Chapter 1

INTRODUCTION

This study considers the effect of a program of cooperative learning in Mathematics on Year 7 students' attitudes towards Mathematics and their subsequent achievement. Specifically, the program focused on developing the skills of decoding word problems.

Background to the problem

Fifteen years experience in the New South Wales public school system as a secondary mathematics teacher fostered in the teacher/researcher a special interest in students' attitudes and their impact on student achievement and subsequent engagement in Mathematics. Currently, the New South Wales Board of Studies in the Years 7-10 Mathematics syllabus supports the need for students to solve problems, and further, these problems should be seen to be relevant to the student's life (Board of Studies NSW, 2002). The teacher/researcher had become increasingly aware of the number of students entering high school displaying a difficulty in interpreting word problems, especially in distinguishing the required operation to solve the problem.

From experience, the teacher/researcher believed that for students to progress successfully through secondary school it is essential they develop the ability to identify appropriate methods to solve word problems because much of their formal, external mathematics assessment is presented in this format. Relevancy is meaningless without the tools for understanding. The teacher/researcher also observed that students faced with word problems and lacking the skills to decode them, in later years seem to lose the motivation to succeed. They perceive Mathematics as difficult, irrelevant and they avoid the challenge. These students also lack the positive self-motivation required to succeed in Mathematics

and are content to copy information from the board or from a friend, believing this is 'work'. Further, they avoid taking the risks of attempting to formulate their own answers for fear of failing yet again, resulting in an attitude of 'not caring'. At this stage, students often become disruptive and a behaviour problem in the classroom.

These students, the teacher/researcher believes, have the right to enjoy and succeed in Mathematics. Rather than allow them to progress through the system without intervention, unsuccessful students should have the opportunity to develop skills in solving word problems in Year Seven, in order to help develop a positive attitude to Mathematics as they progress through their high school years.

While there has been considerable research undertaken investigating students' attitudes to and achievement in Mathematics, little is known about students' ability to use mathematical language to decode word problems and the subsequent effects on their attitudes to Mathematics.

The study was carried out in a government high school located in a town of the City of the Blue Mountains, 80km from Sydney. This town is largely residential, with a small industrial area and serviceable commercial area. The school is a co-educational comprehensive state school and draws its enrolment from the local area and a radius of approximately 30 km. At the time of the data collection, there was an enrolment of 907 students with 450 males and 457 females, with approximately 2% Aboriginal students and 6.3% of students from non-English speaking backgrounds. The staff consisted of 61.2 personnel, of which 42 were full-time teachers with the majority of the teaching staff having 15+ years teaching experience. Within the school, a culture of collaboration exists where teachers help, assist and share ideas within and between Key Learning Areas (KLA). The school provides a less than friendly physical environment. Built in the early 60's, emerging from the functionalist view of Architecture, the buildings are built of brick and

concrete with a distinct lack of colour. The classrooms and service rooms are incorporated into four two-storey, square donut-shaped blocks. The result is four poorly-lit, concrete paved courtyards, overlooked by a perimeter of balconies. The classrooms are entered from these courtyards and balconies. The classrooms are ten by eight metres in size, containing thirty desks and chairs, a teacher's desk and chair and a blackboard and/or whiteboard. Mostly, the classroom configuration consists of either a paired or horse-shoe shaped seating arrangement, facing the teacher's deck and blackboard/whiteboard, which are situated at the front of the room; thus they are well suited for the conventional chalk and talk, teacher controlled classroom. Generally, the mathematics classrooms provide no visual stimulus. The teacher/researcher in her classroom, has endeavoured to present a bright and colourful environment by displaying posters and students' work on the walls. The teacher/researcher had alternated between the pair seating arrangement, the blocks of four seating arrangements and the horse-shoe arrangement and had found the paired arrangement the most appropriate for maximum classroom management. The teacher/researcher's classroom strategies incorporated teacher-focused student questioning with theory presented on the overhead projector and exercises presented on worksheet.

The teaching culture of the mathematics faculty at the school provided a conservative, teacher-centred learning environment, which was considered the most appropriate strategy for 'best' examination results. For this study, the proposed teaching strategy of cooperative learning, suggested by the teacher/researcher, posed a radical deviation from the 'normal' teaching patterns of the faculty.

The class chosen for the study consisted of ten students. This class had been formed from funding provided by a newly developed departmental initiative for students with mild disabilities who required special attention to integrate into secondary school from primary school. This Year Seven class, the first year of secondary school, was allocated to the teacher/researcher by the principal of the school due to the teacher/researcher's particular interest in mathematically challenged students.

The Research Problem

The current Mathematics program, New South Wales Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002) and a model for quality teaching endorsed in NSW public schools (New South Wales Department of Education and Training 2003) provide the systemic background to the study. Research into factors affecting students' attitudes to and achievement in Mathematics, especially related to the cognitive, affective and social domains provides a framework for the study. The review of the social domain focuses on communication in Mathematics, in particular, cooperative learning and specifically, group work. The literature review shows a substantial amount of research has been conducted on the methods and benefits to students having the capabilities to communicate their ability to solve word problems involving higher order thinking in Mathematics, specifically referred to as problem solving,. However little research has been conducted on the problems associated with incorporating communication by cooperative learning, particularly group work, with students who have not necessarily developed this higher order thinking in the early years of secondary school.

In Chapter Two, related research is examined to provide a theoretical framework for the study. Chapter Three has a focus on the research design and methodology. Chapter Four and Five present the findings of the study. Finally, Chapter Six considers the conclusions and implications of the research.

