994). As the model (Figure 77) delineates, teacher cognitive intent was evident through the design and/or selection of tasks. Teacher influences extended to the creation and maintenance of the cooperative conditions and the classroom evaluative climate (Doyle, 1983) before and during the lessons. The cooperative conditions included the selection of the cooperative learning strategies for the study and the training of students in these strategies (see chapter four). The study context also included the familiarization with data collection methods. Monitoring of group processes and academic engagement with the task during the lessons constituted a further important teacher role. Teacher influences are elaborated in this section.

The influence of classroom evaluative climate on discussion

As was outlined in chapter five, a significant finding from the first examination of the transcript data was the extent to which student discussion was influenced by the evaluative climate (Doyle, 1983) in the classroom. Observation noted that an emphasis by teacher B1 (School B) on correct English was a regular part of the evaluative climate in these classrooms and it could be tracked into the students' discussion. This teacher intervened early in lesson one with statements like " ...just one word is not going to be enough. Those questions need you to write a sentence; one word isn't an answer" (Teacher B1, lesson one). Further statements relating to doing a good job "this group has done an excellent job" were followed with a reward for that group from the class management system "five dollars for each of them". Statements like "... choosing the best word for everything" and asking the year three students in each group to check for spelling mistakes had re-defined the task from the students' perspective. From that point on the students were pre-occupied with writing correctly and less concerned with discussing the worksheet questions in-depth.

These kinds of interventions were discussed in post-lesson meetings with the study teachers and they were not repeated for the duration of the study. Notably, student discussion gradually centred less on aspects of correct English and more on the task.

Other aspects of evaluative climate were evident during this first analysis of the transcripts, including a willingness by many students to "please the teacher" by completing the task. Cross-analysis of worksheet, observational and transcript data indicated that task completion was, to varying degrees, a priority for all target groups. Some groups were focussed on completing the task as quickly as possible, providing brief answers involving little elaboration or discussion. Others were concerned with producing quality responses. The approach used by each group seemed to take on a life of its own so that a group "culture" emerged. This culture or style of working was usually determined by the dominant student(s) in the group who usually appeared task-orientated (Nicholls, 1984; Meece, Blumenfeld & Hoyle, 1988; Ames, 1992; Meece, 1994).

The effects of task structure

Investigating the connection between teacher cognitive intent, cooperative conditions, student discussion and student outcomes exemplified that the design and structure of tasks was a critical element of teachers' work. Not surprisingly, this research demonstrated a nexus between the tasks generated by teachers, discussion contextual factors, discussion and eventual student outcomes.

As was discussed in the previous section, if students could not deal with the task because it was too demanding, they were less likely to engage with the content and produce long-term learning outcomes. Evidence existed in this study that the task had been too difficult for some students. Whether the content and text of the lesson were age appropriate for the year two students and some of the year three students is problematic (see chapter five) but attempts were made to overcome these problems (see chapter four). All text was read aloud to the students and teachers were available to re-read and explain any worksheet requirements.

The role of intrinsic appeal of the tasks was highlighted by this research. Not surprisingly, tasks that interested the students tended to receive more attention in discussion and this translated to journal writings and test scores. Quality-type talk was more likely if student interest and curiosity was aroused. Student interests and curiosity were therefore key affective factors in group context, influencing group idiosyncrasies, the quality of talk and learning outcomes. The specific components of quality talk are further discussed later in this chapter and in chapter seven.

The task design was a strong indicator of the teachers' cognitive intent (Doyle, 1983; King, Barry & Zehnder, 1996) particularly through the selection of subject matter. The Antarctic topic lent itself to a large array of possible subject matter but the researcher, in consultation with the study teachers, selected only certain aspects to present to the students. The four broad themes presented in the lessons, *geography, history, living and working in Antarctica and natural history* were the researcher's construction and were influential in shaping the discussion context. Presenting the same topic through differing themes could be expected to lead to different student learning. The structure of the discussion questions on the worksheets was similarly influential. These themes, particularly the latter two (natural history and living and working in Antarctica) were expected to effectively arouse student interest. Teacher/researcher intent appeared successful at least in some measure in that all students learnt something from the unit, the material they learned was closely related to the material presented and was easily connected to the four main themes in the concept mapping exercise.

Student mediations and teacher monitoring effects

Student mediations of teacher cognitive intentions were apparent in this study, indicating that teaching was not causal. Briefly, teaching X did not mean that students learned X, with the effects of student mediations sometimes diverting teacher plans. Although much of the previous discussion in this chapter could be described as student mediations, several specific examples were discerned.

One significant student mediation on teacher plans was the effect of mis-constructions. Students were required to assimilate large amounts of new knowledge and concepts in this unit. Sometimes they appeared to connect various pieces of unrelated information producing mis-constructions of knowledge. When these mis-constructions were discussed in the group and not corrected by the group or by teacher intervention, they tended to persist durably in the students' journals. In this way, the erroneous material could have a lasting impact on teacher cognitive intent. These kinds of errors were insignificant for less important details but caused confusion with key information and understandings. The study students appeared to cling to their mis-constructions tenaciously.

A common mis-conception held by a number of students prior to the lesson was that polar bears live in Antarctica. This was consistently reported in journal and discussion data in all classrooms, requiring correction by whole class teacher intervention at School B and by group members at School A. The important role of strategic teacher intervention during cooperative learning was illustrated by this example. If the study teachers had not noted the errors, students may have incorporated them into their mental representations of Antarctica, making correction in the long term difficult. A similar situation arose in the two School A groups in their discussions about the Robert Scott expedition's use of sled dogs. These students had read some incorrect information that Scott's team had been forced to eat their dogs and this had caused their death. The students were adamant about this when quizzed by the teacher/researcher and needed some convincing that they were in error. Nevertheless, the erroneous discussion may have contributed to good recall about Scott among these groups.

The teacher's role extended to other aspects of the classroom context, notably in the monitoring of group discussion. Some insights into the effects of teacher monitoring during small group cooperative learning were found. Teacher monitoring during the lessons was intended to help students to engage in productive discussion although this was not always achieved.

Confirming findings by King, Luberda, Barry and Zehnder (1998), some groups developed strategies to prevent the teacher detecting that they were off task. The study students were sometimes off task for extended periods and returned briefly to the task as the monitoring teacher approached. The exchange below was from group B3.

Cody: Don't worry ...it's my sharpener.

Rebecca: Well then you should be picking it up.

Cody: He knocked it over.

(Teacher approaches)

Billy: OK get on with the work. CB, OK,CB.

Cody: What kind of dangers would Shackleton and his men have faced?

(Teacher moves past)

Hannah: I'm not picking them up again (something has fallen again).

The occurrence of mis-constructions has been described above. The group had a role in creating and correcting mis-constructions but the longer term success of this peer support seemed to depend on the timely intervention of the teacher "expert" such as in the "polar bears" example. In other instances the teacher was needed to help return the group to quality discussion and to help students with more advanced forms of scaffolding. In the lesson five exchange below, the students had been discussing their choices very superficially. The teacher intervention helped improve the quality of their discussion, at least for the duration of the visit.

Teacher 3:	Cale, why have you chosen Jane?
Cale:	because she's um...
Molly:	...a nurse...
Cale:	...a nurse and like in case they ran out of tablets and...
Teacher 3:	Hang on he's telling us *(interrupted by Kate)*
Cale:	...in case they ran out of asthma tablets
Teacher 3:	Oh yeah, wouldn't they have lots of supplies of them if they went down there?
Molly:	In case they got really badly hurt.

Other examples were detected where teachers intervened and produced clearer understandings for the students. This exchange from group A1 assisted the students' conceptual development about weather balloons. Due to inadequate prior knowledge, the group had been talking about using *hot air* balloons in Antarctica.

Teacher A:	Can you launch a hot air balloon in Antarctica where it's so cold?
Abi:	I don't think so because of the wind.
Joel:	It could be a balloon for sending messages.

Teacher A: Why would you send a message in a balloon when you've got radio?

Abi: I don't know what a balloon launching pad is

Teacher A: It's a place where you launch a balloon.

The teacher returned later to help clarify the students' understandings. The consistent recall of weather balloons by these students indicated a successful intervention.

<u>The effects of group processes on student learning</u>

Context was also influenced strongly by the patterns of dominance and passivity that emerged during the lessons. These not only related to the group culture but also to the cognitive inputs of group members. As was described above, each group seemed to adopt its own idiosyncrasies that appeared to be determined by the conjunction of student antecedents. The groups' degree of prior knowledge and sense of curiosity shaped the direction taken by the discussion, which in turn shaped knowledge co-construction. The group processes thus mediated teacher cognitive intent and student thinking and learning.

Previous research has revealed how strong academic students tend to control the learning situation, sometimes to the detriment of low-achieving, passive students (King, 1993; Day, 1997). The role of strong academic children was also demonstrated by this study. In the case of some groups, the story of the group was told through the eyes of the dominant student. These students typically assumed leadership roles and contributed most of the ideas as well as determining and controlling the group's method of working. The group idiosyncrasies described above were often the province of the stronger academic students. Stronger academic students tended to become frustrated with off task colleagues and sometimes reluctantly continued with the group task as indicated by Max's lesson two statement "that's it you're being silly. I'm leaving...".

Dominant students often exhibited teacher-like behaviours in trying to keep the group on track. They used subtle means to pressure their peers into staying on task and accepting their positions of power. An example of subtle pressure occurred in lesson three, where Max asked a student his last name. Max later confirmed that this had been done to ensure this student was identified on the tape because he was off task. The high levels of motivation of the academic leaders would result in these students persisting in the face of off task opposition. In another example, group A1 student Abi tried to ensure the other students waited until Amanda could catch up. The kinds of exchange below, though rare, provided evidence of some success of pro-social training and the importance of higher academics as leaders.

Amanda: What have we just done then?

Abi: Just wait, just wait. You guys have got to wait for Amanda.

When a group comprised a majority of strong academics as occurred at School A, discussion was enriched and learning outcomes were enhanced. These students provided the driving force for the group and their importance cannot be underestimated.

Not surprisingly, evidence was found that the talk of academic leaders contained high levels of quality talk (see next section). It was these kinds of talk that provided the impetus for the group, resulting in better discussion and learning outcomes. This lesson three example from group B3 is typical of the willingness of students like Rebecca to argue a point.

Rebecca: Yes it's gotta be the ship. How could the ship make it harder?

Cody: Because the ice is so thick that if...

Rebecca: ...no they don't sail in winter they sail in summer when the ice is gone.

Cody: They would die if they fall into the water

Rebecca: So? Even if it was a different ship if they fell over board they'd die.

In some instances, groups did not work cooperatively. On these occasions, although the students were usually involved in completing a task together, their discussion was either off task for extended periods or involved minimal levels of quality talk. Some groups simply took turns in answering each question and at times they worked as dyads, with two members dominating and the other members saying and doing little.

There was evidence from the transcripts that the students understood the roles and rules of group work that they had been taught as part of their preparation for the study. They generally adhered to the cooperative conditions but evidence was also found where these conventions were disregarded. Rianne was observed consulting with other groups. Other students also consulted with other groups as in the following exchange.

Cody: We're having a bit of trouble, can you please help us out? We haven't done the first one yet.

Billy: Yeah we haven't done the first one yet. We're having a bit of trouble because...

Rebecca: Go to *(indistinct; name of another student)* or something like that and get some ideas. Go to Aiden or Robert's group cos they come up with good ideas...Matthew's group. You're Speaker. Ask them if you can talk to them.

In another instance, group B3 had been given instructions by a teacher to work as a team only to continue to work as individuals as soon as the teacher left the discussion context.

Teacher B1: That doesn't mean you can't give your answer though does it, because even though Hannah's writing the answer it can still be someone else's answer.

(indistinct talk by unknown students; teacher leaves)

Cody: It is so cold you can get frostbite.

Hannah: Because you could freeze and it would get....

Cody: You'd get frostbite anyway...

Rebecca: I'm doing number two...

Cody: ...I'm doing number four.

Hannah: You do the last one it's the hardest.

Student passivity was not a direct focus of this research but previous research into passivity during cooperative learning was confirmed (Mulryan ,1992; King, 1993, Day, 1997; King, Luberda, Barry & Zehnder, 1998). An examination of passivity was conducted because, like an investigation of dominant students, it provided insights into understanding group context.

Passivity seemed connected closely to academic task demands. If academic content seemed too difficult, students could not cope so they either became very passive, as in the cases of Amanda and Kirsten, or became disruptive as in the case of Cale. Cale followed a pattern of (1) trying to be involved in the lesson, (2) finding the task too demanding, (3) having his contribution ignored and (4) going off task. Part of Cale's passivity may have been due to age related status differentials since he was in year two (age eight) at the commencement of the study.

Amanda began the unit with confidence because she had studied Antarctica the year before. This confidence soon evaporated in the face of a strong academic group and she gradually became more passive as the lessons unfolded. The limited mid-lesson journal data available for Amanda indicated a student who was struggling with the lesson content. Her later remarks were confined mainly to organising the group task and not to offering ideas and solutions. Kirsten also struggled with the unit content leading to a passive contribution to the group and poor recall in tests and journals.

Molly appeared very passive in discussion but seemed to have learned from the lessons because she scored reasonably well in the post-tests. However, she seemed to need the stimulation the test questions provided for her to recall much about the lessons because she had difficulty with her journal writing although writing was not normally a problem for her. Other students appeared mainly passive in discussion but their journal and test data indicated that they had learned from the unit. Billy and Hannah (group B3) were mainly passive in discussion, possibly due to age status differentials (year two, age eight) but they still demonstrated reasonable outcomes at an age-appropriate level.

Student idiosyncrasies (see above) were further evident in the students who seemed active in discussion but did not perform well in recalling information in their journals. Kate was active in discussion but did not produce very extensive journal entries. Teacher data indicated that her writing skills were sufficient for the task. Curiously, Kate's test scores improved from the three month post-test to twelve months.

The effectiveness of the groups was judged in terms of their group cooperative skills. These skills influenced the nature of the groups' talk. Some groups, particularly groups A1 and A2 cooperated consistently to complete the task and in the process, engaged in more talk likely to lead to enhanced learning. Groups B1 and B2 cooperated effectively occasionally and this also impacted upon their discussion. On the occasions when group B3 engaged in cooperative talk, learning gains were discerned.

6.5. The influence of discussion on student knowledge construction

All groups provided evidence that the quality and quantity of discussion was a significant factor in determining learning. Engagement with material within certain time intervals has been incorporated into learning models (Nuthall and Alton-Lee, 1993). Many educators would regard as axiomatic that the quantity of discussion should influence student learning. That is, the more students discuss a topic and thus engage with the content, the more they will learn. This research has confirmed the axiom but it was found that the discussion→learning connection was more complex that simply a function of the quantity of talk. The *quality* of talk seemed more important in the social construction of knowledge. These specific types of student talk became an important focus of investigation in an attempt to define the nature of quality talk more precisely.

MAKITAB analyses

Types of discussion that could potentially enhance learning outcomes were investigated and isolated using the MAKITAB Small Group Interaction Analysis

System (King et al, 1993). MAKITAB allowed for an in-depth analysis of the quality of student talk and isolation of the specific kinds of talk associated with longer-term learning. The nature of small group talk (Bennett & Dunne, 1991) and *task-enhancing* talk has been investigated previously (King, Barry, Maloney & Tayler, 1994). Recently links have been investigated between training students in philosophical thought and discourse and the kinds of talk generated (Barry, King, Maloney & Burke, 2000). This study differs from previous research into the nature of talk because of the opportunity to track longitudinally the actual affects on student learning of various kinds of talk.

Task related talk of an *elaborative* nature, which led to knowledge co-construction tended to involve relatively high levels of MAKITAB TS09-TS13 and TS15 codes (see Tables 12, 19, 26, 33 & 40; Appendices H & I). Talk coded *TS11* was the specific kind of talk most consistently linked to long-term student learning. This kind of discussion was termed *quality talk* by the researcher for the study's purposes as distinct from task-enhancing talk. Other categories of task-enhancing talk (TS08-10, TS12-13, TS15-16, DS03-04; see Appendix I) did not occur as often as TS11 and were not necessarily associated with TS 11 talk and subsequent links to learning. In some instances, higher order processes involving especially TS11-13 and TS15 codes were by-passed. Students would *propose* a solution (TS10) and the group might proceed directly to *final agreement* (TS12) or *representation* (TS14) of the group answer without engaging in any discussion. Sometimes *sudden insights* (TS09) were ignored or the group produced mainly *routine responses* (TS08). These instances did not involve any TS11 talk and did not usually relate to the learning tracked into the students' tests and journals.

Quality talk involved higher order cognition. The "mulling over" process occurring in TS11 talk, where students *talked about, worked through or reacted to* *ideas, insights or proposals*, was connected particularly strongly to knowledge co-construction and long-term student learning. Quality talk was usually preceded by TS09 (sudden ideas/insights) and TS10 (proposing) codes. The TS12 (final agreement) and TS13 (final rejection) codes, supported by the DS03 and DS04 (Group Dynamics) codes were included in this discussion "loop". The students did not necessarily proceed sequentially through the talk categories but tended to jump from one process to the next non-systematically, confirming research into teaching student heuristics to problem solve (Barry, King, Pitts-Hill & Zehnder, 1998). The various kinds of talk tended to be associated together during discussion. High levels of the TS11 code were tracked to richer long-term learning and enhanced conceptual development. The lesson one exchange below (group B2) illustrates the importance of quality talk in facilitating the students' shared meanings. This group discussed blizzards on several other occasions and consistently used quality talk. References to blizzards appeared consistently in the groups' journals.

Max: No, no to protect them from blizzards and...

Kate: And other things. Cos there might be a wild polar bear out there...

Cale: There's no polar bears there...

Kate: There is so!

Max: Well there might be a woolly mammoth ...(*back to writing worksheet answer*). To protect them from blizzards and other things and other dangerous things?

Students did not need to necessarily engage in lengthy discussion around a given topic. Group B1 displayed consistent recall of the frostbite concept but MAKITAB analysis revealed that of a total of only 15 related statements *all* statements were coded TS09-TS11 (80% TS11). Most of the discussion centred around a misunderstanding (see chapter five, p.201-202) but the discussion had assisted the students to co-construct their mental representations about frostbite, despite a relatively brief group treatment.

The group B3 experience was typical of all groups. Knowledge and concepts recalled in journals and tests usually seemed to have been produced by higher levels of the kinds of talk described above (TS09-TS13), particularly TS11. In each group, higher than normal levels of quality talk had resulted in longer-term knowledge and conceptual development (Table 41). For example, talk in Group A2 was coded as 44.3% TS11 overall (Table 19, Appendix H) but in their discussion about Scott, this had risen to 65.7% (Table 41). Groups such as A2 that achieved high levels of quality talk seemed to gain more academically from the lessons.

TABLE 41

EXAMPLES OF MAKITAB TS11 DISCUSSION ON TOPICS AND NORMAL GROUP TS11 RATES

Group	***Discussion topic***	***% TS11 on this topic***	***Normal TS11 when on task***	***Overall TS11 (includes off task talk)***
A1	Scott's expedition	42.1(12.3% TS09-TS10)	34.2	25.9
A2	Scott's expedition	65.7	44.3	41.1
B1	Blizzards	42.4	29.4	13.4
B2	Blizzards	34 (18% TS09-10)	34.3	20.5
B3	James Cook	41.6	25.2	11.6

A further discussion "loop" was identified which also produced some long term learning outcomes. This occurred in situations when the task required lower order responses from students. Research by King et al (1996) found that task structure was likely to influence the resulting kinds of talk. Thus, lower order cognitive questions produced more lower order discussion and similarly, higher order questions produced more higher order discussion. This finding was confirmed by the present study. The TS08 and TS14 MAKITAB codes appeared frequently when the students were answering the first question in lesson four (Appendix J) which required the students to list animals located on a pictorial map of Antarctica. Most responses to this question were routine and involved minimal elaboration, producing high levels of TS08 codes (*examining, comprehending, clarifying and routine responding*). In these circumstances, the students' emphasis was on completing the task quickly and efficiently, so the TS08 statements were usually linked to high levels of TS14 statements, comments related to the representation, recording and writing of the group product. Although the routine-type responding did produce some academic gains, the higher order talk described above seemed more influential in the long term.