This chapter provided an overview of the inquiry, considering the reasons for the teacher/researcher's interest in this investigation and the context of the study. The next chapter provides the results of a investigation into the literature related to the teacher/researcher's interest into students' attitudes toward and achievement in Mathematics.

Chapter 2

LITERATURE REVIEW

Introduction

Researchers provide a number of solutions to motivating students in Mathematics; verbal praise and positive feedback (Cameron & Pierce 1996); encouraging a comfortable feeling towards mathematics (Middleton & Spanias 1999); appropriate learning approaches (Bessant 1995); providing for appropriate learning styles (Keast 1999; Sloan, Daane & Giesen 2002) 'sense making' (Battista 1999); an open project based environment (Boaler 1998); the implementation of problem solving methods and peer collaboration – cooperative learning (Campbell & Evans, 1997; Cobb, Wood, Yackel & Perlwitz 1991; Ginsburg-Block & Fantuzzo 1998; Jones & Thornton 1993); conceptual understanding and learning to understand (National Council of Teachers of Mathematics, NCTM 2000), relevant meaningful tasks (NCTM 2000) and an authentic and problem orientated approach (Verschaffel & De Core 1997). While each of these solutions is important to motivate students and enhance their achievement in the learning of Mathematics, little research has been focused on improving students' attitudes and achievement by giving them the skills to decode mathematical word problems and so develop their ability to solve more complex problems in the future.

This chapter presents the context and discusses the research into students' attitudes and achievement, and the importance of students' communication when solving word problems. It is divided into five sections.

The first section discusses current directions in the New South Wales syllabus and pedagogy in mathematics. Aspects of the New South Wales Mathematics Years 7 – 10

Syllabus (Board of Studies NSW 2002) and the Quality Teaching in NSW public schools (New South Wales Department of Education and Training 2003) have been included, as this research was conducted in a mathematics classroom in which this syllabus formed the basis of the teaching method.

The second section reviews the literature on student achievement in and the attitudes towards Mathematics focusing especially on engagement and disengagement linking achievement and attitudes to behaviour problems.

The third section continues by discussing the literature on domains associated with student achievement in and attitudes towards Mathematics. Theories and research into cognitive, affective and social domains are described. The cognitive domain addresses how students achieve in Mathematics. The affective domain specifically considers attitudes and beliefs leading to confidence. The social domain particularly discusses cooperative learning as an avenue for communicating mathematical concepts, which may or may not affect students' achievement in and attitudes towards Mathematics.

The fourth section has a focus on problem solving and specifically word problems in mathematics.

Finally this chapter concludes by presenting the research questions that provide the basis for the study.

CURRENT DIRECTIONS IN MATHEMATICS IN NEW SOUTH WALES SCHOOLS

This section is presented in two parts. The first, by referring to the New South Wales Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002), considers the rationale, aspects of teaching and learning strategies and aspects of assessment in the teaching of Years 7 -10 in New South Wales schools. The second part considers quality teaching in NSW public schools.

The New South Wales Years 7 – 10 Mathematics Syllabus – 2002

In 2000, the New South Wales, Board of Studies established a committee to develop a Year 7 – 10 mathematics syllabus based on a new Kindergarten to Year 10 curriculum framework. This framework was informed by current learning theory and research about students' mathematical needs. The Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002) was published and implemented according to the committee's findings.

The Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002) defines Mathematics as

> a reasoning and creative activity employing abstraction and generalisation to identify, describe and apply patterns and relationships. It is a significant part of the cultural heritage of many diverse societies. The symbolic nature of mathematics provides a powerful, precise and concise means of communication. Mathematics incorporates the processes of questioning, reflecting, reasoning and proof. It is a powerful tool for solving familiar and unfamiliar problems both within and beyond mathematics.
>
> (p.7)

The syllabus is intended to provide the opportunity for all students to develop "a positive self-concept as learners of Mathematics, obtain enjoyment from Mathematics, and become self-motivated learners through inquiry and active participation in challenging and engaging experiences" (Board of Studies NSW 2002, p.7). As well as developing the ability to collect, analyse and organise information, key competencies incorporate in the syllabus the ability to communicate ideas and work with others especially when solving problems.

The syllabus emphasises the importance of problem solving as an integral part of mathematical learning and suggests that these problem solving tasks should provide "opportunities for students to solve meaningful and challenging problems in both familiar and unfamiliar contexts, within Mathematics, in other key learning areas and in everyday situations" (Board of Studies NSW 2002, p.10). The Board of Studies NSW (2002) believes that by teaching Mathematics in this way, students will be encouraged and improved attitudes to Mathematics will follow, including an understanding of the importance of Mathematics in society.

The syllabus explicitly includes a section addressing values and attitudes. The section includes having confidence when referring to students' ability. Students should display confidence "in applying mathematical knowledge, skills and understanding to everyday situations and the solution of everyday problems" (Board of Studies NSW 2002, p.11).

Teaching and Learning Strategies.

The New South Wales Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002) incorporates problem solving strategies, inquiry and the ability to use the appropriate technology, communication, reasoning and reflection under the one term 'Working Mathematically'. This learning strategy is embedded in each content section or Strand of the syllabus. Working Mathematically refers to five processes shown in Figure 2.1.

Questioning	Students ask questions in relation to mathematical situations and their mathematical experiences. Encouraging students to ask questions builds on and stimulates their curiosity and interest in Mathematics. 'I wonder if' and 'what if' types of questions encourage students to make conjectures and/or predictions.
Applying Strategies	Students develop, select and use a range of strategies, including the selection and use of appropriate technology, to explore and solve problems.
Communicating	Students develop and use appropriate language and representations to formulate and express mathematical ideas in written, oral and diagrammatic form.
Reasoning	Students develop and use processes for exploring relationships, checking solutions and giving reasons to support their conclusions. Students also need to develop and use logical reasoning, proof and justification.
Reflecting	Students reflect on their experiences and critical understanding to make connections with, and generalisations about, existing knowledge and understanding. Students make connections with the use of mathematics in the real world by identifying where, and how, particular ideas and concepts are used.

(Board of Studies NSW 2002, p.45)

Figure 2.1 Five processes of Working Mathematically.

There is a distinct emphasis on language and the ability of students to understand mathematical problems in order to be capable of not only communicating their ideas, but to question, broaden their understanding by applying strategies to develop reasoning and in turn reflect on the newly acquired knowledge. For each student, this can be accomplished at individual levels of learning and the framework of 'working mathematically' provides an opportunity for achievement at these levels, resulting in engagement in Mathematics.

The syllabus is outcome-based, arranged in Stages and Strands which follow a conceptual sequence from Early Stage 1 to Stage 5 rather than by age, providing six levels of achievement. Each outcome clearly defines the knowledge, skills and understanding which must be attained to fulfill the requirements at a particular stage. Strands include number, patterns and algebra, data, measurement, and space and geometry and these are further divided into sub-strands. Where this syllabus particularly differs from previous mathematic syllabi in NSW, is in the acknowledgment of student learning rates differing from student to student. As a consequence students progress according to their individual knowledge and understanding not their age. For example, a student in Year 7 might be attaining the outcomes at Stage 3 in geometry and Stage 2 in number, while another student may be attaining the outcomes at Stage 4 in number and Stage 2 in measurement.

The implementation of the strategies cited previously as 'Working Mathematically' is not mandatory but provides direction for the classroom teacher. The classroom teacher assesses each student, groups of students or the whole class on the most appropriate means whereby the outcomes for a particular content sub-strand may be attained. The syllabus provides very little direction on methods of assessment but encourages teachers to plan tasks "using a range of appropriate assessment strategies including self-assessment and peer assessment" (Board of Studies NSW 2002, p.167).

The syllabus is decisive in the importance of "assessment for learning" (Board of Studies NSW 2002, p.167). Continual feedback is required for teachers to assess their students' progress and enhance their teaching to improve learning. Students also are expected to assess their progress and take responsibility of their learning.

Quality Teaching in NSW Public Schools

In 2003 the NSW Department of Education and Training, Professional Support and Curriculum Directorate presented to all New South Wales teachers a discussion paper addressing teaching and learning in New South Wales public schools. Its aim was to address quality teaching in New South Wales public schools across all Key Learning Areas (KLA's).

The paper provides a model for three dimensions of teaching – high levels of Intellectual Quality, promoting a Quality Learning Environment and providing Significance to students' work. Each of these dimensions has been divided into elements as shown in Table 2.1.

Table 2.1 The dimensions and elements of the NSW model of pedagogy
(New South Wales Department of Education and Training 2003, p.9)

Intellectual quality	**Quality learning Environment**	**Significance**
Deep Knowledge	Explicit quality criteria	Background knowledge
Deep understanding	Engagement	Cultural knowledge
Problematic knowledge	High expectations	Knowledge integration
Higher-order thinking	Social support	Inclusivity
Metalanguage	Students' self-regulation	Connected ness
Substantive communication	Student direction	Narrative

A number of elements are particularly relevant to the current study. These include Metalanguage and Substantive Communication in the Intellectual Quality dimension, all of the elements in Quality Learning Environment, and Background Knowledge, Inclusively and Connectedness in the Significance dimension.

The following Table 2.2 shows these specific elements with their detailed descriptors.

Table 2.2 Some elements relevant to this study of the model of pedagogy with descriptors
(New South Wales Department of Education and Training 2003, p.9)

Metalanguage	Lessons explicitly name and analyse knowledge as a specialist language (metalanguage), and provide frequent commentary on language use and the various contexts of differing language uses.
Substantive communication	Students are regularly engaged in sustained conversations about the concepts and ideas they are encountering. These conversations can be manifest in oral, written or artistic forms.
Explicit quality criteria	Students are provided with explicit criteria for the quality of work they are to produce and those criteria are a regular reference point for the development and assessment of student work.
Engagement	Most students, most of the time are seriously engaged in the lesson or assessment activity, rather than going through the motions. Students display sustained interest and attention.
High Expectations	High expectations of all students are communicated, and conceptual risk taking is encouraged and rewarded.
Social support	There is strong positive support for learning and mutual respect among teachers and students and other assisting students' learning. The classroom is free of negative personal comment or put-downs.
Students' self-regulation	Students demonstrate autonomy and initiative so that minimal attention to the disciplining and regulation of student behaviour is required.
Student direction	Students exercise some direction over the selection of activities related to their learning and the means by which these activities will be done.

Background knowledge	Lessons regularly and explicitly build from students' background knowledge, in terms of prior school knowledge as well as other aspects of their personal lives.
Inclusivity	Lessons include and publicly value the participation of all students across the social and cultural backgrounds represented in the classroom.
Connectedness	Lesson activities rely on the application of school knowledge in real-life context and problems.

This document emphasises the intended direction of the NSW Department of Education and Training in the immediate future. Its focus is on developing deep knowledge and understanding. Students are encouraged to think beyond skills acquisition, to applying them to relevant everyday problems. Assessment is based on the level at which students can demonstrate their understanding and ability to communicate their ideas

Summary

Both the Board of Studies NSW and the NSW Department of Education and Training present a strong commitment to encouraging students' ability to communicate mathematically, especially in relevant problem solving. The NSW Board of Studies especially emphasises the importance of students enjoying Mathematics and becoming self motivated. The NSW Department of Education and Training encourages among other objectives, deep understanding and knowledge incorporating meta-language and engagement. It is believed by both the NSW Board of Studies (2002) and NSW Department of Education and Training (2003), that ability to communicate ideas will lead students to engage and achieve in Mathematics. These documents provide a systemic background to this study.