By contrast, the second question in lesson four required the students to select the equipment they would need for a research expedition and higher order talk was evident with more TS09-TS13 discussion among some groups. This discussion did not lead to references in journals possibly because the task involved problem solving processes rather than recall of factual information in journals and tests.

The important link between prior knowledge and quality talk was indicated through the application of knowledge acquired in the first three lessons. The lessons had been designed to provide knowledge in the first three lessons and to allow for the application of some of that knowledge in the last two lessons. Application of knowledge from the first three lessons was discerned widely in the groups. In this exchange from group B3 (lesson five), knowledge about meteorologists was applied in selecting likely members of the expedition.

Rebecca: A meteorologist studies the weather.

Cody: Yep.

Billy: Yep, meteorologist.

Rebecca: Do you want Ben to go?

Cody: Yup.

Billy: Yeesss!

Rebecca: He's a meteorologist and he studies the weather.

Knowledge about frostbite was combined with the need for treatment in this example from group B1.

Aiden: What happens if someone gets frostbite. We'll need...

Alan: ...need a doctor. Lucy.

Knowledge about meteorologists and knowledge not provided by the lessons (engineers, computers) was applied in this final group A2 from exchange (lesson 5).

David: OK let's just discuss the reasons again. Why did we take Ben?

Rianne: Because he's a weather scientist and he could tell if there's a storm.

David: And he also can um he's very good with computers...

Rianne: ...and Brad...

Rianne & David: Because he's an engineer!!

Rianne: And good at making things so maybe he could make a house or some... help make the base.

The effects on student talk of open-ended questions was demonstrated further in lesson five where higher order questions led generally to higher order talk. Table 42 indicates the levels of the MAKITAB TS11 code (Appendix H) in lesson five. Group A1 and A2 demonstrated particularly high levels of TS11 and most of their other talk was of a task-enhancing nature (King et al, 1994). The School B groups did not produce the same levels of TS11 but other task enhancing codes (TS08-TS16) comprised the bulk of their discussion. By lesson five, groups B2 and B3 (particularly B3), were not functioning cooperatively and this may account for the lower than usual levels of TS11 (see Table 41).

TABLE 42

Lesson Five TS11 codes

Group	*TS11 code statements (total statements)*	*%*
A1	56 (117)	47.9
A2	92 (162)	56.7
B1	39 (129)	30.2
B2	35 (157)	22.2
B3	16 (92)	17.3

Another finding relating to student talk was that the students did not always approach their discussions systematically. The worksheet questions demanded and achieved some degree of order in the discussion but the students sometimes did not follow this structure. There appeared to be an impulsiveness to their talk. They sometimes jumped spontaneously from thought to thought and returned to material already covered. Their ideas appeared "scattered", not always following what seemed a logical pattern of proposing ideas, discussing them and finally accepting or rejecting them. These findings confirmed research by Barry, King, Pitts-Hill & Zehnder (1998) which investigated student use of heuristics in problem solving.

The TS12, TS13 MAKITAB codes (Appendix H) appeared relatively rarely. Proposals often received tacit agreement or rejection rather than explicit statements. Observation noted that agreement was sometimes achieved by an assumed consensus using non-verbal cues that did not involve talking. Sometimes students also ignored group answers in favour of writing their own worksheet answers. The lack of a methodical approach did not usually seem detrimental to the group output except when associated with high levels of off task talk. The groups' method of working through the tasks was characterized by *child-like* features as opposed to the more systematic, adult-like approach conjectured by the researcher. Despite the expectations of the researcher that the students would work better with a methodical approach, they generally completed the tasks successfully at an age-appropriate level.

Proximate discussion context and knowledge co-construction

Not all material recalled for the journals and tests could be related directly to the quality and quantity of discussion. Several instances were discerned where ideas referred to in the same, overall discussion context seemed to become connected in the students' mental structures in the long term. This represented a very specific component of the discussion situation and was termed the *proximate discussion context* by the researcher. Proximate discussion context seemed to be an influential factor for long term knowledge and concept building. It was related to the other contextual factors described in the previous section but is discussed here because of its direct relationship to the kinds of talk engaged in by the students.

Group B3's brief treatment of the James Cook material illustrated the role of proximate discussion context. The group was discussing James Cook and references to Robert Scott and frostbite were included in the same proximate discussion context, the latter being discussed moments before the mainly MAKITAB TS11 exchange below. Thus Cook, frostbite and Scott were being discussed approximately at the same moment as the students interacted with the task.

Rebecca:	Was Cook the one whose gang died? Oh no cos it was just him.
Hannah:	No Cook didn't die.
Cody:	Scott did...
Rebecca:	...cos it was just him...
Hannah:	No Scott died
Cody:	It was Scott's team died
Unknown student:	Scott didn't die his team did.

Frostbite also formed part of the proximate discussion context for blizzards in lesson one. It seemed that references to Cook, made in the same context as references to frostbite/blizzards and Scott's expedition, became associated together in the students' mental structures and may have triggered recall. Consequently, when writing their journals, the concepts of blizzards/frostbite, Cook and to a lesser extent, Scott, appeared together. This group did not engage normally in particularly high levels of quality talk but 52.7% of their statements within the overall "Cook context" were coded TS09-TS13. References to Cook appeared in journal writings by Rebecca, Hannah and Billy. Billy's first reference to Cook appeared at twelve months, "Captain James Cook was the first person to sail around it".

The effects of proximate discussion context were also evident among group B2 when they discussed the question about Ernest Shackleton in lesson three (Appendix J). The only reference made to Shackleton was when Max read the discussion question, " What kinds of dangers would Shackleton and his men have faced?". The resulting discussion focussed mainly on references to blizzards and whales, already discussed at length in lesson one.

Cale: Blizzards.

Unknown student: Seas.

Kate: Just put blizzards and rough seas...

Cale: Blizzards and ...

Max: Are you putting blizzards?

Kate: Blue whales and rough seas...

Cale: ...blizzards, blue whales and rough seas.

The students appeared to have connected the notions of blizzards, whales and Shackleton together as indicated by their journal writings. Each student recalled some detail about Shackleton, either in tests or journals, despite no specific mention of the explorer other than a student reading the relevant worksheet question.

Shackleton's ship was crushed in the ice.

(Cale, post-lesson)

Shackleton & Mawson were famous explorers. Shackleton's ship stuck in ice.

(Max, three-months)

As with the group B3 example above, the apparently unrelated concepts of blizzards and Shackleton seemed to become associated together in the students' mental structures and were recalled in journals and test items.

Kate, normally a low achiever in English, struggled with the spelling of Shackleton's name (Sakciten, Shatcalten) but was not deterred from including these mis-constructed references in her post-lesson and three-month journal.

Australian bases called Sakciten and Marson (Shackleton & Mawson)

(Kate, post-lesson)

Shatcalten & Marson (*Shackleton & Mawson*) are explorers that were the first people to find Antarctica.

(Kate, three-months)

Molly seemed to have difficulty with the lesson content and produced relatively few journal responses but she transformed her structures about Shackleton into a mis-construction involving Scott's expedition.

Shackleton and his men died because they pulled their things themselves.

(Molly, three-month journal)

Group B2 provided other insights into how proximate discussion context seemed to influence what was forgotten as well as what was remembered. These students reported *no* journal statements about James Cook and scored *no* test items correct. The first analysis suggested that the paucity of knowledge about Cook may have been related to the quantity of talk assigned by the group to the topic. However, contextual analysis found that the already brief Cook discussions were re-directed by a student statement related to how Shackleton's ship had been trapped and crushed in the ice. This seemed to have diverted the students' attention, re-defined the question under discussion, leaving them with a stronger concept of Shackleton but a minimal concept of Cook. Kate read the first question in lesson three (Appendix J) and then seemed intent on an in-depth discussion.

Kate: Now I think we're going to have to have a long talk about this one.

Cale: Maybe because um...maybe because um... you can see a little raft there and maybe because one of the team had to pull the sleds.

Max: No we're not talking about that one we're talking about a ship like this. We're talking about Cook...

Kate & Max: ...how it would have been harder

Max: exploring Antarctica in this big ship...

Molly: Well maybe it might have been heavier than other ships...

Unknown student: It could be...

Kate: Was that the one that was crushed?

Cale: Yeah.

Group A1 also provided evidence of the effects of discussion context. This group discussed notions about weather frequently and the use of the term meteorologist was prominent in discussion and journals (see Case Study 1). The weather concepts were discussed in the same context as blizzards and frostbite. In lesson three, the subject turned to James Cook and the talk was enriched by student prior knowledge, as indicated by these (non-sequential) exerts.

Abi:	It would have been harder because they wouldn't have the type of ships they do these days.
Amanda:	Icebergs yep because this is a wooden ship it's not like how we have it it's a wooden ship.
Clark:	Yeah even the Titanic that was steel.
Joel:	And Cook was famous for his maps.

The discussion included brief references to blizzards as a problem Cook may have encountered, indicating application of prior knowledge that further enriched the student discussion.

Amanda:	Because the ship was like really different like so that with the sails if there was a blizzard they wouldn't know how to deal with it.
Clark:	Amanda, they wouldn't know how big the island is and they wouldn't know about blizzards.

The rich proximate discussion context seemed to lead the students to consistently produce journal data relating to Cook and blizzards/weather conditions indicated that discussing these concepts in different contexts had assisted recall (see chapter five).

<u>Discourse processes that influenced knowledge co-construction</u>

Related closely to the quality kinds of talk described above were several specific modes of language or *discourse processes* that seemed necessary to facilitate social constructions (Table 43). These were seen as components or sub-sets of the MAKITAB codes.

TABLE 43

Discourse processes aiding social construction of knowledge

Discourse process	*Example*
Testing/comparing ideas	**Group is discussing difficulties early explorers had in Antarctica** *Melanie:* They wouldn't know their way around... *Rianne:* They might have crashed into icebergs *Paul:* You sure he would have? *David:* Yeah he was commander of the ship so he might have... *Paul:* ...Hundred to one chance...
Incomplete statements	*Rianne:* You might get lost if you were an Antarctican scientist, you might get... *Paul:* ...lost *David:* Or you could get lost because um a what's it's name (blizzard) comes down and there's lots of snow and you can't find direction. *Melanie*: It has to be about the blizzard remember... *David:* The blizzard can make you lose direction.
Repetitions	*David:* Well let's just go back to question one again. Why would the ice be three kilometres thick?
Simultaneous thoughts	*David:* Now if this group was going to study Adelie penguins what one would we...what sort of... *Rianne & David: (almost together)* ...equipment... *David:* ...yeah equipment would we need.

Students *tested and compared* their thoughts and possible answers against those of their peers as they "mulled over" the lesson content. This appeared to be a process of "floating" ideas where the student did not necessarily expect a response. They often made *incomplete statements* as if their thoughts were trailing off. Other students sometimes completed these statements, seeming to pick up on the same thought. The students reacted positively at these moments and positive group bonding seemed to occur. Students *repeated* themselves frequently and paraphrased each other. This was another part of the general "mulling over". In some cases they would return to discuss a question when they had not been satisfied with the initial answer.

Students sometimes seemed to have the same thought *simultaneously*, indicating that they were thinking alike, similarly to occasions where they completed peer statements. Observational data and the transcripts revealed that the students would also react positively to each other when these "like thought" processes occurred. The opportunity to relate together on tasks, using their own language usually had a positive motivational effect on the groups.

6.6. Summary

The cross-case analysis has reported the findings of this study, guided by the research questions and the model (Figure 77). Evidence of both individual and social construction of knowledge was found. The extent to which individual students constructed their own meanings or were involved in co-constructed knowledge appeared to be a function of the multi-layered contextual factors described in the chapter. Particularly strong contextual factors were student idiosyncrasies, prior knowledge and factors determined by teacher influences.

Prior knowledgė, itself an idiosyncrasy, influenced social construction of knowledge by its effects on the quality of discussion. Groups possessing more collective prior knowledge engaged in more in-depth type discussion resulting in enhanced learning.

Connections were established between teacher cognitive intent, cooperative conditions, student discussion and student outcomes. This research has confirmed several of the student mediation effects described in other studies, notably group dynamics and student preparedness for cooperative learning. Teacher cognitive intent was mediated strongly by student contextual factors other than idiosyncrasies and prior knowledge. These included student emotional responses to discussion questions and interest in the material presented.

A minor finding of this research was the influences on discussion of the affective domain. Students tended to allocate more discussion time to topics that interested them or produced an emotional response.

The chapter also highlighted some aspects of the teacher's role in structuring tasks and establishing the context for cooperative learning. The teacher's roles included establishing the classroom evaluative climate and monitoring student talk and task engagement.

Group processes mediated teacher plans significantly. Dominant and passive students were detected in each of the study groups and they worked cooperatively to varying degrees. When groups did not cooperate they tended to produce lower levels of quality talk.

Quality talk was further defined in terms of the MAKITAB instrument. A further discussion influence on long-term recall appeared to be the proximate discussion context. Evidence was found where discussion of different subject matter in the same immediate context seemed to produce lasting effects.

The student seemed to recall information unpredictably. No stimulus for their memory was provided during data collection and the precise mechanisms that initiated recall remained problematic.

CHAPTER SEVEN

DISCUSSION

7.1. Overview

The chapter is a discussion and explanation of the major findings of this study in terms of the research questions and the theoretical framework and links the discussion to the relevant literature.

7.2. Introduction

An examination of the putative cognitive benefits of cooperative learning led this research to an overarching theme centred upon the nature of knowledge and conceptions of the individual mind. Where are knowledge and the mind located? Is knowledge the province of the individual or is it a socio-cultural construct? What occurs when several minds meet? Guided by the research questions and the theoretical framework, the major research findings are discussed below while converging, in the final chapter, onto the wider theoretical issue of a fourth metaphor of cognitive psychology

Discussion in this chapter is predicated upon conceptions of an individual, *archetypal mind*, located in a socio-cultural setting, influencing the learning of other students and mediating the teachers' cognitive intentions. The notion of an archetypal mind in its context provides an organizing theme for the chapter as the major findings are discussed and explained. The study involved groups of four individual minds meeting in a cooperative learning setting. How did these minds, individually and collectively, react to the learning contexts presented to them in the study? What processes and factors produced knowledge construction and how were teacher influences mediated by the group?

7.3. The mind in context

The most significant finding of this study was the importance of contextual factors and their influences on student outcomes. These findings appear compatible with the contextualist world hypothesis (Pepper, 1942) discussed in chapter three. Contextualism, with its root metaphor of the historic event and the here and now, provided a central philosophical theme for the research and this theme appeared to be increasingly appropriate as the data were analysed. The theme related closely to concepts of situated cognition and the socio-cultural perspectives of learning that guided the research design.

The importance of context to understanding classroom learning can be illustrated by drawing an analogy between the classroom setting and an archaeological dig. An archaeologist finds an artefact such as a brick at the site. The brick on its own may not be of particular interest. It may have been carried there by one of the team of volunteers working at the dig. It could be a house brick, or a paving brick but it could also be a brick from a Roman wall, one from a house in Ancient Troy or even a ballast brick from a sunken ship. The position where it is found, its *context,* is critical to the archaeologist. It is the context that gives *meaning* to the brick and assists the archaeologist to understand more about the site. The brick, or indeed any artefact, is studied exhaustively *in situ*, before removal. A similar situation applies to learning and cognition in classrooms. In order to understand classroom learning and cognition, with its multi-layered, multi-variable context, researchers must pay close attention to context. Research conducted outside real contexts has failed to adequately describe the constructs under study and may lack applicability and relevance beyond the confines of the study (Mayer, 2001). This research was undertaken in real classrooms using authentic classroom tasks, revealing some of the interactions and complexities of the contextual factors that mediated the teachers' intent and the students' learning.

Strong support was found for the proposition that student learning and cognition cannot be divorced from context (Brown et al, 1989; Collins et al, 1989; Billett, 1996; John-Steiner & Mahn, 1996; Nuthall, 1996). The learning of dis-connected, de-contextualized facts appears to be meaningless (Brown et al, 1989; Billett, 1996). Billett (1996) contended that the situational influences on knowledge construction were not well understood.

This study has revealed some of these influences, isolating two major, inter-related contextual factors; *student idiosyncrasies* and *prior knowledge*. These are discussed in the first part of the section, presenting a mainly cognitive psychological perspective. Other contextual factors that proved highly influential to the students' learning and thinking are discussed later.

Contextual considerations may explain in part the idiosyncratic nature of the students' learning found in this research. Student journal entries, their test scores and their discussion all exhibited a uniqueness under the unifying umbrella of the lessons. Although similarities in the students' learning were discerned, sufficient individuality was present to support the hypothesis that this was the meeting of several unique minds, which reacted in unique ways to the experiences in the lessons. Assumptions by educators that focussing on de-contextualized facts and providing students with the same experiences should lead to the same learning are not sustainable. Given the unique biological and experiential history of each individual, each learning experience was clearly not the same for each student.

Student idiosyncrasies, prior knowledge and the construction of knowledge

An early conjecture of this research was that examining the extent of individual versus social construction of knowledge might manifest the benefits of cooperative learning. This proved a fruitful line of inquiry. Evidence was found of both individual and social construction of knowledge but these constructions were characterized and often determined by the idiosyncrasies of individual participants (see chapters 5 and 6).

This finding was not unexpected given the structure of the lessons. The lessons were designed to provide information that could be acquired directly from the lesson texts or from a combination of text and discussion of the worksheet questions. Therefore a degree of social and individual knowledge construction was anticipated. The students demonstrated in their journal responses, test scores and small-group talk that knowledge had indeed been constructed both socially and individually but the extent and nature of the idiosyncrasies displayed in the students' learning was an unexpected finding of this research.

Nuthall and Alton-Lee (1993) also described student idiosyncrasies and Nuthall (1996) alluded to the complex, multi-layered nature of the classroom. Nuthall (1996) argued that increasing understanding of the complexities of the classroom was the most important development of recent research. It is posited that previous researchers may have underestimated the extent of student idiosyncrasies and it appears to be this uniqueness that contributes most significantly to the manifold classroom variables.

In order to explain these idiosyncrasies, a concept of an archetypal mind was developed and investigated. Each of the student participants was visualised as the possessor of a mind, which was the product of its unique biological and experiential history. This mind acts as a functioning biological organism (Vosniadou, 1996) with a unique genetic structure. Its functions are determined by the behaviour of a "vast assembly of nerve cells and their associated molecules" (Crick, 1994, p.3). Enculturation into society exerts a powerful influence from early in the mind's history although not all mental structures are socially constructed (Carey & Gelman, 1991, cited in Bereiter, 1994). The genetic form of this organism has equipped it with certain pre-dispositions that will later translate into academic and other potentialities (Spelke, 1982, cited in Bereiter, 1994). Chomsky (1957, cited in Morgan, 1997) and Vygotsky (1962) proposed that genetic structures existed, which pre-dispose the child to the early acquisition of complex processes such as language. This child's mind accumulates an array of unique experiences that transform a biological organism into a cultural organism with a potential determined by its biology and enhanced by its environment. Enculturation of the archetypal mind has included several years of formal schooling and it now enters a cooperative learning situation in a classroom with other, uniquely pre-disposed minds. Each child's mind therefore brings to the learning situation a unique pre-disposition to react, attend, perceive, learn and behave in certain ways because of its unique history. Possible reactions to learning experiences are multi-variant and highly complex with multiple variables interacting simultaneously to produce unique responses.

The above is more than merely another discussion of the nature/nurture debate because it is contextualized in the classroom and takes account of the interaction between unique minds under cooperative conditions. The second part of the conceptual framework (Figure 3, p.66) depicts the individual as interacting with artefacts and responding to objects and events while immersed in a culturally relevant activity, in this case, the cooperative learning experience. The individual is bounded by the interaction with artefacts but this research has suggested that the role of the individual may be more autonomous than was depicted in the framework. A revised framework needs to include greater recognition for the role of the individual in knowledge construction.

The uniqueness of the mind's response to classroom experience can be explained in terms of *cognitive style theory.* Cognitive style theory delineates learner and context relationships (Morgan, 1997). The role of the individual in experiences is seen as critical, with experiences undertaken at varying intensities. The unique experiential history of the individual produces unique representations in the neural structures. New experience is perceived and acted upon with reference to previous experience. Hence, no two students' perceptions of objects and events will be the same. Cognitive growth occurs through the individual interacting with their environment, a notion compatible with situated cognition perspectives.