FACTORS AFFECTING STUDENTS' ACHIEVEMENT IN AND ATTITUDES TOWARDS MATHEMATICS

This section will discuss research into students' achievement and the effect this has on students' engagement and disengagement.

Student achievement is the fundamental intention of pedagogy. Achievement can be closely linked with motivation and the levels of motivation are the major factors in determining students' engagement and disengagement, which in turn impacts on student behaviour (Middleton & Spanias 1999). Students who display good behaviour are generally engaged in their tasks and this engagement results in a positive effect on their achievement. Students' poor behaviour leads to disengagement, resulting in a negative affect on achievement and also a negative influence on their cohort who maybe distracted by their disruptive actions. Behaviour problems are reduced when students are engaged in meaningful tasks (Bradley 1994). Students need to be intrinsically motivated to engage in academic tasks, resulting in enjoyment, positive self-image, increased time on task and persistence and willingness to risk-take when faced with difficult tasks. More importantly, students who believe they are doing well in class tend to value Mathematics, although students must feel comfortable about Mathematics and expect to succeed before intrinsic motivation can begin (Middleton & Spanias 1999).

The National Council of Teachers of Mathematics (NCTM) has addressed the concern of students' engagement in their document Principles and Standards for School Mathematics (2000). It concurs with the previous research by suggesting that disengagement of many students especially in middle school mathematics, gives rise to serious problems for teachers and society. It cites a number of reasons for this disengagement, noting that Mathematics can be challenging, making motivation difficult for many students who find mathematical content uninteresting and irrelevant. Also parents and the media can have a

negative influence, by reinforcing students' belief that Mathematics is difficult. In addition to the reasons provided by National Council of Teachers of Mathematics (2000), inappropriate teaching styles or teaching materials and not addressing students' needs can contribute to this disengagement or lack of motivation (Larcome 1985). The NSW Board of Studies (2002) has addressed the disengagement of students in its most recent syllabus for Mathematics Years 7-10, requiring the curriculum to be designed to provide educational opportunities to engage and challenge students.

The literature provides many solutions to overcome negative beliefs and thus re-engage students. Students' intrinsic motivation can be enhanced by verbal praise and positive feedback, however these rewards must be only given when 'earned', as indiscriminate rewards may have a negative impact if the student still gains the reward even if the task is not completed to the student's standard (Cameron & Pierce 1994, 1996). Researchers emphasise the need for students to develop strategies for remembering basic concepts in Mathematics as students who constantly have difficulty retaining basic facts become disengaged (Chinn & Ashcroft 1992, Gersten & Chard 1999). The National Council of Teachers of Mathematics (NCTM 2000) when referring to disengaged students in middle grades state:

> teachers at those levels should work to keep students involved in relevant classroom activities, assign projects that make connections between mathematics and students' daily life, and allow students multiple avenues to display what they have learnt. Learning experiences based in the workplace have also proved effective in motivating students who are at risk of becoming disengaged from school.
>
> (p.374)

National Council of Teachers of Mathematics (NCTM 2000) continues

> although the challenge presented by disengagement is formidable, it is not insurmountable. Teachers need to uphold high expectations that all children should learn with understanding ..... by approaching traditional topics in ways that emphasis conceptual understanding and problem solving – many apparently uninterested students can become quiet engaged ..... teachers must help students be confident, engaged mathematics learners.
>
> (p.375)

NSW Department of Education and Training (2000), when referring to engaging students, states,

> schools and teachers who have changed to engage students more positively in their learning are seen as understanding that there will be many circumstances where improvement comes from schools and teachers changing as much as, if not even more than, students. In the teaching act, value should be added through the process to both students and teachers. Then students find the pedagogy engaging and the curriculum relevant, they behave and learn.
>
> (p.79)

Engagement, disengagement, beliefs, motivation, self-image, verbal praise and positive feedback which influence student achievement are indicators of the cognitive, affective and social domains. The cognitive domain relates to the ways students think, learn and develop their understanding of Mathematics, the affective domain considers students' anxieties,

beliefs, feelings and moods while the social domain refers to students' interactions with other students, teachers and also themselves. Research has focused on these domains in varying combinations (Foster 2002; Hannula 2002; Hembree 1990; Ledger 1993; Ma & Kishor 1997; Middleton 1995; Middleton & Spanias 1999; Rufell 1998). Particularly when considering engagement and disengagement, Wigfield & Meece (1988) connect the cognitive and affective aspects of mathematics achievement. Their research pertains to anxiety and suggests there is a correlation between students' beliefs in the importance of mathematics and the amount of time they are engaged in mathematical activities.

> researchers should now examine the antecedents of the affective and cognitive components of maths anxiety in the home and school environments in order to provide a better understanding of their developmental course ..... that intervention programs to alleviate the negative effects of maths anxiety must deal with both affective and cognitive aspects of maths anxiety.
>
> (Wigfield & Meece 1988, p.215)

The influences on students' attitudes towards and achievement in Mathematics in each of the cognitive, affective and social domains are now considered.

Cognitive Domain

Educational researchers have long focused on the acquisition of knowledge and theories of student learning. Piaget & Inhelder (1969) described a hierarchy of levels, linking cognitive development to biological development. They stressed the need for learners to progress through this hierarchy at their own pace, negating enforced acceleration. Cognitive development interrelates with an understanding of the environment and the construction of that understanding. Piaget described this understanding as adaptation and believed it is the essential ingredient of learning. Adaptation according to Piaget occurs in two ways, assimilation allowing the fitting of new concepts into existing concepts and association,

allowing the broadening of existing concepts. Piaget's ideas became the precursor to constructivist thinking where "each learner must construct meaning for him or herself ..... What a child learns is not a copy of what he observes in his surroundings, but is a result of his own thinking and processing" (Martin 1997, p.157). Bruner built on Piaget's work, and is generally credited with introducing "discovery" or "inquiry" learning.

These theories were developed further during the mid-90's when a debate developed regarding the benefits of relevant, mathematical tasks, in particular for students with learning difficulties (Scrugg, Mastropieri, Sullivan, & Hesser 1993; Sullivan, Mastropieri, & Scrugg 1995). Some researchers believed both higher order thinking students and learning difficulty (LD) students who were given coaching in thinking activities could recall and comprehend information more efficiently than if taught from a textbook (Scrugg, Mastropieri & Sullivan 1994). Others believed some higher ability students could benefit from inquiry learning but there was insufficient evidence to support success in students with learning difficulties (Ellis 1993). The increased number of "inclusion" classes, where students with disabilities are being taught alongside students who are achieving normally in schools today has made the debate more relevant (Mastropieri, Scruggs & Butcher 1997). The NSW Department of Education and Training approach can be defined as separate and connected learning (Keast 1999). Students learn differently, with some responding well to learning which is not connected to relevant tasks (separate) and those who need connection. Keast's (1999) research showed traditional mathematics emphases separate teaching and relates well to separate learners but alienates connected learners. These connected learners need classroom mathematics to connect with their day to day experience.

Misconceptions in the understanding of mathematical concepts can be addressed by the 'conflict teaching approach' which is based on Piaget's notion of cognitive conflict, where teacher and learner are able to discuss the learner's misconceptions (Swedosh 1999). Sloan, Daane & Giesen (2002) also believe there is a strong relationship between mathematics anxiety and learning styles discounting "global learning styles". They argue students are

analytic learners preferring "traditional, sequential and rule-based instruction" (p.86) and teachers should be taught to recognise the needs required by the learning styles of students.

Affective domain

Following Piaget, researchers in education began considering not only the cognitive development but also the emotional influences on learning. Bruner (1968) in contrast to Piaget claimed "any idea or body of knowledge can be presented in a form simple enough so that any particular learner can understand it in recognizable form" (p.84). He defined the three means by which concepts can be built as enactive (physical), iconic (visual), and symbolic (spoken language and written symbols). He considered the aspects of teaching that are essential for teachers to consider include assessing children's predisposition to learning, the structuring of the knowledge to be taught, the sequence in which the knowledge should be presented and the motivation and rewards provided. Bruner considered, as well as the cognitive domain, also the affective domain where delight and achievement comes with motivation and reward. Skemp (1971, 1979) took this further, by first considering the cognitive aspect of learning, seeing acquisition of knowledge as hierarchical, allowing individuals to organise their mathematical knowledge, but believed goals and motivation tell us how students learn. He discussed emotions, especially pleasure and displeasure, fear, anxiety, relief and security. Thus Bruner and Skemp when discussing the acquisition of knowledge and the level of understanding of the cognitive domain extended their thinking to include the affective domain.

Generally, the descriptors for the affective domain are attitudes, beliefs and emotions (McLeod 1992), while knowledge and thinking are considered to be the descriptors for the cognitive domain (Brown & Borko 1992). Mcleod (1992) develops this distinction by asserting beliefs, attitudes and emotions have varying degrees of intensity of response. Beliefs that develop over longer periods are of the cognitive domain, while emotions that

develop and disappear quickly are more likely to be of the affective domain. McLeod (1988) states "the terms beliefs, attitudes and emotions are listed in order of increasing affective involvement, decreasing cognitive involvement, increasing intensity and decreasing stability" (p.246). The words 'hot' and 'cold' have been enlisted to describe the word affect, comparing 'hot' to emotions and 'cold' to likes and dislikes (Mandler, 1988, 1989). Kazelskis (1998) is very convincing in considering negative and positive affects on Mathematics identifying

> the negative affect towards mathematics items indicates feelings of discomfort, restlessness, uneasiness and confusion ..... the positive affect towards mathematics items indicate a sense of ease, a lack of discomfort and the absence of fear.
>
> (p.628)

The NSW Board of Studies (2002) has followed these ideas, considering both the affective and cognitive domain. It states that Mathematics teaching should "encourage and enable all students to enjoy learning, and to be self-motivated, reflective, competent learners ..... assists students to maximize their achievement in Mathematics through the acquisition of additional knowledge, skills and understanding, values and attitudes" (p.5). Affective and cognitive domains are linked by stating "the aim of Mathematics in K-10 is to develop students' mathematical thinking, understanding, competence and confidence in the application of Mathematics their creativity, enjoyment and appreciation of the subject and their engagement in lifelong learning." (p.11)

Attitude and beliefs are aspects of the affective domain which specifically affect the students' ability to assimilate knowledge so as to engage in learning.

Attitudes

Attitude maybe defined as "a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or other person" (Aiken 1970 p.551). McLeod (1992) also discusses negative and positive feelings when referring to attitudes and cites them as affective responses, which have moderate intensity and reasonable stability and defines attitude towards mathematics simply as a positive or negative emotional response. Student tend to formulate their attitudes towards Mathematics between the ages of nine and eleven and these attitudes, especially when negative, are difficult to reverse, often persisting into their adult life (McLeod 1993; Newstead 1998).