The uniqueness of individual responses to the same experiences was revealed in the learning journal data, indicating that the students had transformed information in unique ways. At a first examination the journals seemed unpredictable and random. Items recalled for one journal were often forgotten later. Sometimes items recalled immediately after lessons were not recalled at three months and then recalled again at twelve months. Students' *own constructions* revealed a similar pattern. Own constructions occurred when students applied prior knowledge or knowledge gained from the lessons to produce an accurate, new construct. When included in one learning journal, own constructions were usually not repeated. Students who made their own constructions seemed to produce them in an on-going flow that was not replicated and seemed to be unrelated to their most recent attempts.

A similar pattern was discerned with student *mis-constructions.* These journal entries occurred when students connected different pieces of information together to produce an incorrect construct. Mis-constructions were as unique to the individual as were their own constructions. Once "mis-constructed", the incorrect idea tended to be discarded but some of these constructions appeared more stable over time. When Paul wrote in his pre-lesson learning journal; " ... lots of people die in Antarctica" this entry represented mis-constructed prior knowledge and it was not repeated again until twelve months when it became "a lot of people die trying to reach the South Pole".

The students' idiosyncratic own constructions and mis-constructions suggested that knowledge, once acquired, continued to be altered in the students' mental representations, appearing to undergo an *evolutionary* process. This process seemed to continue even after students were no longer engaging with the topic. Knowledge did not appear as a fixed, bounded construct in this research but as "...an unpredictable grappling with ideas" (Meloth & Deering, 1999, p.250). The study students constructed individual meanings from the same material and the uniqueness of each mind in the various groups produced unique meanings within and between groups.

The impact of discussion on student learning also seemed idiosyncratic for each individual and was exemplified by the journal writings of group A2. David, Rianne and Melanie appeared to gain from the discussions, at least in the short term. Less impact of the talk was discerned for Paul. Although he reported several discussion-related codes in his early learning journals, Paul had forgotten these by the three and twelve month entries. Melanie's recall of discussion codes varied but in her final (twelve-month) learning journal as much as one third of her entries were discussion related. In contrast Rianne was generally quite actively involved in discussion but her recall decreased markedly over time. David seemed to retain some of the discussion related material but most of his final learning journal consisted of text and own constructions.

Not all knowledge seemed to be constructed as a result of group interaction. Individual knowledge construction was found in several cases where students' knowledge appeared to be directly transmitted by reading text or from the rare whole class teacher interventions. This finding is at odds with the notion that knowledge must be constructed from prior knowledge, one of the main tenets of some constructivist theories (Good & Brophy, 2000). Rebecca (School B) appeared to gain little from discussion and provided examples of individual knowledge construction. In the lesson three (Appendix J) text it was mentioned how the first people to make landfall in Antarctica were sealers. No other student recalled this information and it did not appear connected to any other fact. Rebecca consistently recalled this fact in her post-lesson, three-month and twelve-month journals. Another example of a student learning new information without reference to prior knowledge was Molly (group B2, Figure 60) who exhibited no prior knowledge of Mt Erebus or the explorer Shackleton (among other information) in her pre-lesson journal but remembered details about this subject matter in the post-lesson and three-month journals. However, Molly mentioned penguins in her pre-lesson journal and subsequently elaborated this knowledge later, indicating that she was capable of accessing her prior knowledge. These examples illustrate how information seemed to have been received, stored and recalled without the students necessarily referring to prior knowledge.

The above findings led the researcher to speculate about how information was stored and retrieved. Was the storage and retrieval organized and systematic or was it connected more at random? Did student idiosyncrasies alone explain what was remembered and what was forgotten in the journals and tests?

Accepting assumptions about the unique, archetypal mind may explain some of the idiosyncrasies found in this study but the effects of classroom events and student attention during the actual moments when the students were engaged with the subject matter also appeared influential. Classroom events were subject to change and unpredictability. Not surprisingly, individual student attention varied over the course of the lessons. The important link between learning and attention has been described well (Biggs & Moore, 1993, pp 207-209; McInerney & McInerney, 1994, pp 184-185; Maltby, Gage & Berliner, 1995, pp 247-248; Best, 1995, pp. 33-69) but the literature refers principally to an information processing model where information is received in the learner's sensory register. This research emphasized the contextualized nature of student attention or consciousness, a state that was not only influenced by context but also comprised one of the contextual variables.

In order to receive information, multiple variables (see chapter 6) needed to coalesce so that information could be received and learning could occur. The variables represented an aggregation of individual consciousness and classroom events from *moment to moment.* These variables seemed to impact strongly upon the likely learning outcomes of the students and may further explain the idiosyncrasies found in this study. Some student discussion appeared directly linked to learning outcomes but substantial portions of other discussion seemed forgotten. The effects of *proximate discussion context* (see chapter 6) indicated that some moments in discussion appeared linked to pieces of information and were retained and associated together in the students' mental representations. Recall of other discussion moments and information were discarded. These associations may be explained in terms of links between *episodic* and *semantic* memory (Tulving, 1985; see chapter two) and the convergence of student consciousness during those moments to create a social construction of knowledge between two or more group members.

Most of the previous cognitive research has focussed on the mind consciously attending to one object or event at a time, suggesting *series* processing. Dennett (1993) contended that an individual mind functions as a kind of *parallel* processor, being able to perform several different tasks at once. The child in a cooperative setting may be conscious at different levels and this state of consciousness may fluctuate rapidly. The child may be thinking of the next lunch break, discussing subject matter, reacting to social or emotional stimuli and feeling physically uncomfortable *simultaneously.* Not all matters warrant the same degree of attention. Crick (1994) described attention as withdrawing from some events in order to deal with others or a "filtering out *un*attended events" (p.60). The individual's consciousness during cooperative discussion may fluctuate widely between attending to subject matter, contributing to discussion and so on, producing variables that complicate further the realities of each individual at any given moment. Not only are the antecedent factors unique but the individual's thoughts and consciousness also varies momentarily. For each individual, the realities perceived, grounded in unique biological and experiential histories, are unique. What seems to be the *same* learning experience from the teacher's perspective, in this case, a cooperative learning situation is in reality very different for each student. Cognitive gain under cooperative conditions seemed to require a coalescence of the individuals' *unique momentary states of consciousness.* This state, combined with student idiosyncrasies added further dimensions to the cooperative learning setting and may explain why some discussion resulted in long-term learning and other discussion was forgotten. Pepper's contextualist root metaphor (1942), with its focus on historic events and the here and now, seems particularly relevant when considering moments of student consciousness.

The idiosyncrasies of individual minds may explain some of the individual knowledge constructions found in this study but evidence was also found of socially constructed knowledge. How did these minds interact in cooperative small groups and what influence did they exert upon each other in the social construction of knowledge?

This research revealed some of the impact these unique individuals had on the learning of their peers while they were actively attending to the task. Despite the mediating effects of idiosyncrasies, the groups combined to produce some lasting knowledge constructs, suggesting that cooperative learning strategies had been an effective medium for cognitive growth. Four uniquely pre-disposed minds came together in small groups. Each group created a unique cultural milieu, which was a function of their individual uniqueness. This cultural milieu in turn shaped their knowledge, understandings, values and attitudes mainly through talking around the subject matter and social construction occurred when the students' consciousness was aligned during discussion. The specific nature of the students' talk was the most significant determining factor in the co-construction of student knowledge. The nature of this talk is discussed in the next section.

The influence of student talk on the construction of knowledge

Not surprisingly, student prior knowledge appeared as a strong influence on student talk. The students were presented with a large array of unfamiliar subject matter. Some students approached this subject matter with confidence because they already possessed a foundation of prior knowledge, which included previous success at these kinds of tasks. Prior knowledge was also idiosyncratic. Some students knew very little about Antarctica. Others possessed quite substantial knowledge. With two or more group members contributing their prior knowledge to the discussion, the effect was to produce richer talk that appeared to enhance learning. Confirming research by Nuthall and Alton-Lee (1993), this research was able to demonstrate how greater pools of prior knowledge impacted on the social construction of knowledge by enhancing student talk and leading to improved outcomes for the group members.

In addition to the prior knowledge findings, the present study defined more precisely the kinds of talk likely to lead to long-term learning. Previous researchers have described the nature of student talk under cooperative conditions (Bennett & Dunne, 1991; King et al, 1993,1994). King et al (1994) described *task-enhancing talk* in terms of MAKITAB codes (TS08, TS10, TS11, TS15, TS16, DS05, DS06, DS07 & DS12, see Appendices H & I). This study generally confirmed these findings with the exception of the TS08 code (examining, comprehending, clarifying and routine responding) and the addition of TS09 (sudden insights). The former (TS08) was talk directed mostly at task completion and often led directly to answers being produced (TS14) with minimal discussion. Sudden insights (TS09) were uncommon, but were usually linked to higher order-type discussion.

Talk involving elaboration of ideas and higher order cognitive processing involved high rates of MAKITAB code TS11. These were the processes of *negotiating, arguing* and *re-acting to ideas, insights and proposals*. They were identified as the principal processes likely to lead to improved learning and were termed *quality talk* for the purposes of the study. Quality talk was closely connected to the collective prior knowledge of the group. Knowledgeable groups produced better discussion because they were able to propose ideas to their colleagues and argue their points of view, thus enriching the discussion. Groups that did not normally engage in high levels of quality talk seemed to retain more long-term knowledge when they did. These findings can be explained from several theoretical perspectives.

In terms of student memory, Tulving's (1985) description of *episodic memory* may explain the gains attributed to cooperative learning strategies. These strategies provide a context or episode that allows students opportunities to engage with content through talk. Cooperative learning settings provide an episode in the child's experience, which may be remembered as much as the subject matter. This association between specific classroom moments and material discussed at those moments, termed the *proximate discussion context,* was discussed above. Episodes such as this may bring individuals' thoughts closer together at that time and may have a lasting impact upon memory.

The context of discussion also seemed to affect student *application* of prior knowledge. Prior knowledge did not always lead to new conceptual development. One example was Joel's (group A1) pre-lesson journal (Figure 13) when he wrote, "people can die of Hypothermia easily if they don't wear the right clothing" but it was problematic why this term was not referred to again specifically in discussion or in journals. The group discussed clothing when answering worksheet questions (Appendix J) and concepts about the need for special clothing were evident in all journals. Joel's knowledge of the term hypothermia seemed to have been subsumed into other mental representations. He seemed particularly concerned about blizzards and eye protection. Had this term been injected into the group's discussion it may have enriched the language context and contributed to the group' co-construction of knowledge.

Two language-focussed perspectives (Nuthall, 1997) may also explain the impact of quality talk. Students explore and organize thoughts through talk, and thus learn by using language and learn language by using it (Barnes, Britton & Rosen, 1969; Halliday, 1978). Under this perspective, knowledge and students' reactions to learning opportunities are negotiated and created through talk (Dixon, de la Cruz, Green, Lin & Brandts, 1992). The second language-focussed perspective is closely linked to socio-culturalist, language-as-cultural-artefact views with their Vygotskian origins (Nuthall, 1997). This perspective would explain quality talk in small groups as forms of discourse, which express values, concept development and ways of thinking inherent in the various socio-historically-derived curriculum areas.

Cooperative learning may also be beneficial because it provides the kinds of opportunities to explore ideas, review thoughts and mentally rehearse described in a *cognitive-elaborative* perspective (Wittrock, 1978, 1990; O'Donnell & O'Kelly; Slavin, 1995). According to these researchers, individuals must actively process new material if it is to be remembered. The ultimate result of these processes is re-organized, integrated information and enhanced understanding (Woolfolk Hoy & Tschannen-Moran, 1999). Explaining new material to other individuals, such as in cooperative learning situations, can be a very beneficial part of the cognitive-elaborative process (Slavin, 1990, 1995). Cooperative learning settings provide opportunities for the cognitive gains achieved through peer collaboration (Dansereau, 1985; Palincsar & Brown, 1984) through the processes of quality talk defined above.

A *Piagetian* perspective on quality talk would adopt a developmental perspective, suggesting that dialogue between children of differing developmental levels, attempting to explain or justify their point of view, will lead to progression to higher cognitive developmental levels (De Lisi & Golbeck, 1999; O'Donnell & O'Kelly, 1994). According to this perspective, peer support provides the contexts and interactions necessary to help children revise existing cognitive systems. Piaget (De Lisi & Golbeck, 1999) argued that cognitive systems in formation were more context dependent than cognitive systems nearer completion. This supports notions about the importance of quality talk because this talk represents the moment when student cognitive systems are forming. A Piagetian perspective would also argue that knowledgeable students benefited from the discussion more than their less knowledgeable peers because they had existing mental structures upon which to elaborate.

Piagetian theory can also be applied to explain why some student discussion did not lead to long-term learning. In his later work, Piaget (1985) argued that the driving force of cognitive change was the connection between *perturbation, regulation* and *compensation*. Perturbations were the individual's perceptions of success or failure in making meaning of new experience or objects. If perturbations did not occur, schema remained unchanged. If perturbations did occur, the child would sometimes repeat the existing behaviour or make no attempt to modify cognitive systems. This was Piaget's recognition that in the real lives of children, lack of success in intellectual endeavours did not guarantee cognitive change (De Lisi & Golbeck, 1999). In the present research, students appeared to be in varying states of perturbation but learning did not necessarily result. In some cases, unable to make meanings, no effort seemed to have been made to assimilate and accommodate the new material. Contextual variables, particularly affective factors such as student motivation, attitudes and curiosity, appeared to result in some students avoiding engagement with the content, resulting in attempts to complete tasks with minimum effort. These minimalist approaches resulted in more lower order talk and less higher order, quality talk.

Returning to the original theoretical perspective of this research (see chapter 3), the potential benefits of cooperative learning may also be explained in terms of Vygotsky's (1978) *zone of proximal development*. The small group discussions, particularly of the quality type, seemed to provide a kind of "shared" or "communal" zone of proximal development. Students were able to relate to each other using their own kinds of language (Halliday, 1978). In some cases, the use of specific language defined the students' understandings of the material, such as in the case of one student whose prior knowledge included the term meteorologist (see chapter 6). Knowledgeable students played the role of "expert" even though their level of knowledge may have been only marginally ahead of other (novice) students and evidence was found in the data of students providing a small degree of scaffolding for their peers.

The cognitive benefits of cooperative learning, particularly when quality talk is engaged may be explained further within a Vygotskian framework in terms of the individual's unique momentary state of consciousness. At any given time, individuals may be aware of and thinking about multiple objects or events. Students engaged in cooperative talk or indeed, *any* classroom activity together, may align their thoughts and attention momentarily. That is, the talk creates a momentary convergence of individuals' states of consciousness or attention. Socially constructed knowledge was conceptualized in this study as a concurrent state of consciousness or a sharing of meanings for the brief moments of the activity or discussion. Individuals were then envisaged as taking the shared meaning away from the group situation and constructing their own meanings. These meanings continued to evolve over time. They were usually similar to the other group members but rarely the same because the individuals' perceptions of the learning experiences were unique. Thus, what seems to be the same learning experience for students is actually unique to the individual because of their idiosyncrasies.

This study has provided strong evidence of the situated nature of student learning and cognition. The influences of two important contextual factors (student idiosyncrasies and prior knowledge) on the mind and the effects of student talk have been discussed in relation to individual and social knowledge construction. Several other contextual factors were identified (see chapter 6) as influencing the socio-cultural setting of the research. The following sections continue to explore these factors, broadening discussion of the archetypal mind in its social context.

<u>The role of group processes</u>

Patterns of dominance and passivity (see chapters 5 and 6) were significant in this research because of their influences in shaping group context. These patterns influenced the creation of each group's socio-cultural milieu, which had been initially shaped by the interaction of unique minds. It was found that the interplay between individuals was another important factor in producing higher levels of quality talk.

Pre-eminent among findings about group dynamics was the role of dominant students. Students with good prior knowledge (David, Clark, Abi, Max and Rebecca) drew high status from their academic ability and tended to assume leadership roles, dominating group operations and discussion and determining group culture (see chapter 6). The group culture was a major mediating factor on teacher cognitive intentions. Dominant or leader-type students were usually task-oriented and exhibited high degrees of intrinsic motivation and the groups made positive gains with the tasks. Some groups (A1 and A2) comprised a majority of task-oriented students which led typically to higher levels of quality talk because in these situations quality talk became part of the group culture. In these instances, group processes had helped to create the conditions needed for quality talk and the resultant cognitive gains. When the task motivation was to "get finished" this resulted in less quality talk and usually meant less learning.

Some students' influence on the group context was socially based. Alan achieved his status from his social skills and popularity rather than academic ability. This was not always a positive influence. He tended to ignore the contributions to discussion of other students and this led at times to conflict, more off-task behaviour and the withdrawal of some group members. Max was also prone to ignore other students and to proceed on his own with the other group members providing a backdrop resulting in similar effects to Alan's group. Training in pro-social group skills had not been effective with Alan and Max. They seemed unaware of the need to include all group members. As a consequence, status in the cooperative setting seemed to mirror the usual status relationships in the classroom. Abi was one student who seemed aware of the need to include all group members. Her motivation was partly socially based and directed towards conducting a cooperative discussion. She intervened if she thought the group members were not cooperating. Abi's approach was not common among the study groups, particularly those from School B. This finding led to conjectures about whether cooperative learning was worthwhile if the usual classroom patterns of behaviour and task engagement are maintained. Interventions like the status treatments described by Cohen, Lotan and Catanzarite (1990) would seem recommended in these circumstances.

Although the groups appeared to function reasonably well, the dominant students were not always able to guide the group towards positive outcomes. As has been found elsewhere (Mulryan, 1992 & 1995; King, 1993; Day, 1997) less able students tended to become passive while some students tended to dominate discussion. If one or more students dominate discussion, such as in Max's case, cooperative learning may be counterproductive because cognitive benefits of the quality talk may be neutralised. However, despite the apparent negative aspects of dominant/leader-type students, the influences of these individuals were very significant to the success of the group. They provided the driving force for group task engagement and discussion. Without them the groups may not have functioned successfully. Harnessing the potential power of these kinds of individuals must become a priority for teachers planning to use cooperative strategies.

Passivity was noted in each group particularly when accentuated by age differentials and a lack of prior knowledge. Rebecca emerged as the leader of group B3 but this group did not function cooperatively. Two of the group members may have become passive due to their relative young age (seven years) and inability to cope with the subject matter, and contributed little to the discussion. Billy responded by becoming disruptive. This caused conflict and seemed to lead Rebecca to withdraw from the group, as indicated by the predominance of material learned directly from text.

The discussion above illustrates how social psychological factors can exert an influence on teacher intent and student cognition by affecting the learning context. The critical role of the teacher in creating and maintaining optimal social settings for cooperative learning is discussed further in the final chapter.

Student intrinsic motivation and the affective context

The dominant students in all groups exhibited strong intrinsic motivation to complete tasks. This represented a further influential contextual factor determined by student idiosyncrasies. Apart from individual characteristics, intrinsic interest and curiosity in the subject matter seemed to heighten motivation. The effects of student interests and curiosity on intrinsic motivation are well researched (McInerney & McInerney, 1994; Good & Brophy, 2000). This finding was not unexpected given the nature of the topic and the lesson structure but the type of data allowed for an in-depth examination of students' reaction to the subject matter. Examples were described above (see chapter 5 and 6) where certain discussion topics took the students' attention and dominated large portions of their discussion. Subject matter involving an element of danger or shock seemed particularly popular, such as blizzards, frostbite and the death of Robert Scott's team. The discussion about Scott's team being forced to eat their sled dogs (based upon incorrect information), by both School A groups seemed to particularly arouse the students' attention. Another appealing topic was the idea of tunnels connecting buildings. This reaction to subject matter can be explained in terms of the archetypal mind and its state of consciousness. Since the mind in context may be simultaneously thinking of more than one thing at a given time, material that arouses the consciousness is more likely to be taken into mental structures and recalled over time. All group members being aroused at the same time leads to more quality discussion and hence more learning.