'I dislike algebra!', 'I like geometry!', 'I find statistics boring!' are typical responses referring to attitude. Leder (1993) believes attitudes towards Mathematics vary. Just as there are many disciplines in Mathematics, there are different feelings about each of these disciplines. Middleton & Spanias (1999) use the term enjoyment when referring to attitudes towards Mathematics, finding in their examination of recent research, students may have enjoyed mathematics in primary school but as they progress into middle school their enjoyment decreases. Neale (1969) in his definition of attitudes links these to beliefs. Neale (1969) defines attitudes towards mathematics as

> a liking or disliking of Mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at Mathematics, and a belief that Mathematics is useful and useless. (p.632)

Beliefs

Beliefs tend to be cognitive in nature and relate to the importance of mathematics (Brown, Carpenter, Kouba, Lindquist, Silver & Swafford 1988) such as 'Mathematics is difficult!' 'The maths I do at school, I will never need!'

Beliefs are developed through experience (D'Andrade 1981), can be heavily influenced by parents (Parsons, Alder & Kaczla 1982) and the climate of the classroom (Schoenfeld 1989). Middleton (1995) describes the beliefs students and teachers have about motivation, finding students and teachers have similar beliefs regarding the interrelationship between arousal and control level for intrinsic motivation of mathematical activities. Teachers' perceptions of students' motivation are generally formed from their personal conceptions of intrinsic motivation with little understanding of the motivational beliefs of their students. Teachers should be more attentive to individual differences regarding student motivation (Middleton 1995) and be aware of their beliefs that what is best for a student does not necessarily equate to the real situation (Shield 1999). Teachers' ideals of what is right for a student may not necessarily fit the day-to-day pressures of teaching and it is necessary for teachers to make curriculum decisions to compensate.

Researchers consider a belief in self-worth and confidence coincides with achievement. There is a positive correlation between confidence and achievement in Mathematics (Reyes 1984) and this finding emphasizes the need for students to feel confident and have a positive disposition towards numeracy to be able to achieve, by applying their knowledge in the long term (Klein 1999). For students to gain confidence in learning Mathematics they need to interact with each other on a one to one base within a whole class environment, relying on each others' confirmations of their self worth (Foster 2002).

Opposing confidence is anxiety. Richardson and Suinn (1972) define mathematics anxiety as "feelings of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p.551). Ruffell, Mason and Allen (1998) provide a 'multidimensional' definition of attitude toward Mathematics consisting of three components relating to emotional response, beliefs and behavior towards Mathematics. Betz (1978) attributes the feelings of being "uncomfortable, nervous, uneasy and confused" (p.446) when describing students' anxiety towards mathematics and his research has found a high correlation between mathematics anxiety and test anxiety. Students who experience mathematics anxiety tend to display a negative performance and achievement in the discipline (Cooper & Robinson 1989: Engelhard 1990; Hembree 1990; Liebert & Morris 1967; Morris, Davis & Hutchings 1981; Richardson & Suinn 1972; Sarason 1986; Tocci & Englhart 1991; Wigfield & Meece 1988).

A strong correlation has been found between measures of dislike and anxiety about Mathematics, measures of performance in mathematical settings and measures of test anxiety (Brush 1978). Anxiety maybe equated with fear as a strong emotion (Hart 1989) as distinct from worry which is more of a cognitive response of anxiety resulting in negative expectations (Wigfield & Meece 1988). McLeod (1988) compares mathematics attitudes and anxiety believing attitudes are long term, small in intensity and either negative or positive while anxiety is more intense, negative and short term. Battista (1999) declares

> maths anxiety is widespread. So rampant is it in numeracy that there is little stigma attached to it. Many adults readily confess, "I was never good at Math" as if displaying a badge of courage for enduring what for them was a painful and useless experience. In contrast, people do not freely admit that they can't read.
>
> (p.426)

Much research has taken place on mathematics anxiety and its negative affect on performance, progress and achievement (Hembree 1990, Richardson & Suinn 1972; Wigfield & Meece 1988). This anxiety can relate strongly to disengagement where students may go as far as to avoid mathematics classes (Betz, 1978). Hembree (1990) in particular, found when considering mathematics anxiety "higher achievement consistently accompanies reduction in mathematics anxiety" (p.44) and it is possible to restore the performance of highly anxious students to a level of low mathematics anxiety by treating the cause.

Researchers are realizing that the affective domain is as important as the cognitive domain in informing teachers of student learning. Strategies include the improving of the emotional classroom climate to reduce anxiety and by increasing enthusiasm for learning by introducing problem solving which is relevant to students' experience (Brophy 1983, Thompson & Thompson 1989).

Social Domain

The social domain encompasses the way in which people relate with others and their environment. Research has shown collaborative learning to be a positive strategy for improving the classroom climate by providing students with opportunities for verbalization, allowing students to resolve conflicts in understanding, and giving students increased responsibility (Davidson 1985; Lindquist 1989; Phelps & Damon 1989; Yackel, Cobb, Wood, Wheatley & Merkel 1990). As discussed earlier, several reasons have been proposed as to why children present negative attitudes to Mathematics, including negative experiences in the early school years, parental attitude, and poor environment. Further suggestions have been made reversing negative attitudes. One such suggestion involves encouraging students to work in a cooperative learning environment where they are able to discuss their work with their peers (Newstead 1998).