Memories or associations in the child's mental structures may also have been stimulated by the affective contexts created by the cooperative learning settings. It appears self-evident that emotional reactions to subject matter make recall more likely. For example, the individual mind may have reacted with positive emotions to an event in the cooperative setting, resulting in a pre-disposition to remember the events at that moment and the associated subject matter. Research by Battistich, Solomon and Delucchi (1993) found correlations between students' perceptions of high quality group experiences and their motivation, concern for others and self-esteem. Positive feelings about episodes may have triggered episodic memory (Tulving, 1985) and influenced recall. A negative reaction may have produced the same effect. The discussion about Robert Scott and sled dogs produced a shocked emotional reaction and high levels of quality talk in the School A students. This information was recalled strongly later. Rebecca (group B3) appeared unhappy with the progress of the group and may have had unpleasant memories of the lessons. Her learning was mostly related to information she remembered from the lesson texts, indicating that the group experience may have been associated with unpleasant memories.

The nature of cooperative learning alone may contribute to student learning, providing a setting for social development (Gibbs, 1987). Cooperative learning is an intensely human encounter, often involving sustained use of the ultimate human artefact, language. From the child's perspective, cooperative learning may be remembered in its own right as a pleasurable episode of socio-cultural/linguistic interaction. Involvement in these kinds of lessons may be recalled even when the subject matter is forgotten.

7.4. Summary

The above discussion has described and attempted to explain the major findings of the study. Conceptions of a unique, archetypal mind constituted a theme for the discussion. Two major contextual factors affecting student learning and cognition in cooperative groups were student idiosyncrasies and prior knowledge. The unique mind of each student produced idiosyncratic reactions to the cooperative setting and contributed to the socio-cultural milieu through which knowledge was constructed. Knowledge appeared as both individual and social constructions and was influenced heavily by the quality of discussion. The students' minds appeared to share co-constructed meanings as their consciousness converged and their knowledge continued to evolve over time. A key influence on the quality of discussion was student prior knowledge. Prior knowledge also emerged as a strong influence on the group context. Motivational influences and factors from the affective domain were also found to be important contextual factors. Contextual factors mediated teacher cognitive intent strongly, particularly through their influence on the production of quality talk.

What are the implications for teachers of the interaction of unique minds under cooperative conditions? How can cooperative learning be structured in order to optimise student thinking and learning? Where does the mind reside and to what extent does this research suggest the existence of a possible fourth metaphor of human learning? These questions are addressed in the final chapter.

CHAPTER EIGHT

CONCLUSIONS AND IMPLICATIONS

8.1 Overview

The chapter concludes the thesis with a summary of findings directed at answering the research questions. The previous metaphors of learning are evaluated in the light of the findings of this research and with reference to the conceptual framework of this study. Implications for educators are described. The chapter concludes with a discussion of further research and posits a possible fourth metaphor of cognitive psychology.

8.2 Synoptic responses to the research questions

This study was based upon two general lines of inquiry, aimed at investigating the processes whereby student learning and cognition occur under cooperative conditions and the influences of the group on the construction of knowledge. These lines of inquiry led to three main questions, each with subsidiary questions. The following sections address the research questions explicitly as a means of summarizing the research findings and indicating where the findings overlapped some questions. Implications for teaching, theory and recommendations for further research follow.

Knowledge construction under cooperative conditions.

Evidence of both individual and social construction of knowledge was found in this research (see question 1.1). Individuals constructed knowledge idiosyncratically and some individuals appeared to operate as singletons within the confines of the group. Evidence was also found to support the tentative hypothesis advanced in chapter one that knowledge would be mostly socially constructed. The socio-cultural milieu of the group, shaped by student idiosyncrasies and other contextual factors, did produce some knowledge constructions but the individual students' minds seemed to operate on the constructs after they left the group setting. However, when taken at its broadest scope, all knowledge seemed shaped by social-cultural influences. Language and other social semiotics are uniquely human cultural artefacts and it is these that are ultimately responsible for all learning but in the specific cases studied here, the individuals mediated any social constructions strongly and demonstrated a capacity to learn adequately through direct transmission of knowledge. Socio-cultural perspectives on learning may need to pay more heed to the role played by the individual mind in learning and cognition.

The most significant factor affecting knowledge construction of any sort was the amount and quality of discussion (see question 1.2). This study found that previous findings on task-enhancing talk had not described the full depth and complexity of student discussion. In-depth, "mulling over" kinds of talk were identified as the most likely to lead to enhanced student outcomes. The cross-referencing of journal and discussion data made this finding possible over an extended time frame. This finding has implications for teachers wishing to pursue these strategies (see section 8.5. below).

Despite the idiosyncrasies of groups and individuals, involvement in cooperative learning appeared to bring learning outcomes closer together than was expected had the students completed the lessons alone. This coalescence was attributed to the students' participation in cooperative talk, particularly of the "quality talk" type. Cooperative learning seemed to align student consciousness for the moments of the discussion and produced some commonalities in what was remembered. Left alone to read and complete the lesson activities, the students may have learned an even more divergent range of material than actually occurred after their group experience. Cooperative

Cooperative learning provided a beneficial vehicle for the co-construction of knowledge among these students.

The factors mediating student learning in small groups

Student idiosyncrasies emerged as the major factor that mediated student learning. These were discussed in the previous section and chapter seven. One idiosyncratic aspect that emerged in this study was the students' prior knowledge (see question 2.1). This played a highly significant role in shaping the kind of discussion engaged in by the group. As was described above, quality talk led to improved cognitive gains. A major influence on quality talk was the collective prior knowledge of the group. Groups possessing more prior knowledge produced more quality talk and subsequently learned more. The implications for teachers of these findings are described below in section 8.5.

Other contextual factors (question 2.2) were influential in shaping the students' discussion. These included the development of group processes, the students' intrinsic motivation to complete tasks and factors determined by students' affective responses. Since these factors relate to group processes and student characteristics they are discussed in the next section.

The teacher intent, conditions, discussion and student outcomes connection

Investigations into the teacher cognitive intent, cooperative conditions, discussion and student outcomes connection (question 3) led to the tracking of teacher cognitive intent through all aspects of the lessons. At each stage the role of teacher decision making and behaviours were crucial influences on subject matter, activity design, the cooperative structures used, group processes, teacher monitoring approaches and the way in which students demonstrated their learning. However the research showed that although teacher decisions and behaviours were very influential, the individual students and the groups mediated teacher intent very strongly. Although some direct causal links between teaching and learning were found, all teaching (via cooperative discussions, reading text and teacher intervention) was mediated by the unique minds of the students located in their context.

Group processes produced strong mediational effects on the teachers' cognitive intentions. The groups developed idiosyncratic "cultures", which were determined by the dominant/leader-type students. These students were generally leaders because of their academic status and their strong individual motivation to complete tasks. When the group culture involved a willingness to engage in quality-type talk, the group appeared to make cognitive gains. When the leader excluded other students, passivity became a problem and the group did not perform as well. Some groups were intent upon task completion at the expense of quality talk. This circumstance led generally to poorer engagement with the unit content and poorer long-term outcomes.

Not surprisingly, students' emotional reactions to the unit content or to the group experience itself produced discernible outcomes. Emotional responses to material with shock value or an element of danger were linked to student recall. Students also seemed to learn better if they appeared comfortable with the group's functioning. Students who were unhappy with their colleagues appeared to withdraw from the group.

8.3. Implications for theory

The previous metaphors of learning have not adequately described the full nature and complexity of human learning. This appears to have occurred in part because of the directions taken by the research from its earliest roots. The early research was influenced heavily by the experimental perspectives promoted by Thorndike (O'Donnell & Levin, 2001). As a consequence, researchers into human learning seemed compelled to conduct laboratory experiments and lost the connection with real classroom contexts. What followed was a series of theories and metaphors derived from de-contextualized situations (Mayer, 2001). Had Dewey's interest in the social context of education received more attention from researchers and become the dominant research paradigm, learning theory and progress towards a theory of teaching might now be more advanced. This study attempted to investigate student learning and cognition in context in response to calls for research by various authors (Bereiter, 1994; Mayer, 1996; Nuthall, 1996; Vosniadou, 1996).

Whether knowledge is either individually *or* socially constructed has been the subject of debate (Bereiter, 1994; Cobb, 1994; Nuthall, 1996). Does the individual "own" the knowledge or does knowledge owe its existence to the socio-cultural setting? Is knowledge ever independent of the individual's subjective perceptions of experience? The present study investigated these questions and adopted a pragmatic, pluralist stance, supporting the views of researchers such as Bereiter (1994) and Nuthall (1997). In Prawat's (1996) terms, a MIND-WORLD position was adopted. Bidell (1992) in arguing for a combination of both major approaches to cognitive development with their roots in Piagetian and Vygotskyian theories, supported the pluralist approach. Billett (1996) also contended that understandings about how knowledge is co-constructed are best undertaken by identifying areas of compatibility between constructivist and socio-cultural perspectives.

Nuthall (1997) proposed an incorporation of socio-cultural and linguistic perspectives into cognitive constructivist perspectives as a means of investigating how language and social influences construct knowledge in the classroom. The conceptual framework of this research was based upon Vygotsky's theories but these were never taken as hypotheses not to be challenged. The data demanded a focus upon the mental representations of the individual learner, appropriate to a constructivist perspective, as well as attention to the socio-cultural setting inherent in the research design. Reconciliation between the two broad perspectives was attempted in this study because evidence of both individual and social knowledge construction was found.

Despite the powerful influences of student idiosyncrasies, it was acknowledged that the students' learning did not occur in a vacuum and could not be separated from its socio-cultural milieu. Language and other social semiotics were the vehicle for knowledge construction and transmission but once knowledge entered the mind of the individual and was subjected to on-going, evolutionary processing, it seemed to become a unique, idiosyncratic product. The consciousness and perceptions of individuals appeared as significant influences on the final shape of their knowledge. Whether knowledge could exist immaterial of the mind as in Popper's World 3 (cited in Bereiter, 1994) remained problematic. It is conjectured here that knowledge could be immaterial of the mind if it is created by contexts such as cooperative learning settings. In these circumstances, the immaterial knowledge does not exist in a useful form until incorporated into the idiosyncratic mind.

The core of this study has been an investigation into the existence of a fourth metaphor of cognitive psychology, drawing on Pepper's (1942) *contextualist root metaphor* of historic events and live events of the here and now. The research seems to suggest that in view of the inadequacies of the first three metaphors, a fourth metaphor that acknowledges the complexities of the classroom and the idiosyncrasies of individuals may indeed be emerging.

The relationships between context and the unique human mind have been central foci in this study. The two broad perspectives on student learning, the cognitive-constructivist and the socio-cultural, were reconciled by illustrating both the contextualized nature of learning and the role of the individual's uniqueness. Although some pre-dispositions to learn may exist genetically and the final shape of knowledge seemed to be the product of cognitive processing carried out by the uniquely pre-disposed mind, the original form of knowledge appeared to be the product of the individual mind's socio-cultural, historical milieu. A student seemingly working alone in a library or on a computer is embedded in a complex socio-cultural context and draws on essentially human social semiotics, particularly language, to make meaning of experience. Complex systems like libraries and computers are the products of thousands of years of human knowledge and invention, so interacting with them at any level is an historical, socio-cultural experience. Even the form of curricula presented to students is a socio-cultural construct. While the initial shape of the knowledge may have been culturally determined, the individual seemed to generate its final, interconnected form.

The conceptual framework in chapter three was revised in order to afford greater recognition to individual antecedents and the role of the individual mind in shaping the final form of the knowledge. Figure 78 expands on the socio-cultural constructivist model represented by Prawat (1996) as a possible stage towards the delineation of a fourth metaphor. The individual is seen as bringing an idiosyncratic biological and experiential history to the culturally relevant context. This context comprised the cooperative learning sessions during the study lessons. The group members interacted during the lessons using "artefacts" such as language and other social semiotics. The total classroom context provided the objects and events that underpinned these interactions. The extent of interaction was determined by the individuals' states of consciousness as they interacted with the objects and events in the lessons. The revised framework depicts an interaction between individuals and objects/events as a two way process because both individuals and objects/events influenced each other. The students ultimately extracted co-constructed and individually constructed knowledge from the cooperative settings and appeared to continue to shape this knowledge over time.

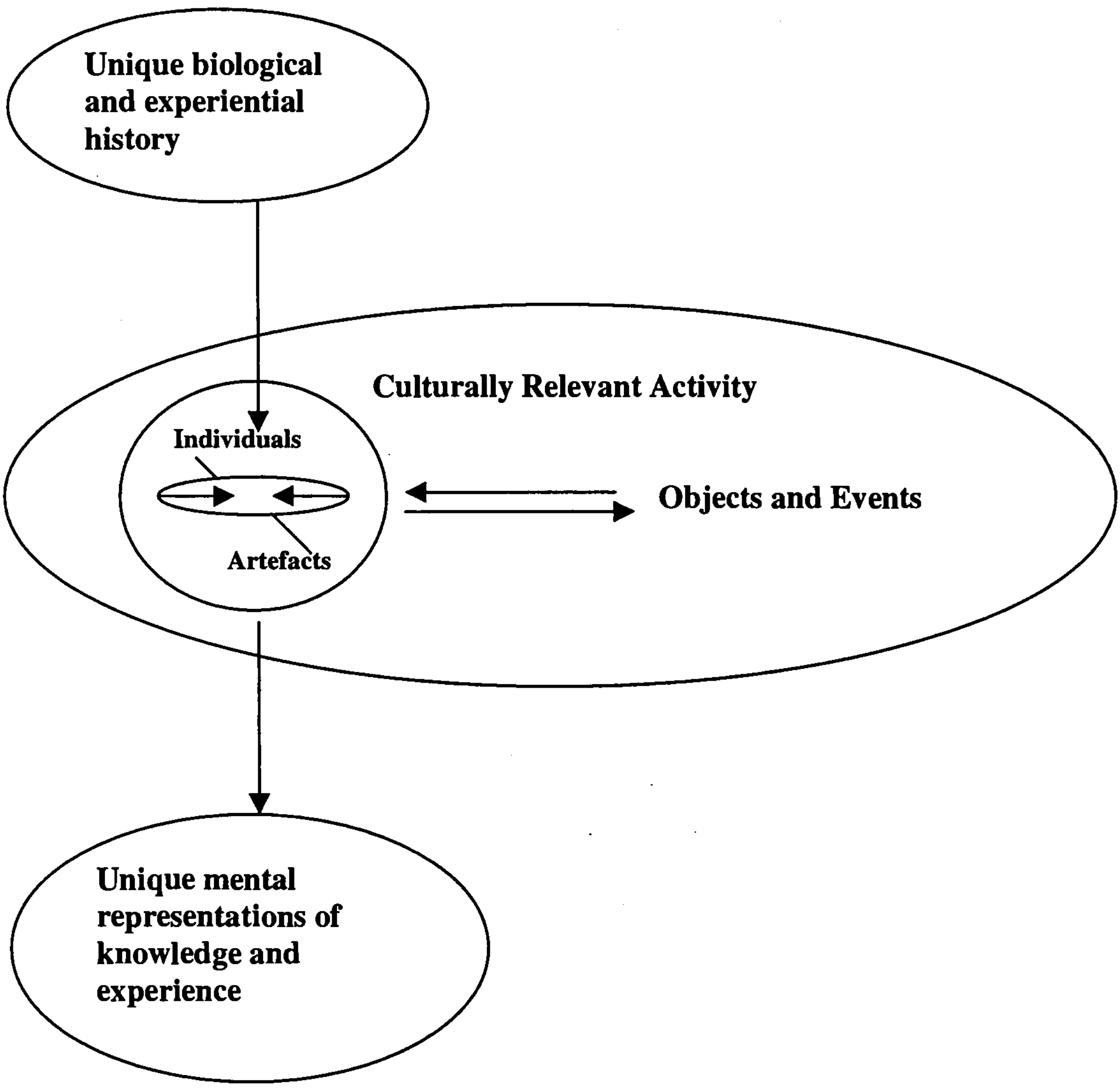


Figure 78. Revised conceptual framework. Socio-cultural constructivism and the fourth metaphor.

Source: Adapted from Prawat, R.S. (1996). Constructivisms, modern and postmodern. *Educational Psychologist, 31* (3/4), 215-225.

The revised framework (Figure 78) posits that the students' mental representations of knowledge and experience are interconnected idiosyncratically. The use of concept maps in chapter five highlighted this interconnectedness and was conducted by the researcher as a means of presenting and analysing data. It must be emphasized that the concept maps represented the *researcher's* interpretations of an organising structure and may have borne little resemblance to the way knowledge about Antarctica was actually organised within the students' minds. The students' minds may have actually represented their knowledge more like Figure 79 where all pieces of information are stored in interconnected neural structures but are not necessarily organised into any particular form. That is, the information may have been stored almost at random, roughly in the same brain region and the extent to which the individual can recall the information may be in part a function of their idiosyncratic ability to make and activate the connections.

Antarctica in Figure 79 is represented here not as a central organizing structure, as in the concept maps, but as a piece of information linked to all other pieces. Some concepts are linked together directly, others are not. New information might be stored in a single neuron or a within an existing network. Over time, new pieces of information might be connected in new ways to existing constructs. Knowledge represented in this manner in the minds of students could explain why knowledge seemed to continue to evolve. New own constructions and mis-constructions occurred as new connections seemed to be made and various parts were connected and re-connected. This representation may also explain the idiosyncrasies and apparent unpredictability of student recall. Not only the storage of information but also the cuing of memory seemed to be idiosyncratic. Interestingly, engaging in small group talk, especially quality talk as defined by this research, appeared to align student recall more closely.

Figure 79. Possible representation of a sample student concept map, with lines representing neural connections.

The proximate discussion context found in this research also suggested that associations in the brain may be more random and less organized into "schema" than had been previously thought. Concepts discussed in the same contexts did not appear directly related but the students seemed to associate them together. It is postulated here that information may be stored in the neural structures in a seemingly random manner and accessed according to a form of episodic memory of when it was encountered.

Although the information may all be interconnected, specific parts of the brain may store various pieces of seemingly unrelated information. These kinds of structures could explain the production of own constructions and mis-constructions where information is connected, sometimes erroneously. Recall may be the result of cues that activate certain neural structures and do not activate others. What stimulates the recall of a particular piece of information? Does this relate to the ways in which the information is stored in the brain? Does the recall of one piece of information activate a stream of connections linked to the individual's consciousness? These questions remained problematic.

The investigation of human consciousness led to conjectures about what occurs inside the individual brain (Dennett, 1993). Clearly, information storage, cognition and even feelings must be stored somehow in the neural structures of the brain (Crick, 1994) but questions arise about the precise mechanisms of the neural functions and what stimulates recall? Neuroscience may eventually answer these kinds of questions, which are beyond the scope of the present study, but sufficient evidence was found to permit the researcher to speculate about the nature of the mind at the level of its neurons and neural networks.

Evidence was found that knowledge or the recall of knowledge did not seem to remain static once it had entered the brain. The students in this study seemed to produce an evolving, fluid, unpredictable array of knowledge in their learning journals. Knowledge recalled once was often forgotten later. Sometimes, knowledge was developed over time and at other times it was either forgotten or simply not recalled in the tests and journals. This indicates that knowledge was not fixed and bounded but appeared more like the grappling with ideas described by Meloth & Deering (1999).

Students produced their own constructions and mis-constructions at different intervals but these were often not repeated later. New mental representations were created even if there was no new engagement with the subject matter suggesting that the students were continuing to process the information over time, producing new constructs and associating some information together incorrectly. Abi's mis-construction "there are data bases there" and her new, own construction, "the blizzards start early July and finish by late August" produced at twelve months illustrate this point. She had connected information learned during the lessons to other material in the elapsed time in the latter example. One factor affecting this evolving nature of knowledge was exposure to new related material but in most cases the students seemed to reorganize their mental representations of information with no additional stimulus. The example of Joel's non-use of the term hypothermia after the pre-lesson journal suggests that the term had been subsumed into other structures but the precise reason why he did not use the term again remained problematic. What kinds of mechanisms or connections cued in the memories of the study participants? These findings suggested a conceptualization of a dynamic, ever-changing mind consisting of interconnected parts and mediated by its context.