Barnes (1998) believes collaborative learning is a form of classroom organization where students work together, in small groups, on a shared activity and with a common goal, using the terms collaborative learning and cooperative learning interchangeably. Cooperative learning describes an instructional arrangement for teaching academic and collaborative skills to small, heterogeneous groups of students (Rich 1993; Sharan 1980). "Cooperative learning is deemed highly desirable because of its tendency to reduce peer competition and isolation, and to promote academic achievement and positive interrelationships" (Rivera 1996, p.1). It can be implemented into a learning program for both students with or without learning difficulties to improve their mathematics achievement (Slavin, Leavey,& Madden 1984; Slavin, Madden, & Leavey 1984). Cooperative learning also fulfils the requirements of the National Council of Teachers of Mathematics (NCTM 1991) which suggests that learning environments should be created that promote active learning and teaching; classroom discourse; and individual, small-group, and whole-group learning. Verschaffel & De Corte (1997) concur, by suggesting a "problem-oriented approach to mathematics education" (p.599).

While facilitating student learning may be recognised as a positive benefit of a cooperative learning strategy, Slavin (1989) suggests research needs to consider other parameters for its most successful implementation. Some studies have investigated variables such as the nature and purpose of the task, the learning strategies employed, the occurrence of academic disagreement among group members, the time spent on task, the support and feedback of peers in the group, the ability levels of group members, the composition of the group, the role of the teacher in preparing students for small group activities, classroom management, the age of the students, and the role of explanations given and received within the group (Good, Mulryan & McCaslin 1992; Johnson & Johnson 1985; Noddings 1989). As well as these benefits, disadvantages such as students not extending their meta-cognitive potential when working collaboratively in problem solving but opting for the most assessable rather than the appropriate result, have been presented in research by Stacey (1992).

Research shows that collaborative learning strategies in Mathematics are of particular benefit to girls (Leder 1993). It has been found that working collaboratively rather than competitively suits the preferred learning styles of most girls; girls generally have good communication skills and benefit from and enjoy discussion; small collaborative groups facilitate "connected" learning and support and encourage risk-taking; and collaboration results in a less hierarchical classroom (Cordeau 1995; Jacobs 1994; Morrow & Morrow 1996; Solar 1995). Girls tended to achieve better in Mathematics in a collaborative environment (Peterson and Fennema 1985). More recently, Boaler (1997a; 1997b; 1997c) made a comparative study of two schools with very similar populations, one using an approach based on collaboration and open-ended inquiry, and the other a traditional textbook-based approach. In the first school, girls reported increased confidence and enjoyment of Mathematics, whereas girls at the second school reported widespread disaffection, lack of confidence and a feeling that they were not being given a chance to understand.

SOLVING WORD PROBLEMS IN A COOPERATIVE CONTEXT

The solving of word problems can be successfully implemented into a cooperative learning strategy. Word problems in Mathematics, as used in this study, involve questions written in usually simple sentences incorporating the four mathematical operations: addition, subtraction, multiplication and division. An example of a word problem would be: There are 22 students in 7G and 26 students in 7O. How many students altogether? A more complicated word problem requiring deep understanding and knowledge, could be termed problem solving, a term often used in the research literature. Traditionally students are taught procedures without the opportunity to develop ways of thinking to enhance their problem solving skills. As a consequence they forget them, so the ideas must be taught year after year. Klien (1998) coined the phrase, "mathematics-as-usual", where students believe

if they listen to teacher's explanations, relating them to various problem solving questions, they will learn mathematics 'best'. Battista (1999) advocated a 'sense making' curriculum where problem solving is relevant to the students' general experiences allowing ideas to be retained for long periods providing an opportunity to build on existing knowledge. Boaler (1998) compares the traditional approach to Mathematics with an open, project-based environment. The former provides procedural knowledge that is of little use when confronted with unfamiliar situations while the later develops conceptual understanding, which have broader applications.

Problem solving methods and peer collaboration have positive effects on academic motivation, academic self-concept and social self-concept, especially with low achieving students (Campbell & Evans 1997; Cobb et al. 1992; Ginsburg-Block & Fantuzzo 1998; NCTM 1989, 1991, 1995, 2000). NCTM (2000) proposes that further study needs to evaluate fully the effectiveness of such approaches showing concern as to whether these methods are actually reaching the classroom.

While Koller & Schnabel (2001) confirm that "the relation between academic interest and mathematics achievement is moderated by changes in the instrumental settings ..... and the associated positive and negative consequences" (p.466). Nevertheless good teaching relies on knowing when to intervene in the learning process and being flexible in strategies, which may help students when motivation is necessary (Chinn 1992). This maybe as simple as being aware that certain students do not understand or have problems understanding the basic number facts (Cumming & Elkins 1994). It may be necessary when developing arithmetic word problems to form a link between reality and language which in turn links with written symbols and these links be imbedded in students' cognitive structures (Lean, Clements & Del Campo 1990).

When considering addition and subtraction in one application arithmetic word problems, Heller and Greeno (1978) developed a classification system where the operations relate

directly to one of three semantic schemas, Change, Combine or Compare. There are six problem types in the change schema, combining start, change and result, with a direction of increase and decrease. In the combine schema there are two disjointed subsets and a superset which is the union of the two subsets. The compare scheme also has six problem types related to the direction of more or less, being referent, different and compared. Herbel-Eisenmann (2002) provides a mathematical language framework, consisting of three categories, where students can be encouraged to accrue layers of meaning. Contextual language is dependent on specific, re-occurring contexts or situations. Bridging languages divides into classroom generated language, which is generated by teacher-student and transitional mathematical language describing a location or process that is associated with particular representation. Official mathematical language would be recognised by the general mathematical community.

The process of performing and learning when engaged in problem solving requires meta-cognitive and meta-affective processes and interactions in the classroom (Gomez-Chacon 2000). Both cognitive and affective domains are essential considerations when investigating students' processing of mathematical problem-solving (Gomez-Chacon 2000).