Given the essentially human, idiosyncratic nature of learning found in this research, biological metaphors (Vosniadou, 1996) seem more appropriate when depicting human cognition and learning. The "Mind-as-Rhizome" metaphor (Deleuze & Guattari, 1983; Schuh, 1999), with its images of interconnected ideas and a dynamic and constantly changing nature, appears to better describe human learning, when compared to "Mind-as-Computer" and constructivist metaphors. Findings about the uniqueness of the students' knowledge, the contextual factors determined by ***human*** interaction and how this knowledge seemed to develop in idiosyncratic ways suggested to the researcher that the mind might be conceptualized as located in the neural structures of the *human brain* itself. In ontological terms, the "being" of the individual resides in the mind. This conceptualization seems to provide a more definitive biological metaphor to inform research and teaching practice. Diagrammatic representations of human neural structures (Crick, 1994; Morgan, 1997) appeared to have characteristics of interconnectedness in common with rhizomes. An advantage of the brain conceptualization seemed to be the existence of various types of nerve cells (neurons) and neural structures (Morgan, 1997). Could these types of cells and structures perform different functions? Neural network models of brain functioning (Barnden, 1995) represent information in the brain as connected *networks* of units. Some units may have a single meaning while others may be meaningless individually unless activated together with other units and networks. These networks and connections are unique to the individual. Mental representations of this kind may explain the idiosyncrasies in student learning and cognition found in this study.

As a consequence of this line of reasoning, a "Mind-as-Brain" metaphor is posited where the behaviour of the brain's cells and neural structures determines the cognitive processes and the storage and retrieval of knowledge (Dennett, 1993; Crick, 1994). The mind-as-brain in this metaphor is the unique product of its biological and experiential history and is conceptualized as a three-dimensional, dynamic organism consisting of interconnected parts. In order to account for the brain existing in a socio-cultural context, "Mind-as-Brain" is elaborated to "Mind-as-Contextual Brain". The axioms of the naturalistic paradigm (Lincoln & Guba, 1985; see Table 4, p.60) occupy a cental position in this conceptualization. Realities are multiple, constructed and holistic, the knower and the known are interactive and inseparable and all entities are in a state of mutual, simultaneous shaping.

Any theoretical discussion about metaphors should not be conducted in its own right without reference to teaching practice because it is this connection which maintains links with real classroom contexts and provides relevance to the research. The next section describes implications for teaching from the present study with a particular emphasis on the viability of cooperative learning strategies for classroom practice.

8.4. Implications for teaching

The present study supports the use of cooperative learning strategies in the classroom, providing certain conditions are applied. These relate to the preparation of students and teachers for cooperative learning, teacher monitoring, activation of prior knowledge, structuring of tasks, classroom evaluative climate and structuring of groups. The ultimate goal of these measures is to create the conditions necessary for students to engage in quality talk for sustained periods. It is through these kinds of talk that cognitive gains can be made.

Quality talk appeared as a key mediating factor between teacher intent and student outcomes. The teacher/researcher designed certain questions for discussion, which would normally be expected to produce student learning. However, learning was less likely if quality talk was not present. Therefore a major role for the teacher in cooperative learning seems to be the engineering of the conditions necessary to produce high levels of quality talk. This role has implications about task design, student preparation, teacher monitoring and group dynamics.

Quality talk involves higher level cognitive processes. This research has confirmed recent findings that open-ended tasks are more likely to lead to higher order discussion (King, Barry & Zehnder, 1996). Teachers intending to use cooperative learning to produce these kinds of talk need to design tasks conducive to higher order discussion. Some subject matter may not demand these kinds of talk. This study also found that cooperative learning could be effective if lower order talk occurred but if the teacher plans for students to engage in quality talk, open-ended tasks appear as a pre-requisite. Teachers applying the principles of Philosophy for Children have demonstrated the value of promoting student skills such as argumentation and justifying points of view. In one study, training in philosophical thought processes led to significant increases in rates of higher cognitive level talk (Barry, King, Maloney & Burke, 2000). If teachers implement these kinds of training combined with metacognitive training (Mevarech, 1996), and structure open-ended tasks to produce more quality talk they are likely to produce significant gains in cognitive growth.

Student preparation for cooperative learning requires careful thought by teachers. Practice has previously involved training students in group roles and rules and helping procedures in order to maximize peer collaboration (Johnson, Johnson, Holubec & Roy, 1984; Nattiv, 1994; Ross, 1994 & 1995). Additional student preparation measures, directed at improving the quality of talk are described below.

This research demonstrated the central role of prior knowledge in student discussion. Student preparation should include greater attention to activating (Mevarech, 1996) and assessing prior knowledge before undertaking cooperative learning. Although not a major focus of this study, evidence was found that consciously activating prior knowledge seemed linked to learning. More prior knowledge led to more quality talk, which led in turn to more learning. Teacher assessment of prior knowledge may indicate that students lack the knowledge necessary in order to produce high levels of quality talk. In these situations it is recommended that students receive instruction directed at improving their knowledge base *before* undertaking cooperative tasks. This is part of the "scaffolding" described by Meloth and Deering (1999). The study provided its own example of how prior knowledge could contribute to quality talk. In the last two study lessons, student talk indicated that knowledge acquired in the earlier lessons had been recalled and applied to discuss open-ended questions. The students were able in varying degrees to bring together their mental representations of subject matter, use generally high levels of quality talk and resolve the issues presented to them.

Students could be assigned sections of subject matter, using the Jigsaw structure in order to become "expert" and could then peer tutor their group before planned cooperative discussions commence. Cooperative learning should not be regarded as the only means of instruction. It is recommended that it be reserved for strategic times in the coverage of a unit of work, combined with other methods. Discussion questions need careful design to take account of prior knowledge and assisting students to make connections to authentic settings.

Patterns of dominance and passivity became a problem for some of the study groups. Preparation for cooperative learning needs to involve effective training in including all group members so that students do not adopt their usual status positions and lapse into learning helpless and passive behaviours. Dominant students in particular need training and practice in peer tutoring techniques so that their potential to provide the group with impetus is harnessed. The task engagement of all group members needs monitoring. Monitoring should include considerations about whether students are actually engaged in cooperative discussion and whether group roles and rules are being followed.

Teacher preparation should involve a clear delineation of the teacher monitoring role. Cohen (1994) favoured an approach involving minimal teacher interference, preferring teacher statements that delegate authority for completion of the task to the students. Cohen recommended teachers keep monitoring to a minimum and quickly move away to avoid interruptions to the flow of discussion. Given the findings on quality talk and contextual factors, this study supports Meloth & Deering's (1999) view that teacher monitoring should focus on facilitating productive discussion and not be so concerned with the amount of time spent with the group. In some cases, only a few words may be needed to achieve this end but teachers should be ready to step in or out of the discussion and stay for as long as the situation demands.

Teacher monitoring includes alertness to group disharmony, which can lead to unproductive talk. This study supported previous research which found that some groups become pre-occupied with socially-oriented talk and apply minimal attention to on-task talk (King, Barry, Luberda & Zehnder, 1998). Disharmony was noted particularly among groups B2 and B3. This appeared to result from differences in student motivation to the task and where a dominant student ignored some students' ideas. Both of these conditions at times led to off-task talk and mild conflict. Conflict situations seem likely to lead to unproductive emotional responses in students. The teacher's role in these circumstances should be to intervene in order to re-direct the students into productive discussion. If this cannot be achieved, groups may need to be re-structured in the short term and longer term efforts need to be made to improve students' pro-social skills. This study also confirmed previous findings (King, Barry, Luberda & Zehnder, 1998) where students appearing to stay on task when the teacher was in the proximity and returning to off -task talk as the teacher moved away. Normal classroom management practices, as delineated by Kounin (1970) apply in these situations.

Meloth & Deering (1999) argued that although collaborative learning, particularly cooperative learning strategies, have been promoted widely, little attention had been directed at guiding teachers in their role. Meloth and Deering (1999) contended that this was likely to cause confusion because teachers were being asked to change their normal practice and assume a less dominant role. This kind of confusion was likely to lead to teachers not persisting with the strategies. Before teachers attempt these forms of *complex instruction* (Cohen, 1991) they may need to assess their own beliefs and understandings about learning. Holding traditional, transmission views of learning and having insufficient understanding of the theoretical underpinnings of a particular approach, may pre-dispose attempts at collaborative learning to failure (Meloth & Deering, 1999). Teachers need to reflect upon their own beliefs and theoretical knowledge about peer collaboration and to develop an awareness of the possible constraints of these strategies before attempting to apply them in the classroom. Without these kinds of reflection the use of collaborative learning is likely to be ill considered and counterproductive.

The present study raised issues about the ways teachers craft the classroom evaluative climate (Doyle, 1983). In order to generate quality talk, students need to be encouraged to "tease out" their discussion and focus more effort on the quality of their talk and group product rather than on completing the task as quickly as possible. Teachers who have defined task completion as the real task of students may find their students tend to produce glib responses in order to get the task finished quickly. Such an approach is not conducive to quality small group talk. This study found direct evidence in the first lesson of a teacher re-defining the task for her students when she referred to the use of English and writing "enough" in their worksheet answers. Instead of focussing on in-depth discussion, the students became pre-occupied with correct spelling and writing a longer answer. In preparing the ground for effective cooperative learning, evaluative climate needs to harness the wonder and inherent curiosity of students and empower them with ownership of the discussion. Teachers need not feel they must entertain students (Good & Brophy, 2000, pp. 219-220) but the links between student interest and quality talk found in this research suggest the need for greater teacher consideration in selecting interesting, meaningful subject matter. A measure of control to students over the discussion can have significant effects on intrinsic motivation, which can be one of cooperative learning's strengths (Sharan & Shaulov, 1990).

A metaphor that emphasizes the uniqueness of the individual has clear implications for teachers. Despite awareness of individual differences and stated commitments to individual needs, teachers and education systems often seem unable to take sufficient account of their students' uniqueness. Tailoring differentiated learning programs to the individual has been a desired end for decades but the realities of limited resourcing, large classes and classroom complexity force teachers to use strategies that do not necessarily suit student idiosyncrasies.

This study found that the idiosyncratic mind generates a unique perception of the moment. In cooperative learning, students may experience moments where all group members are focussed on the same material or activity at the same time and this is more likely to lead to a convergence of the students' learning but there are other moments when this does not occur. Teachers should be acutely aware of these mediations and endeavour to bring student focus closer together for more sustained periods. If the teacher is able to engineer the kinds of quality talk described above, the potential of cooperative learning to produce academic gains is optimised.

8.5. Possible directions for further research

Nuthall and Church (1973) argued that research into classroom thinking and learning should proceed through an observational/descriptive phase and progress through correlational and experimental designs, with each phase being informed by the previous phase and maintaining an awareness of classroom realities. Nuthall (1997) contended that research on learning and teaching had progressed too quickly through the phases and had become too narrow in their focus and conceptions of teaching and learning. He argued that new research paradigms had returned research to observational/descriptive studies and the cycle now appeared to be an upward spiral. Research was needed which embraced the complexities of classrooms in order to observe and understand them. This study supports the need for further research that examines the manifold complexities of the classroom in real contexts.

This was a descriptive study, which sought to describe and explain how knowledge was constructed under small group cooperative learning conditions. While not an exploratory study, intending to identify variables for further research, a variable was identified that seems to warrant further research. This was the *proximate discussion context*, a variable that appeared linked to the groups' perceptions of the moment, determined by the students' individual consciousness. Additional research using similar techniques of data collection and analysis could confirm or refute proximate discussion context.

This study further defined quality talk using the MAKITAB instrument (Appendices H & I). Research is needed to verify these findings among wider samples of students because of their potential to inform practice. Correlational and experimental designs seem appropriate for these kinds of research. Another line of inquiry that may be required is the effects of quality talk in different socio-cultural contexts. This research acknowledges that one of its limits was the narrow socio-cultural backgrounds of the participants and the researcher speculates that quality talk may not produce the same influences on learning in cultures other than the one pervading this study. For example, do Australian Aboriginal children react in the same ways in small groups or do they become reticent in discussion? Is cooperative learning a culturally appropriate medium for the various ethnic groups represented in contemporary industrial society?

This study found that the younger students at School B seemed less able to participate in the lessons and tended to become passive. Additional research should be conducted in order to increase understandings of the age-appropriateness of cooperative learning. Do students need to be at certain developmental levels before they can participate productively in cooperative learning? What factors determine age-appropriateness?

The important influence of high status, dominant students was confirmed by this study. Dominant students (Rebecca, Max, Clark, Abi, David) in this study seemed to derive their high status from their academic competence although one student (Alan) derived his status from his social position. Research into status differentials has examined the passivity phenomenon (Mulryan, 1992; King, 1993, Day, 1997) but dominant students appear under-researched. What factors affect the status of dominant students? Some research has been conducted into using knowledgeable students as peer tutors but more research into the characteristics and role of dominant students is needed. This research could parallel work already conducted into passivity.

Teacher preparation for cooperative learning would also benefit from further research. Meloth and Deering (1999) have delineated some of the potential difficulties in the implementation of cooperative learning strategies. Research could inform practice and reduce some of the difficulties of in-service training.

This study has suggested that understanding how information is stored, organized and retrieved in the human brain's neural system may have implications for teaching practice. Research of this kind may be able to describe more precisely the location of knowledge and cognition in the neural structures. Although beyond the scope of the present study, research in neuroscience has the potential to unlock the brain functions that lead to learning and cognition (Dennett, 1993; Crick, 1994; Barnden, 1995). These kinds of questions need to be addressed if classroom learning and cognition is to be understood and a theory of teaching and learning is to be advanced.

8.6. Concluding comments

This research has demonstrated that human learners bring idiosyncratic biological, cultural and experiential histories to learning contexts. It is the interplay between the cognitive functions of unique individuals that shapes the socio-cultural milieu of the group. The case study students engaged with content and discussion in idiosyncratic ways, creating an idiosyncratic group context. The group context helped construct new understandings and the individual eventually produced self-mediated constructs that evolved over time. This research investigated only a small part of the school lives of a group of students and highlighted the manifold classroom variables. The variables mediated student learning to produce uncertain outcomes despite clear teacher cognitive intent. Quality talk in cooperative learning settings helped to reduce this uncertainty and promoted more commonalities among group members' learning. Cooperative learning was a rich learning context for the students' minds, which permitted the coalescence of multiple variables and produced cognitive gains during those moments of classroom experience.

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APPENDIX A

Outline of Commonly Applied Cooperative Learning Strategies.

Appendix A

Outline of commonly applied cooperative learning strategies.

Teams-Games-Tournaments

TGT (De Vries & Slavin, 1978; De Vries et al 1980; Slavin, 1986) is a co-operative structure that involves students working together to master content and then applying their learning to competitive games situations. Groups are heterogeneous for the study phase and same-ability (homogeneous) for the competitive phase. Team scores are calculated by combining individual scores.

Student-Teams Achievement Divisions

STAD is a simplified version of TGT (Slavin, 1986) where games or tournaments are replaced by quizzes which are taken individually. Team scores are based on how much students have improved (Good & Brophy, 1997). This strategy reduces some of the negative aspects of competitive structures.

Team-Assisted Individualization

This is a team structure combining individualized mathematics instruction, co-operative methods and group rewards similar to STAD (Slavin, 1990). This is a structured program which, unlike TGT and STAD, depends on specified materials.

Jigsaw and Jigsaw II

Jigsaw and Jigsaw II (Aronson, Blaney, Stephan, Sikes & Snapp, 1978; Johnson, Johnson & Holubec, 1990; Kagan, 1990) are attempts to reduce status difficulties in co-operative settings and to improve individual and group accountability. Students work in heterogeneous groups.

In Jigsaw, each student is provided with unique information, becoming expert in the area. Expert groups meet to discuss their part of the project. After expert group meetings, groups are re-constituted and each child “teaches” their material to the other group members. All individual inputs into the group are necessary for the success of the group product.

Jigsaw II is an adaptation of Jigsaw (Slavin, 1990) especially suited to text-based material. Students are provided with the same materials but are assigned different parts of the project.

Learning Together

Learning Together is a co-operative structure where students work to achieve mutual goals (Johnson & Johnson, 1994). Groups are heterogeneous. Students work together on a single academic task, producing a team product. Rewards are shared if groups achieve success against pre-determined criteria. Pro-social skills are taught and practiced if necessary. Research into this approach (Johnson, Johnson, Holubec & Roy, 1984; Johnson & Johnson, 1985; Bennett, Rolheiser-Bennett & Stevahn, 1991) identified five essential elements required for successful co-operative learning; (1) positive interdependence (2) face to face interaction between students (3) individual accountability (4) social skills and (5) group processing.

Group Investigation

Group Investigation (Sharan & Hertz-Lazarowitz, 1980; Sharan & Sharan, 1990) requires a high degree of student autonomy and self-management ability (Bennett et al, 1991). Using this structure, students complete a unit of study by proceeding through six phases; (1) grouping (2) planning (3) investigating (4) organizing (5) presenting and (6) evaluating.

Informal co-operative structures

In addition to the widely practiced co-operative structures above, several less formal approaches have been developed (Bennett et al, 1991; Good & Brophy, 2000). In practice these kinds of structures need less time to explain to students and can be applied quickly. They are also useful as a means of introducing co-operative learning to classes. Structures which are mainly conducted in dyads are included such as *Think-Pair-Share* (Kagan, 1990), *Formulate-Share-Listen-Create* (Johnson, Johnson & Bartlett, 1990) and *Say and Switch* (Bennet et al, 1991). Other simple structures which are applied in small groups include *Roundtable/Roundrobin, Three-Step Interview, Corners* (Kagan, 1990), and *Graffiti* (Gibbs, 1987). These approaches feature brainstorming-type strategies and rapid exchange of ideas.

NOTE: For additional details of these strategies see Bennett, Rolheiser-Bennett & Stevahn (1991).

APPENDIX B

Parent and School Principal Permission letters.

Appendix B; Parent permission letter

Dear Parent or Guardian,

My name is Scott Zehnder and I am currently studying for the post graduate degree of Doctor of Philosophy at Edith Cowan University. My research topic is *"Student Cognition in Cooperative Small Groups"*. Your child's teacher has expressed a willingness for me to conduct research in his/her classroom and I must now formally request your permission to use data gathered from your child in my study.

My research aims to investigate the thinking and learning which occurs during small group cooperative learning. In order to do this I plan to collect data in the form of audio taped and transcribed small group discussions, copies of student learning journal entries, test scores from specially developed tests in the Studies of Society and Environment curriculum area, work samples in the same curriculum area and observational notes during the course of five lessons. Duration of the lessons will be approximately forty minutes. The lesson topic will be one usually covered by students of this year group. Data collection will not affect the students' normal class work. All data and results will be confidential. When the thesis is completed students will be assigned a pseudonym in order to preserve their anonymity. Pseudonyms will also be used if the results of this study are published. Teachers and students involved in the study are free to withdraw at any time.

If you have any inquiries regarding my study, please direct them through your child's teacher and I will be happy to discuss them with you. If you consent to your child's involvement in the study please complete the form below and return it to the school. Thank you for your time.

Yours sincerely,

SCOTT ZEHNDER Dip. Teach., B.Ed., M.Ed.

I ________________________________consent to my child ____________________

involvement in Scott Zehnder's research. I understand that all data and results will be kept confidential and my child's anonymity is guaranteed. I also retain the right to withdraw my child from the study at any time.

Parent's signature __________________________

Student's signature _________________________

Appendix B; School A Principal Permission Letter

Dear Alan,

As you are aware I am currently studying for the post graduate degree of Doctor of Philosophy at Edith Cowan University. My research topic is *"Student Cognition in Cooperative Small Groups"* and since I plan to collect additional data from my own classroom I must now formally request your permission to conduct the study at our school.

My research aims to investigate the cognitive processes which occur during small group cooperative learning. In order to do this I plan to collect data in the form of audio taped and transcribed small group discussions, copies of student learning journal entries, test scores from specially developed tests in the Studies of Society and Environment curriculum area, work samples in the same curriculum area and observational notes during the course of five lessons. Duration of the lessons will be approximately forty minutes. The lesson topics will be ones usually covered by students of this year group. Data collection will not affect the students' normal class work. All data and results will be confidential. When the thesis is completed students will be assigned a pseudonym in order to preserve their anonymity. Pseudonyms will also be used if the results of this study are published. Teachers and students involved in the study are free to withdraw at any time.

If you have any inquiries regarding my study I will be happy to discuss them with you. I look forward to receiving your response to my request. Thank you for your time.

Yours sincerely,

SCOTT ZEHNDER Dip. Teach., B.Ed., M.Ed.

[redacted]

Appendix B; School B Principal Permission Letter

Dear Ken,

My name is Scott Zehnder and I am currently studying for the post graduate degree of Doctor of Philosophy at Edith Cowan University. My research topic is *"Student Cognition in Cooperative Small Groups"*. Three of your teaching staff have expressed a willingness for me to conduct research in their classroom and I must now formally request your permission to conduct the study in your school.

My research aims to investigate the cognitive processes which occur during small group cooperative learning. In order to do this I plan to collect data in the form of audio taped and transcribed small group discussions, copies of student learning journal entries, test scores from specially developed tests in the Studies of Society and Environment curriculum area, work samples in the same curriculum area and observational notes during the course of five lessons. Duration of the lessons will be approximately forty minutes. The lesson topics will be ones usually covered by students of this year group. Data collection will not affect the students' normal class work. All data and results will be confidential. When the thesis is completed students will be assigned a pseudonym in order to preserve their anonymity. Pseudonyms will also be used if the results of this study are published. Teachers and students involved in the study are free to withdraw at any time.

If you have any inquiries regarding my study I will be happy to discuss them with you. I look forward to receiving a written response to my request. Thank you for your time.

Yours sincerely,

SCOTT ZEHNDER Dip. Teach., B.Ed., M.Ed.

[redacted]

APPENDIX C

On-Balance Judgement Standards from Western Australian Literacy and Numeracy (WALNA) Testing for Determining Appropriate Student Participant Writing Standards.

Narrative Marking Guide

1	On balance judgement

0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Planning attempted but no story. Draws pictures only. No attempt at written words.	Students who have achieved level one show a growing awareness of the many purposes for written texts. Students show an emerging awareness of the nature, purposes and conventions of written language. They experiment with using written symbols for conveying ideas and messages.	Students who have achieved level two produce brief written texts understood by others which include related ideas and information about familiar topics. Students have a beginning knowledge of conventions for using written texts.	Students who have achieved level three write longer texts, using ideas and information about familiar topics. They communicate familiar ideas and information for particular purposes and known audiences. Students use many of the conventions of narrative. They make attempts at spelling new words.	Students who have achieved level four use familiar ideas and information in their writing, showing control over the way some basic text types are written. They try to adjust their writing to meet readers' needs. They have a sound basic knowledge of how to use English.	Students who have achieved level five experiment with writing longer texts that discuss challenging aspects of subjects and present justified views on them. They understand important elements of how texts are constructed and experiment with these elements in their own writing. Students show a sense of the requirements of readers and experiment with manipulating prose for effect.	Students who have achieved level six write in a variety of ways to explore complex issues. Their spelling, syntax and command of text structures are adequate for most expository and imaginative writing. They increasingly recognise the importance of making their meanings clear for readers by using correct punctuation, spelling and grammar and by manipulating words and the structure of texts.	Students who have achieved level seven explore ideas about texts and issues in an organised and precise way. They express themselves precisely when writing for complex purposes and they try to match text type, structure, tone and vocabulary to the demands of situations.	Students at level eight write with an assurance, precision and vitality that testifies to a high level of social, cultural and linguistic understanding. They explore complex themes and issues in a variety of styles that compel readers' interest and attention.

Appendix C; Level One writing sample (WALNA)

TO the centre of the earth
Once upon a time there were two devils named Grant and Bryan wanted to dig to the centre of the earth so thay did. It took many weeks to dig to the centre of the earth but they got there where they got there thay planded a bomb and the earth blow up and evre Body got Blown to smitherns and the devil's heads Blow up.

APPENDIX D

Education Department of Western Australia
Level One Writing Strand Outcome Statement.

Writing

Strand Outcome Statement

[illegible]

1

Students typically know that print carries a message and produce symbols to which they assign their own message. They produce approximations of conventional written symbols and usually write from top to bottom and left to right, sometimes leaving a space between word-like clusters of letters. Others may find their writing difficult to read.

Students typically write for their own purposes and audiences and their own name is one of the first recognisable words they write. They understand that writing and drawing are different. They usually write about their own experiences and attempt texts such as lists, greeting cards, messages or explanations to accompany their drawings.

In producing written symbols, students typically use known letters and approximations of letters, including a mixture of letters and other symbols. They use initial letters and some known letter patterns to represent their ideas. They show some awareness of directionality and start to make decisions about how to organise print on the page, possibly following layouts they have seen.

Students typically use a range of strategies to help them produce words when they are writing. For example, they say words aloud and sound them slowly as they write, use alphabet charts, use knowledge of letter names and sounds, copy environmental print, and ask others for help. They may also dictate their message for others to write.

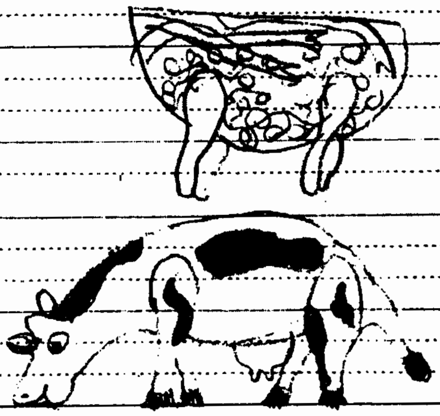
APPENDIX E

Education Department of Western Australia English Work Samples
Student Level One Work Sample.

My first picture
shows as when
a cow is
running around
for some nice
fresh green grass
to eat.
M.S grey green
[redacted] White
[redacted] blue

Several months later the student revisited the pictorial story map and wrote about it.

How cows
make
milk



by
Michael

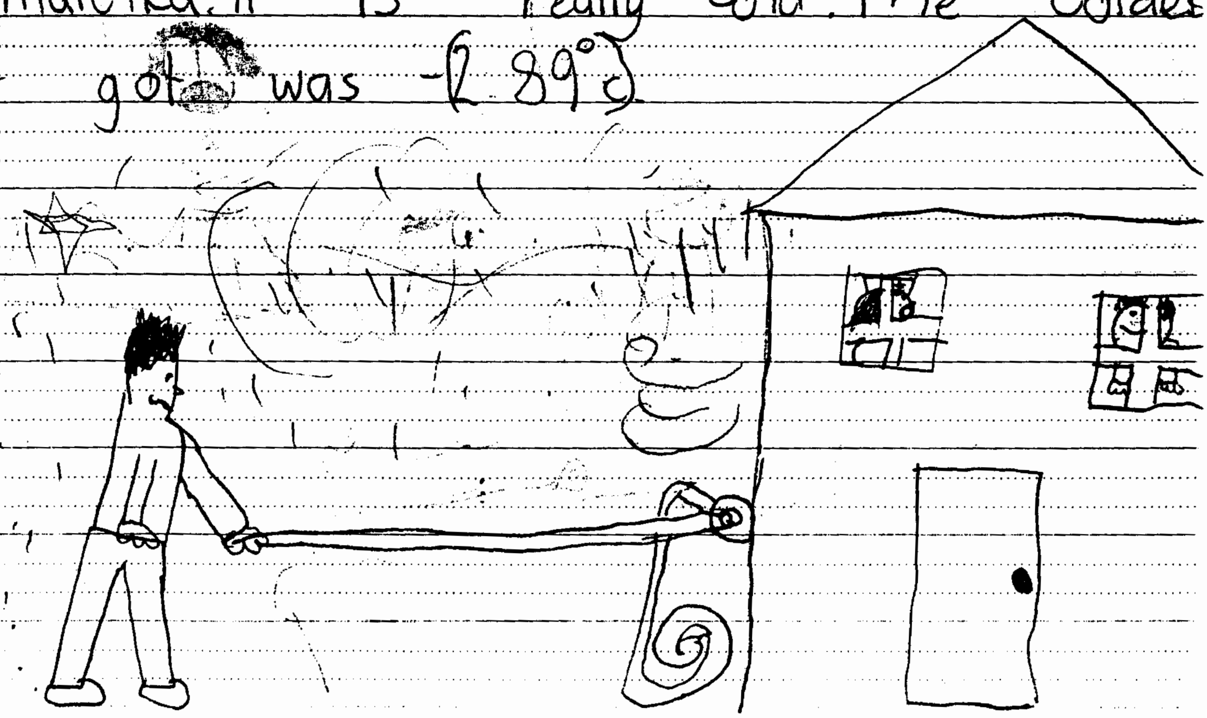
APPENDIX F

Samples of Raw Learning Journal Data from Non-Case Study Students.

Antarcica has lots of Snow and blizzards.
There is know no Polar bears liveing in Antarcica.
The animals who live there are Penguins, Whales
and fish. There was a race to see who could
get to Antardica first. The first crew to get
there was Shacklten but they died. The second crew
to get there was Morson that crew lived.
Children can not go to Antarctica
because they will freeze. The hozon ozone laar layer
had a whole in it. You have to have
special clothing and gear. the clothing
was wool jackets, long pants, spacial gogls and
a woolen hat. There iquwitmint equipment was rops ropes,
spacid special hamers hammers, sdicial special shose shoes so they
do not slip. In Sammer there is a sun
but th in other sesons seasons it is dark
and the moon is out.

· No Polar bears don't live in Antarctica.
· Mawson, Shackllton, Cook and Amandason had a [illegible] [illegible] Antarctica.
· ~~Amalox~~ Animals do live in Antarctica EG pegauin, wolfs, seals, whales and fish.
· It can't get hoter than 20 degreas.
· Antarctica is down the bottem of the would
· You get blizzards in Antarctica.
· Antarctica is very cold.
· Antarctica is like a cold deset.
· Antarctica is not a island
· If You are in a bizzard you would get blowen away.
· You need warm clothes in Antarctica
· If you get hit by a bit of ice you may get a frostbite

I Learnt Polo bears dont live in Antarctica. There is a base called Casy. You need a doctor with you You need rope, warm clothes and touches. You can only go outsid with rope when there is a blizzard. Birds, pengins and wales ~~live~~ live there. Children are not allowed ~~a~~ in Antarctica. It is really cold. The coldest it got was -(2 89°c).



APPENDIX G

Objective Test.

ANTARCTICA OBJECTIVE TEST

Read the questions carefully. You can ask for help if you do not know some words. Choose the best answer for each question.

1. One way Antarctica is different from the Arctic is
(a) it is very, very cold (b) it is smaller and colder
(c) it has land under the ice (d) it has not been explored

2. Which of these sentences is **false**?
(a) Antarctica is the fifth largest continent
(b) the ice is very thin in Antarctica
(c) no country owns Antarctica
(d) Antarctic winters have very short days

3. Choose the **true** sentence.
(a) James Cook was the first to explore the Antarctic
(b) Cook found land in Antarctica
(c) Shackleton's men all died in Antarctica
(d) Robert Scott used dog-sleds

4. The Antarctic has only one active volcano. It is ...
(a) Mt Everest (b) Mt Egmont
(c) Mt Erebus (d) Mt Cook

5. The first man to reach the South Pole was
(a) Scott (b) Cook (c) Mawson (d) Amundsen

6. Cook explored the Antarctic in a ship called the
(a) Resolution (b) Titanic (c) Endeavour (d) Arctic Explorer

7. The only food for wildlife in Antarctica is in the sea so
(a) the animals live inland
(b) the animals live on the coast
(c) there are not many animals there
(d) only seals and penguins live there

8. Which types of penguins are found in the Antarctic?
(a) emperor, adelie and gentoo penguins
(b) emperor, adelie and Antarctic penguins
(c) emperor, adelie and Ross penguins
(d) emperor, skua and chinstrap penguins

9. Which country claims the most territory in Antarctica?
(a) Australia (b) USA (c) France (d) New Zealand

10. The Australian Antarctic bases are called
(a) McMurdo, Clinton and South Pole
(b) Vostok, Auckland and Wellington
(c) Casey, Mawson and Davis
(d) Amundsen, Scott and Shackleton

11. Meteorology is the study of

(a) weather (b) rocks (c) volcanoes (d) seals

12. The main kinds of animals in the Antarctic are

(a) seals, leopard seals, seasnakes and whales

(b) penguins, seals, whales and sea-birds

(c) kangaroos, wombats, koalas and penguins

(d) seals, dolphins, killer whales and sharks

13. Which explorer's ship was stuck in the ice?

(a) Shackleton (b) Cook (c) Mawson (d) Amundsen

14. The biggest known iceberg came from Antarctica. It was bigger than

(a) Belgium (b) Antarctica (c) Australia (d) New Zealand

15. The lowest temperature ever recorded was in Antarctica. It was ...

(a) - 15.2°C (b) - 29.2°C (c) - 59.2°C (d) - 89.2°C

16. Which type of penguins incubate their eggs in the Antarctic winter?

(a) adelie (b) chinstrap (c) gentoo (d) emperor

17. Why is it important to keep your feet dry in the Antarctic?

(a) sweat can freeze and cause frost bite

(b) sweat can make your feet get slippery

(c) sweat can make you too thirsty

(d) sweat can make you use too many socks

18. Which scientific discovery was made in Antarctica?

(a) holes in the greenhouse layer (b) Mt Egmont

(c) Halley's Comet (d) holes in the ozone layer

19. People want to save the whales in Antarctica because

(a) they breed there (b) there are only 500 whales left

(c) most of the world's whales live there (d) it's very cold

20. A famous Australian Antarctic explorer was

(a) Douglas Mawson (b) James Cook

(c) Ernest Shackleton (d) Roald Amundsen

APPENDIX H

Summary Chart of MAKITAB Small-group Interaction Analysis System.

Faculty of Education
School of Education Studies
Pearson Street
CHURCHLANDS WA 6018

SMALL GROUP LEARNING INTERACTION ANALYSIS (MAKITAB)

February 1993

EDITH COWAN UNIVERSITY
PERTH WESTERN AUSTRALIA

WHOLE CLASS INTRODUCTION	GROUP TASK	GROUP DYNAMICS	MONITORING GROUP	WHOLE CLASS INTERVENTION	WHOLE CLASS WRAP-UP
IS01 Recapitulating from previous lessons	**TS01** Management - materials / movement	**DS01** Decision-making processes	**MS01** Checking progress	**NS01** Recapitulating previous activity	**RS01** Recapitulating / summarizing lesson
IS02 Explaining task content / procedures / materials	**TS02** Clarifying task directions / requirements	**DS02** Assigning role(s)	**MS02** Clarifying or eliciting task content / solution	**NS02** Clarifying task content / procedures / materials	**RS02** Marking / collating findings
IS03 Feedback - positive		**DS03** Task feedback - positive	**MS03** Feedback - positive	**NS03** Feedback - positive	**RS03** Feedback - positive
IS04 Feedback - negative		**DS04** Task feedback - negative	**MS04** Feedback - negative	**NS04** Feedback - negative	**RS04** Feedback - negative
IS05 Setting context	**TS05** Determining work actions	**DS05** Challenging group member(s) / asserting	**MS05** Clarifying task procedures	**NS05** Checking thinking process(s)	**RS05** Reviewing thinking process(s)
IS06 Explicit teaching of content	**TS06** Accepting work actions	**DS06** Positive response to challenge / assertion	**MS06** Giving answer / solution	**NS06** Explicit teaching of new content	**RS06** Looking ahead
IS07 Recapitulating task content / procedures	**TS07** Rejecting work actions	**DS07** Negative response to challenge / assertion	**MS07** Giving explicit directions	**NS07** Giving explicit directions	**RS07** Giving directions
IS08 Control / discipline	**TS08** Examining, comprehending, clarifying & routine responding	**DS08** Seeking approval / feedback	**MS08** Control / discipline	**NS08** Control / discipline	**RS08** Control / discipline
IS09 Student question / comment	**TS09** Sudden ideas / insights	**DS09** Self-evaluation - positive	**MS09** Student initiated contact	**NS09** Student question / comment	**RS09** Student question / comment
	TS10 Proposing	**DS10** Self evaluation - negative	**MS10** Resolving problems (dynamics)	**NS10** Checking progress / marking	
	TS11 Negotiating, arguing, reacting to ideas, insights or proposals	**DS11** Monitoring behaviour in group			
	TS12 Final agreement	**DS12** Group evaluation			
	TS13 Final rejection	**DS13** Aggression / conflict			
	TS14 Representation	**DS14** Seeking help			
	TS15 Reviewing	**DS15** Offering help			
	TS16 Monitoring student / group progress				

SPEAKER - LISTENER

1-4	Female student
5-8	Male student
9	Group
U	Unknown student
C	Class
T	Teacher
H	Helper
P	Parent
O	Outsider
S	Self
X	Other

CODING NOTES

##99	Non-task related (IS, TS, MS, NS, RS)
0000	Cannot code
S	Statement - For coding questions substitute
?	for a cognitive question and
X	for all other forms of question

Summary Chart of MAKITAB

<u>APPENDIX I</u>

Extracts from MAKITAB Technical Report.

Source: King, L., Barry, K., Maloney, C., & Tayler, C. (1993). ***The MAKITAB small-group learning interaction analysis system (Technical Report).*** **Perth, Western Australia: Edith Cowan University.**

Used with permission.

Group Task : Attending To The Task/Fulfilling The Task

Definition of Task:

A definite piece of work assigned to or expected from a group/class.

Interactions in this category relate only to student talk.

TS01 Management - Materials/Movement

Interactions associated with the type of material to be used, or the collection, arranging or distribution of materials and equipment required for group working on the task. Interactions which involve movement in terms of work space are included in this category.

This category does not include movement (physical activity) or the manipulation of materials (e.g., calculators, geoboards) as part of the work task.

Examples:	TX01 : 1-2	Do you have a good crayon?
	TS01 : 1-5	Okay, use pencil.
	TS01 : 1-6	Come and find the picture.
	TS01 : 2-1	Okay, we're going to need all the pizzas to do this worksheet.
	TS01 : 2-5	Toss me the fraction strip showing one-quarter.
	TS01 : 2-6	I need to go on the other side of the desk so that I can draw the right way up.
	TS01 : 5-6	We need to go inside now.

TS02 Clarifying Task Directions/Requirements

Comments and questions *seeking* to clarify directions, instructions or requirements to be followed when doing the task. This includes conferring to obtain help from the teacher or seeking directions on what to do when a task is completed. Reading instructions/questions from a worksheet are also included in this category. Questions read from a worksheet are coded TS02; student generated questions in this category are coded TX02.

Examples:	TS02 : 5-1	And then you're supposed to colour it in.
	TS02 : 5-2	We have to do this together.

(examples cont'd)

TS02 : 6-1	The question says, "Who eats the most pizza?" [worksheet question].
TS02 : 6-2	Wait a minute. We should put our names on it.
TX02 : 1-2	Sara, how do you spell your name [to write on worksheet].
TS02 : 2-1	S-a-r-a.
TX02 : 5-9	Do any of you know what you're doing?
TS02 : 1-5	No.
TS02 : 6-5	Tell the teacher.
TS02 : 5-6	Why don't you finish it first.
TS02 : 5-2	Let's do number 3 first.
TS02 : 1-6	No one else has got their hands up.
TX02 : 6-1	Now what did you want?
TS02 : 1-6	I want to know what she told us.
TS02 : 2-6	I want to too.
TS02 : 6-9	Hands up then.

TS05 Determining Work Actions

Interactions which involve *determining who will undertake* or *who has undertaken* particular *work actions* (i.e., jobs) toward achieving the *group task*. This includes *volunteering for* or *unsolicited rejection* of a task. Task determination can lead to *overt acceptance* (TS06) or *overt rejection* (TS07) or there may just be tacit acceptance or rejection (implied, so it generally cannot be coded).

This category is distinguished from TS08 in that the work actions are distinct jobs which contribute to the working of the group task. The work actions *are not* routine manipulative operations which may be part of the learning. Work actions (jobs) may be determined in the planning process or arise in response to a definite need during the working of the task. The category of determining work actions may also be used in the sense of checking up to see who has undertaken a particular work action for the group.

Coders should bear in mind the purpose of the category is to identify interactions which determine work actions (jobs) and students who play a significant part in *setting up and carrying out work actions* (jobs) that facilitate the achievement of the group task (i.e., the active participator). This category does not pertain to structural roles (e.g., recorder) in the group (see DS02).

Examples:	TS05 : 5-6	I'll finish the legend.
	TX05 : 5-2	Who's going to do the drawings?
	TX05 : 6-5	What am I doing? *(examples cont'd)*

	TS05 : 6-1	I'm not going to construct halves and eighths.
	TS05 : 6-2	Whoever gets done first will make halves.
	TX05 : 1-6	Who did this one?
	TS05 : 2-5	I'll cut them out now.
	TS05 : 1-5	I thought you were going to draw a picture, Carol.
	TS07 : 2-1	No, I'm working on this.

TS06 Accepting Work Actions

Comments by a group member that *confirm* the acceptance of particular work actions (jobs).

Examples:	TS05 : 2-6	You do the map.
	TS06 : 6-2	Okay.
	TX05 : 1-5	Will you make thirds?
	TS06 : 5-1	If that's what you want, I'll make thirds for you, Susan.

TS07 Rejecting Work Actions

Comments by a group member that *confirm* non-acceptance of particular work actions (jobs).

Examples:	TX05 : 1-2	Do you want me to take this home to my brother to do?
	TS07 : 2-1	No way, he might wreck it.
	TS05 : 1-5	You're meant to be drawing.
	TS07 : 5-1	No, I'm not.
	TX05 : 6-1	Are you doing the pepperoni pizza?
	TS07 : 1-6	No, I want to do tuna.

TS08 Examining, Comprehending, Clarifying and Routine Responding

Comments, questions and other interactions which are associated with *identifying, defining* or *paraphrasing content; examining, discussing* or *gathering information; elaborating upon content; clarifying facts and concepts; manipulating materials or equipment* in *relation* to *task content or procedure; making routine, low level responses (chatter) while working through task content/procedure.* This category also includes the sharing or collating (not discussing to reach consensus) of answers in independent format lessons.

Examples:	T?08 : 1-2	How do you spell science?
	TS08 : 2-1	S-C-I-E-N-C-E.
	TS08 : 1-5	It's just the same set out in a different way.
	T?08 : 5-1	Can you think of some other combinations that make up three quarters? [would lead to TS09 or TS10]
	T?08 : 1-6	Why do you have to add to get the answer?
	TS08 : 6-1	Because she ate half and quarter of each pizza.
	TS08 : 2-6	There now--divide it [the pizza] up into how many people you have to share it with.
	T?08 : 6-2	With you? With you three?
	TS08 : 2-6	No look. It says that Anna and Ben decide to share a pepperoni pizza.
	TS08 : 3-5	Mine's a big one.
	T?08 : 1-5	What did you get?
	TS08 : 5-1	Six.
	T?08 : 1-6	What's the exposition?
	TS08 : 6-1	Same as the introduction--the background stuff.
	TS08 : 5-9	I like this activity.
	T?08 : 5-6	What did you get on number 3?
	TS10 : 6-5	One whole.

TS09 Sudden Idea(s)/Insight(s)

A 'flash-in-the-mind', impulse, insight or creative idea which is related to the task but is *not a definite* recommendation for inclusion in the group task.

Examples:	TS09 : 1-9	Hey, I've got a good one. We could have a cyclone.
	TS09 : 2-9	Half! Gosh! Gosh, they're all going to be a half.
	TS09 : 5-9	Oh, I have an idea: it could be bacon, bacon and cheese.
	TS09 : 6-9	I know what we could do.

TS10 Proposing

Interactions in which a group member(s) offers for consideration, acceptance or action a *definite recommendation, suggestion, prediction, plan, method, explanation* or *answer* for inclusion in the group task. This offer may take the form of a proposal, an extension of a proposal, or a counter-proposal. A proposal, extension of a proposal, or counter-proposal may be *ignored, negotiated over, accepted* or *rejected* (see TS11-TS13).

Examples:	TS10 : 1-9	Let's say we are in a group and we go around the world in a voyage and the next morning we wake up and we're wrecked.
	TS10 : 1-9	Let's crush it.
	TS10 : 2-9	Make a big ice-cube out of cardboard and join it on.
	TS10 : 3-9	It would work with a hammer.
	TS01 : 1 -9	If you were really hungry would it be better to share a pepperoni, cheese or bacon pizza? [Note: A student reading from the worksheet.]
	TS10 : 2-9	Cheese, I think.
	TS12 : 5-9	Cheese.
	TS10 : 5-6	Now you add all these together.
	T?11 : 6-5	Are you sure?
	TS11 : 5-6	Yes.
		[The discussion continues before closure.]

TS11 Negotiating, Arguing, Reacting to Ideas, Insights or Proposals

Comments and questions in which group members *talk, work through, or react to ideas, insights or proposals*. These interactions normally involve higher cognitive level interactions such as *reciprocal discussion, consideration of implications, application of content, examination of different points of view, verbalization of reasoning processes, critical thinking*, or *statements for and against a proposal or counter-proposal*. Normally TS11 will follow TS09/TS10, but interactions may occasionally revert to TS08.

Examples:	TS10 : 1-2	Ben ate the least pizza.
	TS11 : 2-1	No, he didn't.
	TS11 : 2-1	Look – Candice gets one-third and one-
	TS11 : 2-1	quarter. / Ben gets all those pieces, so it
	TS11 : 2-1	couldn't be Ben. / Anna gets that and that, but one-third is smaller [sic] than
	TS11 : 2-1	one-quarter. / So it has to be Candice.
	TS11 : 2-1	Darren gets one-third.
	TS11 : 1-2	Yeah, but . . . *(cont'd)*
	TS10 : 5-9	Candice and Darren ate the least pizza [i.e., a counter proposal].

TS11 : 6-9	Two-sixths is smaller than three-ninths.
TS11 : 1-9	Wait a minute, two-sixths equals one-third. Three-ninths equals one-third.
TS11 : 2-1	Yeah.
TS10 : 1-9	So they're the same. Talking about two-ninths, no, so Anna and Ben.
T?11 : 2-9	How can Ben be eating the least? [rhetorical question]
TS11 : 2-9	He ate the most.
TS11 : 5-2	Uh-huh, see Anna.
TS11 : 1-9	Two-sixths equals one-third. Three-ninths equals one-third.
TS11 : 6-9	So they all eat the same.
TS11 : 6-9	Unless two-sevenths is bigger.
TS11 : 1-6	Two-sevenths isn't bigger.
TS11 : 5-9	Two-sevenths is smaller.
TS11 : 1-9	Well they're both the same. Candice and Darren ate the same. So that means Candice and Darren ate the least pizza.
TS12 : 5-1	Yes, that's what I said.
TS12 : 1-5	Okay.
TS11 : 1-6	It can't be seven-eighths. Look, here's half, and right below is four-eighths.
TS11 : 6-1	Seven-eighths would be more than four-eighths.
TS11 : 1-6	So it would be more than a half, too.
TS12 : 6-1	Okay.
TS11 : 2-5	Kevin Costner can't play Romeo.
T?11 : 5-2	Why not?
TS11 : 2-5	He doesn't look Italian.
TS12 : 6-5	Yeah, he's not young enough, either.

TS12 Final Agreement

Interactions in which a group member(s) *agrees to final recommendations, suggestions, plans* or *answers* for inclusion in the group task.

Examples:	TS12 : 1-9	We all agree that the title should be 'How to Survive in a Cold Climate'.
	TS12 : 5-9	Yes, it's hot water.
	TS10 : 1-5	Wrap it in material.
	TS12 : 5-1	Yes, what a good idea. Let's do that.
	TS12 : 6-9	I have to go along with it, I don't have any choice.

TS13 Final Rejection

Interactions in which a group member(s) *reject recommendations, suggestions, plans* or *answers* for inclusion in the group task. The rejection is *final* and *dismisses* content from further consideration for the group task.

Examples:	TS13 : 1-6	No way, we're not having that.
	TS13 : 6-1	We will not have that pop-up.

TS14 Representation

Comments, suggestions or questions associated with the *actual recording* or *representation* of the *product* or *recommendations* for *inclusion in the group product*. This includes such acts as writing, drawing, colouring, erasing, preparing a chart and performing. When TS14 occurs concurrently with another category (TS08, TS10, TS12) then code the interaction as TS14.

Examples:	TS14 : 5-6	Write it down as best you can.
	TS14 : 5-1	Write that three-eighths is a proper fraction too.
	TS14 : 5-6	I've almost got it erased.

TS15 Reviewing

Comments and questions related to *going back over developed content* in order to *check its usefulness, appropriateness* or *accuracy*. This may involve inquiry, questioning, inspection, reworking, or evaluation of the developed content for the group task. Reviewing also includes the redoing of an experiment to check the accuracy of a result.

Examples:	T?15 : 5-2	What have you got written down so far?
	TS15 : 2-9	Hey guys, listen to what I've written.
	TS15 : 1-9	Okay, let's check.
	T?15 : 1-9	What's the same as two-fifths?
	TS15 : 2-1	Four-tenths.
	TS15 : 6-1	We shouldn't have cut these, these are messy.
	TS15 : 1-9	This one is the best.

TS16 Monitoring Student/Group Progress

Interactions, observations, comments or suggestions about *progress* in terms of *use of time* or where the student or group *is in relation to task achievement or other groups*.

Examples:	TX16 : 1-2	Are you almost done?
	TS16 : 1-9	Come on, come on, let's get busy.
	TS16 : 2-9	Here, we have to do fourths.
	TS16 : 5-9	We are running out of time.
	TS16 : 6-9	All done.
	TS16 : 1-9	Let's get this done.
	TS16 : 1-9	I've finished.
	TS16 : 2-9	I haven't done number 2 yet.
	TS16 : 5-9	We didn't do that one.
	TS16 : 6-9	That group is ahead of us.
	T?16 : 1-9	What have we discovered so far?
	TX16 : 1-2	We'll do it after, okay?
	TS16 : 1-5	Now we got to show Mr Brown.

TS99 Non-task Related

Actions, comments and questions which indicate *non-involvement* with or *distraction from the task* being worked by the group. This *does not* include *off-task, conflict* (DS13).

Examples:	TS99 : 5-6	Look at the blood on my thumb.
	TS99 : 1-2	Will you come and play after school?
	TS99 : 2-1	One of the tadpoles is dead.

DS02 Assigning Role(s)

Interactions related to determining who will fulfil, or has fulfilled, particular *structural* small group member roles (recorder, timekeeper, judge, encourager, etc.) as opposed to *task* oriented actions.

Examples:	DX02 : 5-6	What do I do?
	DS02 : 6-5	You are the director.
	DS02 : 1-9	I'm timing.
	DS02 : 1-2	You be the recorder; you write the answers.
	DS02 : 2-1	Okay.
	DX02 : 5-9	Guys, I'll be the direction reader, okay?
	DS02 : 2-5	I'm still the writer.

DS03 Task Feedback -- Positive

A group member(s) provides *positive evaluative comment, encouragement*, or *affirmation* to another group member(s) *about the progress of the group task, an individual work effort* or *work action (job)*. Praise or admiration are included. This category does not relate to student behaviour during group work.

Examples:	DS03 : 3-5	Our story is pretty good, look how much we've done.
	DS03 : 5-3	That looks good.

DS04 Task Feedback -- Negative

A group member(s) provides *negative or critical evaluative comment* to another group member(s) about the *progress of the group task*, an *individual work effort or work action (job)*. Criticism or personal, derisive comment *about task performance* is included. This form of comment may move into non-productive or personal conflict, and then becomes DS13. The DS04 category does not relate to student behaviour during group work.

Examples:	DX08 : 5-6	Which one looks best?
	DS04 : 6-5	No-oo, he should have big wings.
	DS09 : 1-6	It's easy.
	DS04 : 6-1	I know, that's why she wanted to do the pepperoni.
	DS04 : 2-1	That writing is messy.
	DS04 : 1-2	I have nothing to say. I'm not doing any more.

DS05 Challenging Group Member(s)/Asserting

An individual group member *interrupting, asserting* or *reasserting* the right to speak, to *contribute content*, to *argue content*, to *follow procedure*, to *demand a response* or *contribution* from another group member. If not listening to the tape or observing, it is often difficult to distinguish between DS05 and other categories. If in doubt, code as the other category (e.g., TS05, TS08).

Examples:	DX05 : 1-9	Listen, can I speak?
	DS05 : 2-1	I want to finish.
	DX05 : 1-2	Why should it be your way?
	DS05 : 2-1	Shh, I'm talking.
	DX05 : 1-2	Can I write something down?
	DS05 : 1-9	Let me do something.
	DS05 : 2-1	Let me see the cheese.
	DS07 : 1-2	No.
	DS05 : 6-9	Wait, wait.

DS06 Positive Response to Challenge

Following a challenge (DS05) from a group member, *agreement* or a *positive response* is given.

Examples:	DX05 : 1-5	Can I go ahead?
	DS06 : 5-1	Yes, go ahead.
	DS05 : 1-6	I want to do something with that flower.
	DS06 : 6-1	Okay, do it.

DS07 Negative Response to Challenge

Following a challenge (DS05) from a group member, *rejection* or a *negative response* is given.

Example:	DX05 : 1-6	Can I go ahead?
	DS07 : 6-1	No, I don't want you to.

Examples of DS05, DS06, DS07:

DS05 : 1-2	Here. If it's my thing, then I write it down.
DS07 : 2-1	No.
DS05 : 1-2	Yes, because it's fair.
DS06 : 5-1	It does not matter.
DS06 : 1-9	Well then I'll just write it down.
DX05 : 1-9	Can I write something down?
DS07 : 2-1	And I have, Anna.
DS05 : 1-2	I'm doing it.
DS07 : 2-1	No, do this.

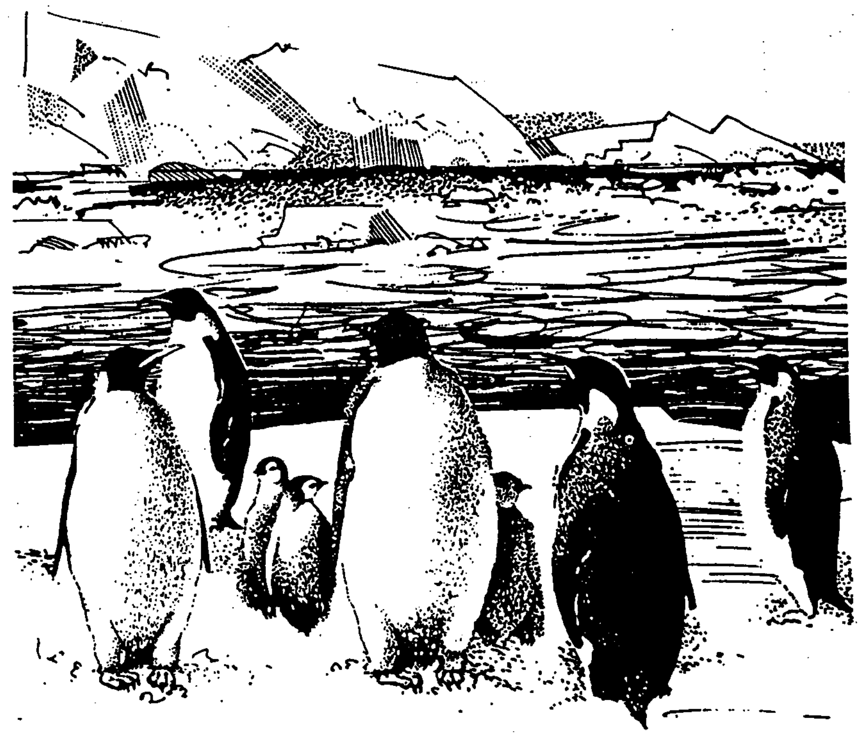
APPENDIX J

The five lessons on the Antarctica topic used during the study.

ANTARCTICA-THE FROZEN CONTINENT

Imagine a place colder than the **freezer** in a refrigerator. **Antarctica** is a place like that. It is the world's fifth largest **continent** (large land mass). The coldest **temperature** ever recorded (– 89.2 ° C) was in Antarctica. There is no soil where trees and flowers can grow in Antarctica. There are no rivers.

Most of Antarctica is covered by ice and snow. Some of the mountains and rocks are bare because the strong winds in Antarctica blow the snow away. When the winds blow the snow into the air this causes a storm called a **blizzard**.



In some places the ice is over 3 KM thick! When huge chunks of ice break off they are called **Icebergs**. One of these icebergs was bigger than **Belgium** (a country in Europe). But even a place as cold as Antarctica has an active **volcano**, called **Mt Erebus**.

No one lives in Antarctica. There are no towns or homes like ours. No country owns it but many countries claim territory there. Australia has the biggest claim. Some countries have scientific bases in Antarctica where they study all kinds of things.

The scientists stay for only one year at a time. They are not allowed to take their families with them so there are no children in Antarctica.

DISCUSSION QUESTIONS

1. Why do you think the ice is so thick in Antarctica?______________________________

____

2. A blizzard is a very dangerous storm to be caught out in. Why? Give at least two reasons.

____

____

3. Why do you think no one lives in Antarctica?

____

____

____

4. What do you think scientists might study in Antarctica?

____

____

____

____

WORKING IN ANTARCTICA

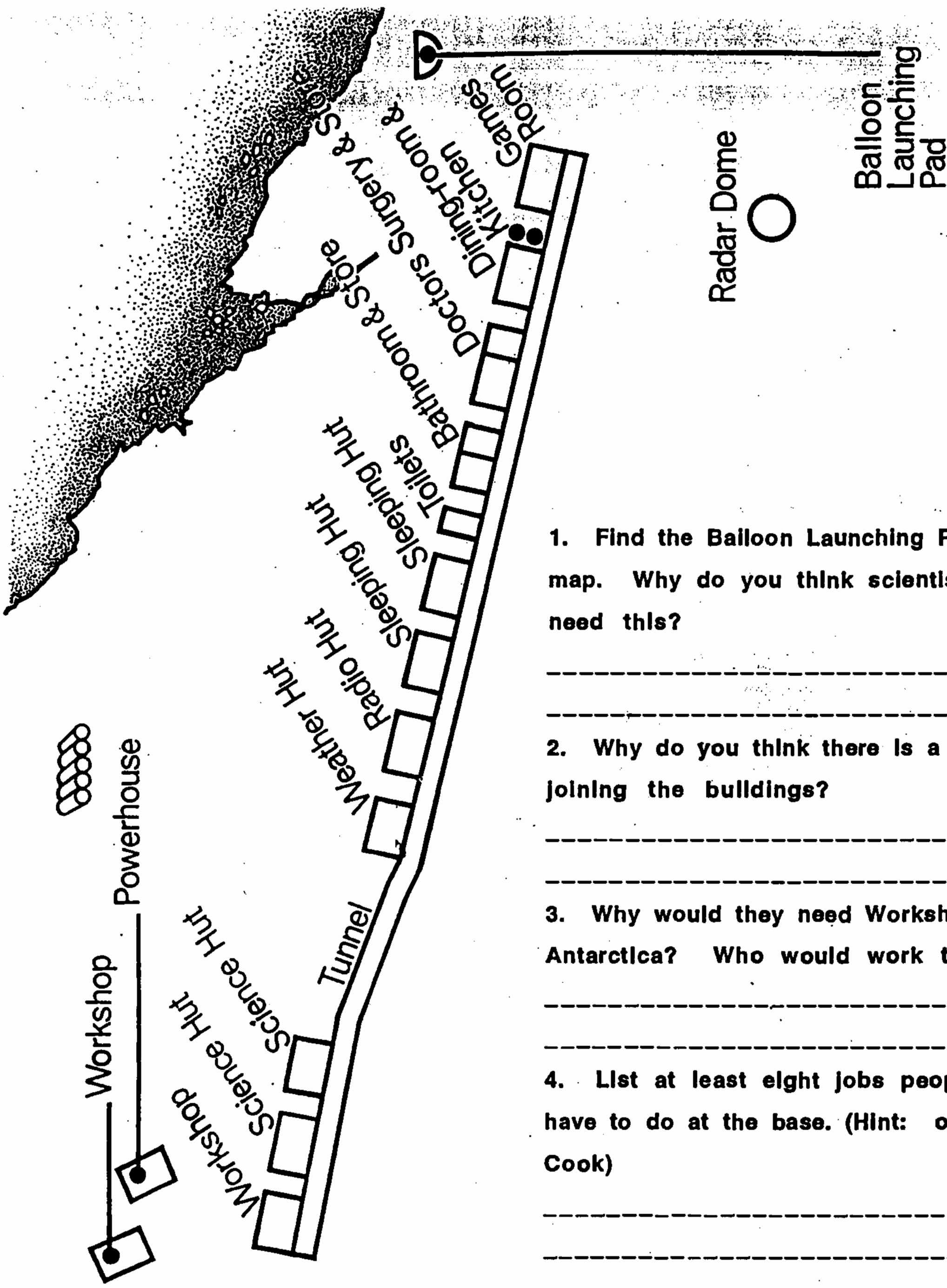
Although no one lives all the time in Antarctica there are often many **scientists** who do **research** there. These scientists are usually sent to Antarctica for one year at a time. Australia has three **bases** in Antarctica called **Casey, Mawson and Davis.**

All the **supplies** needed at the scientific bases must be brought in by sea. This can only be done in summer because for the rest of the year the seas around Antarctica are frozen. The winter in Antarctica means very little daylight so the scientists must work indoors for most of the time. If they need to work outside they have to wait for good **weather**.

Going outside means wearing lots of layers of clothes. The first layer is special **thermal** cotton underwear then woollen shirts, trousers and sweaters. The last layer is wind-proof and water-proof **overalls** and **parkas.** Special gloves, boots, beanies and **snow goggles** are used.

The body and especially the feet must be kept dry because sweat can freeze and cause **frost-bite**. Frost-bite is when the skin or flesh is so frozen that it dies. People lose fingers, toes or even parts of their nose to frost-bite.

Now read, discuss in your groups and answer the questions on the other side of this sheet.



1. Find the Balloon Launching Pad on the map. Why do you think scientists would need this?

____

____

2. Why do you think there is a tunnel joining the buildings?

____

____

3. Why would they need Workshops in Antarctica? Who would work there?

____

____

4. List at least eight jobs people would have to do at the base. (Hint: one job is Cook)

____

____

EXPLORING ANTARCTICA

Two hundred years ago no one had heard of Antarctica. An English captain, **James Cook** was the first to sail near Antarctica in the ship **Resolution.** He sailed right around the continent in **1773** but did not sight land. He told people back in England that there must be land down there because he saw signs of land out at sea.

The first people to land in Antarctica were **sealers** who caught seals for their fur and blubber.

Exploration of Antarctica began in the late 1800s and a race began to be the first to the South Pole. A British team, lead by **Scott** and a Norwegian team lead by **Amundsen** set out for the South Pole in 1911. Amundsen's team reached the Pole first. They used dog-sleds to carry their supplies. Scott's team reached the Pole later and they all died. They had tried to pull their sleds themselves.

Another explorer, **Shackelton** lost his ship (Endurance) when it became stuck in the ice. The ship was crushed and Shackleton had to lead his men to safety on an open-boat voyage across dangerous seas. None of Shackleton's men died.

A famous Australian explorer was **Douglas Mawson.** He also **survived** many dangers in Antarctica.

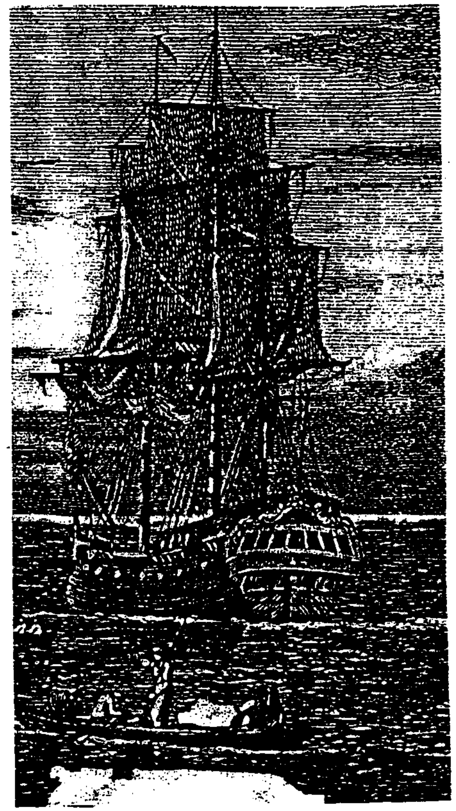
Now read and discuss the questions on the other side of this sheet.

1. Cook's ship was a sailing ship like the one in the picture. Would exploring Antarctica have been harder for Cook? How? Give four ways.

2. Why do you think Scott's team died but Amundsen's lived? Give two reasons.

3. What kinds of dangers would Shackleton and his men have faced?

4. What kinds of dangers would an Antarctic explorer face today?



SCIENTISTS IN ANTARCTICA

Scientists study many things in Antarctica. They are interested in **whales** because most of the world's remaining whales live there. Scientists in Antarctica **discovered** that the earth's **ozone layer** had a "hole" in it. This means we have less protection from the sun's harmful rays.

Part 1

With your group look at the map and answer these questions:

1. What kinds of whales, seals. sea-birds and penguins live in Antarctica.

____

____

____

2. Why do you think all the animals live in or near the sea?

____

____

Part 2

Imagine your group are a team of scientists who are going to study Adelie penguins. **Look at the list of equipment below and choose only <u>fifteen</u> items to take with you for a two week expedition.**

1 pair binoculars	two 20L water containers
1 microscope	four pairs of boots
tweezers	spare boots
first aid kit	spare clothing
2 2 man tents	notebooks and pencils
1 five man tent	50 metres of rope
food for one week	one rifle
food for one week	one set of signal flares
food for one week	two-way radio
four sets of outer clothing	2 pairs snow skis
four sets of inner clothing	1 life raft

Imperial shags
Gentoo penguins
Antarctic cod
Chinstrap penguins
Antarctic Circle (approx. 66.5° South)
SOUTH ATLANTIC OCEAN
Right whale
Elephant seals
WEDDELL SEA
Iceberg
Antarctic petrels
Survey ship
Adélie penguins
Fish factory ship
Humpback whale
Antarctic fulmars
Leopard seal
Emperor penguins
South polar skua
Crabeater
Elephant seals
Snow petrels
BELLINGSHAUSEN SEA
RONNE ICE SHELF
Survey plane
QUEEN MAUD LAND
AMUNDSEN-SCOTT STATION (USA)
MARIE BYRD LAND
ANTARCTICA
SOUTH POLE
Krill
Crabeater seal
Antarctic fulmar
Roald Amundsen (Norway) first reached South Pole December 1911
Adélie penguins
Robert Scott (UK) reached South Pole January 1912
Elephant seals
Ross seal
Snow petrels
Blue whale
South polar skua
ROSS ICE SHELF
VOSTOK STATION (Russia)
Iceberg
Adélie penguins
Krill
Tourist liner
Emperor penguins
SOUTH PACIFIC OCEAN
Leopard seal
WILKES LAND
Antarctic cod
Ross seal
Killer whale
DUMONT D'URVILLE STATION (France)
Leopard seal
INDIAN OCEAN
Fin whale
Ice fish
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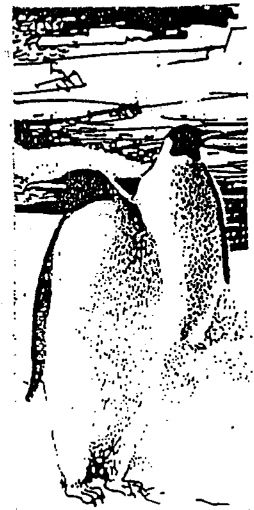


NEW BASE IN ANTARCTICA

Imagine a new scientific base, Hawker, is going to be started in Antarctica. Only **five** people are going to be sent there to get the base ready for use.

Look at the list and decide with your group which five people should be in the first group to start the new base. Your group has to agree on the choices and each group member must be able to explain your decisions.

All of these people would have to train before they went to Antarctica.

Ben, 38 years, meteorologist (weather scientist). Very fit and has skills with computers.

Lucy, 49 years, doctor. Has not been to Antarctica but is a good ice skater.

Brad, 45 years, engineer. Good at making things. Suffers from asthma.

Sue, 35 years, chef. Doesn't like the cold but has been snow skiing. Vegetarian.

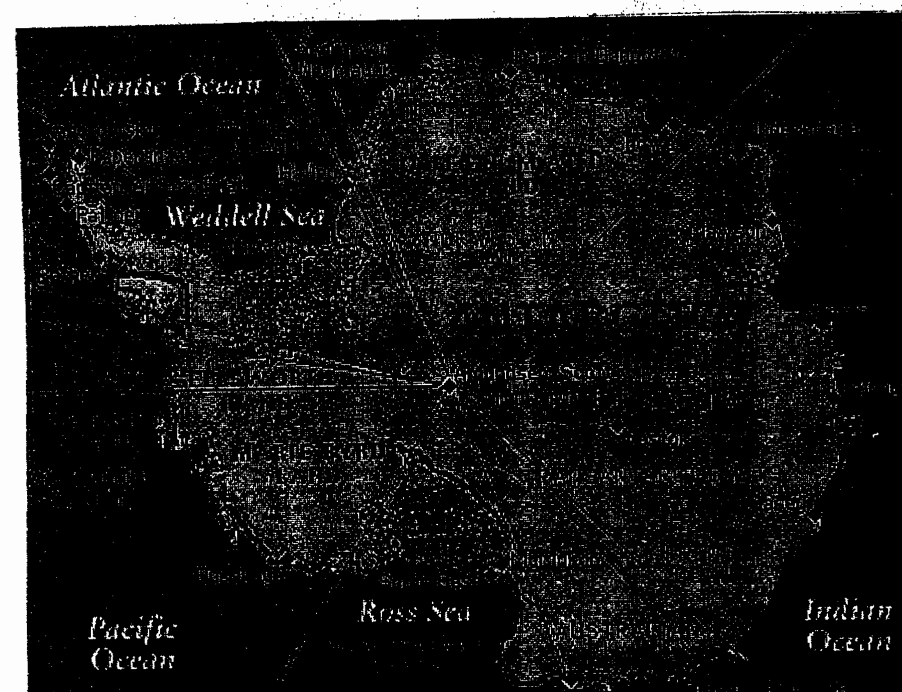
Luke, 22 years. Physical Education teacher; very fit and has studied science.

Dave, 29 years, former fisherman and can use radios. Has a bad back.

Sarah, 41 years, biologist (animal/plant scientist). Has a heart problem which she takes tablets for.

Simon, 24 years, mechanic. Quite fit. Spent time in jail for car stealing.

Jane, 22 years, nurse. Part time dancing teacher. Just became engaged.



APPENDIX K

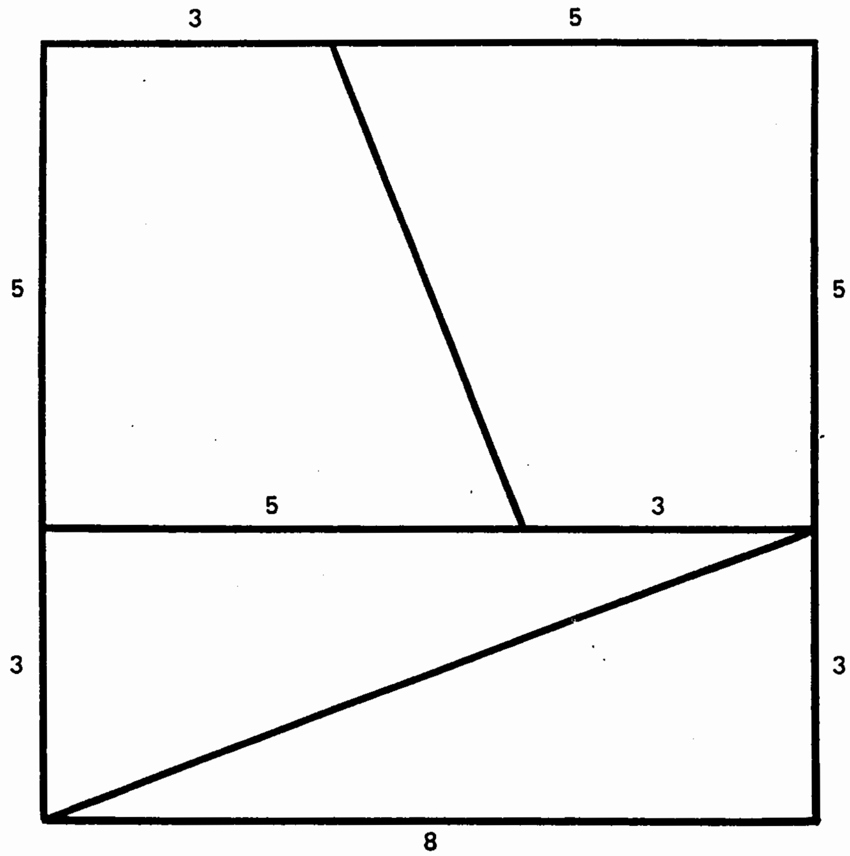
Three Mathematics Problem Solving Lessons from the training phase of the study.

Lesson One

PUZZLERS

Cut out an 8 x 8 square from a sheet of squared paper.
(Area = 64 square units)

Divide the square up as below and cut out the pieces:—

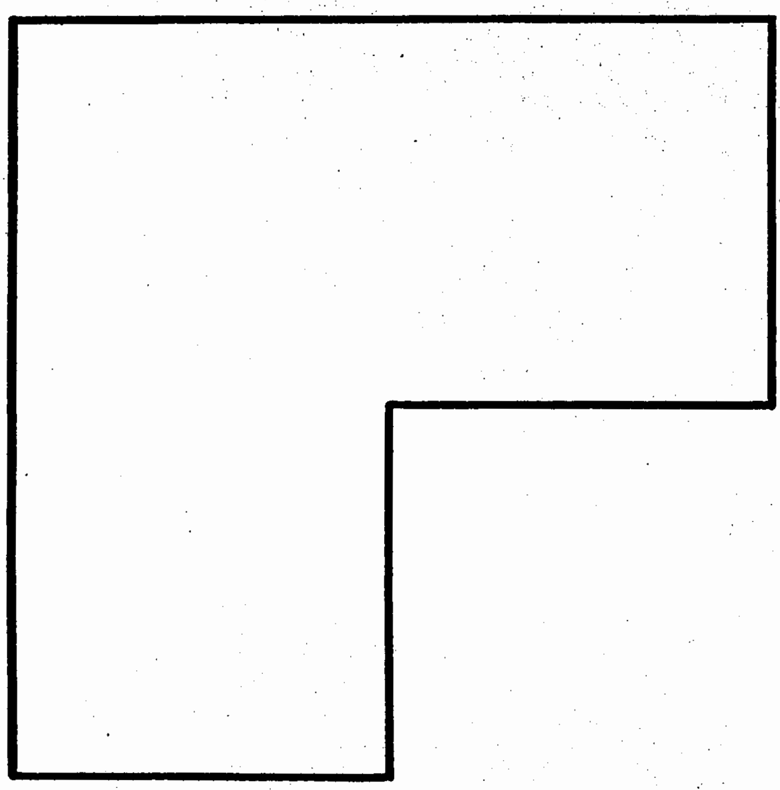


Re-assemble the pieces in the form of a rectangular type of figure. What is the area of this figure? Can you explain the difference????

Lesson Two

PUZZLERS

Divide the ¾ square figure below into 4 congruent regions:—

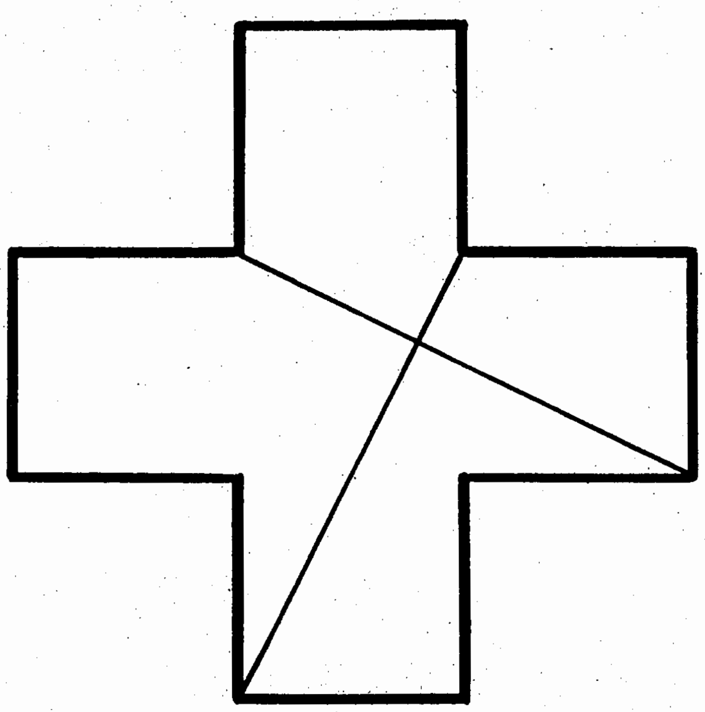


The regions must have the same shape and size.

Lesson Three

PUZZLERS

Copy the figure below and divide it up with the pieces indicated:—



Fit the pieces together to form a square.

APPENDIX L

Roles and Rules Charts displayed during the training phase and the study lessons.

GROUP RULES

Move quietly

Speak softly

Stay with your group

Take turns

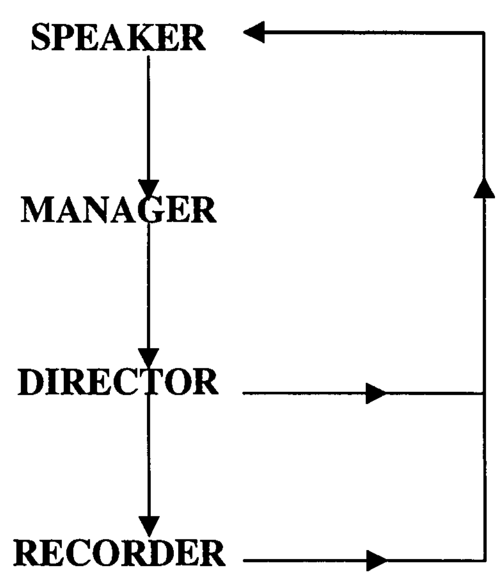
Do your jobs

Ask for help

Give help if asked

Only see a teacher if you're all stuck

GROUP ROLES



APPENDIX M

Extract from Education Department of Western Australia Social Studies Syllabus (1981) indicating Antarctica topic, year 3 "Living in a Harsh Environment".

3	4
ENVIRONMENT	
LIVING IN A HARSH ENVIRONMENT • The way in which people meet their basic needs is dependent upon, or influenced by, their natural environment. **Subject Matter**: Life in the Arctic, Antarctic or in desert regions of Western Australia.	**WORLD ENVIRONMENTS** • The Earth is part of a solar system. • Soil, water, air and solar energy are essential elements of all natural environments. • Natural environments differ throughout the world. **Subject Matter:** The solar system; Earth and the solar system; polar regions, desert regions, mountain regions, tropical regions and temperate regions.
RESOURCES	
ECONOMIC DEPENDENCE • A number of people may be involved in producing a commodity. • People buy both goods and services. **Subject Matter**: The production of bread; and different ways of paying for goods and services.	**CHOICE** • Scarcity necessitates choice, and choices show what people care about. • People use scarce natural and man-made resources to produce goods and services. **Subject Matter**: The use of such resources as the hard-wood forests of Western Australia.
SOCIETY AND CULTURE	
COMMUNITIES, FAMILIES AND TRADITIONS • Children learn the customs and traditions of their families. • Customs and traditions vary among families and communities. **Subject Matter**: The origins and celebration of customs and traditions by families and communities in our multicultural society, and in other societies.	**CULTURE** • The environments in which people live consist of natural and cultural features. • The culture in which people live influences their values and actions. • Different societies transmit their culture to their members in different ways. **Subject Matter**: Such cultures as the Bushmen of the Kalahari Desert.
CHANGE	
COMMUNITIES AND CHANGE • Change takes place in communities as new ideas are put to use. **Subject Matter**: Changes in buildings, transport or life-styles in the local community, and in contrasting communities, since early settlement.	**EXPLORATION AND DISCOVERY** • World-wide exploration and discovery have extended knowledge of the world. • Increased contact between cultures has led to changes in lifestyles. **Subject Matter**: Marco Polo, Columbus, Da Gama, Magellan, Cortez and Pizarro.
DECISION-MAKING	
COMMUNITY RULES • Rules are necessary when people belong to groups. • Rules provide for social order and individual freedom. **Subject Matter**: Such groups as Cubs, Brownies and swimming clubs. Traffic rules, litter regulations or conservation issues.	**MAKING DECISIONS** • Individuals have values which influence their decisions. • Individuals often make decisions as group members. • Group members receive benefits and have responsibilities. **Subject Matter**: The family, school, church, sporting team or recreation club in the local community.