SUMMARY

With the aim of determining the advantage of communication when solving word problems in Mathematics and its influence on students' attitudes and achievement leading to engagement or disengagement in Mathematics, Chapter One reviewed the literature and research on students' achievement and attitudes, the cognitive, affective and social domains, cooperative learning and the solving of word problems.

In the first section of this chapter, both the NSW Board of Studies and the NSW Department of Education and Training support the importance of students' ability to solve relevant problem solving.

The second section of Chapter One shows a considerable amount of research has been undertaken on students' attitudes and achievement and also the cognitive, affective and social domains. There has also been significant research recently into cooperative learning and problem solving.

Despite the NSW Board of Studies and the NSW Department of Education and Training emphasis on language, communication and the importance they place on problem solving, in particular word problems, and also the expectation of employing cooperative learning as a teaching strategy, very little research has been undertaken to assess the effect of this strategy on students.

This conclusion, initiated the teacher/researcher to devise the research question:

> **In what ways does a program of targeted intervention using cooperative learning strategies to aid the decoding of word problems influence students'**
>
> 1. **achievement on tests of mathematical word problems; and**
> 2. **attitudes to Mathematics in the cognitive, affective and social domains?**

The following chapter will describe the design of the investigation into cooperative learning as a communication strategy to improve the decoding of word problems.

Chapter 3

RESEARCH DESIGN

Introduction

Chapter Two began by discussing two documents recently instated in New South Wales schools as reference for the teaching of Year Seven mathematics students. These documents, Mathematics Years 7 – 10 Syllabus (Board of Studies NSW 2002), a mandatory document, and Quality Teaching in NSW Public Schools (New South Wales Department of Education and Training 2003) emphasized the importance of students engaging in positive communication in relevant problem solving. The chapter continued with an evaluation of the related literature regarding students' attitudes and achievement, especially referring to the cognitive, affective and social domains.

Chapter Three describes the research design that has been developed to investigate the research question posed. It has been divided into five sections. The first section briefly describes action research as the methodology selected to investigate the research question. The second section describes the data collection methods. It also explains the strategies employed by the researcher to control bias and to ensure objectivity. The third section provides a detailed description of the participants and the procedures employed in the study. The fourth section describes the process by which the data was analysed. The teacher/researcher formulated a method of coding for analysing the responses to the questionnaires and tests administered to the students during the data collecting period. The final section in this chapter evaluates the research design. It discusses the strategies used to strengthen the validity and reliability of the investigation.

RESEARCH METHODOLOGY

This section considers the research method chosen for this investigation. Both quantitative and qualitative approaches were used within an action research framework. These terms will be briefly discussed prior to considering action research.

Quantitative and Qualitative Research

Qualitative research, in particular ethnographic research, has been increasingly used to investigate social science since the 1980's (Huberman & Miles 2002). It has the major characteristic of being naturalistic, studying people, things and events (Punch 2001). Further, specifying educational research, Cohen, Manion and Morrison (2001) give two reasons for the usefulness of this method, arguing it adapts naturally to the classroom environment and preserves the integrity of the classroom situation. The essential idea of ethnographic research is its interest in "the meaning of actions and events to the people we seek to understand" (Spradley 1980, p.5). There has been an ongoing debate since the mid-1960's regarding the usefulness of quantitative versus qualitative research as well as the use of incorporating both forms of research to gain a full understanding of an inquiry (Bouma & Ling 2004). The teacher/researcher's challenge was to find an equitable balance to provide data which would result in conclusions which have validity and reliability.

Action Research

This research emerged out of a need, observed by the classroom teacher, who was also the researcher. She had become aware of the students' difficulties in interpreting word problems and the negative attitudes they expressed towards their ability in Mathematics. It was decided to conduct an action research study to investigate these issues with the purpose

of establishing a method for students to improve their processes for decoding word problems and ultimately improve their attitudes towards and achievement in Mathematics.

Kemmis and McTaggart (1992) developed a "guide for teachers and administrators interested in improvement and change in their schools" (p.1), defining action research as:

> a form of *collective* self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out .... The approach is only action research when it is *collaborative*, though it is important to realize that the action research of the group is achieved through the *critical action* of individual group members.
>
> (p.1)

The classroom teacher became the participant observer and the researcher. A participant observer, as well as observing the activities of a particular group is a member of the group (Bouma & Ling 2004; Sarantakos 1993). Throughout this study the term 'teacher/researcher' will be used to denote the teacher/researcher role. Initially the teacher/researcher identified a thematic concern (Kemmis & McTaggart 1992), which was the students' attitude toward Mathematics and their difficulties in solving word problems due to poor literacy skills. This concern questioned a link between developing in students an understanding of the language of word problems and a positive improvement in their attitude towards and achievement in mathematics. In identifying the thematic concern, action research engages four fundamental aspects (Kemmis & McTaggart 1992). These aspects form a spiral involving the development of a plan, implementing the plan, observing the effects of the implementation of the plan and reflecting on the observations in order to develop a reformed plan, implementation, observation and reflection.

The plan proposed by the inquiry was to change the social intercourse of the classroom and have students work in groups. By giving them a tight framework of cooperative groups and a scaffold of word problems in which to work, it was hypothesised that it would be possible to improve students' cognitive, affective and social domains and in turn positively affect their attitudes toward and achievements in mathematics. The three domains were identified as important by a consideration of the literature on attitudes towards and achievement in Mathematics (see Chapter 2). The students were consulted and the proposed activities described, so that they were fully informed about the aims and processes of the teaching interventions, in line with the collaborative principles of action research.

The plan's implementation occurred over a four week period. It involved pre- and post-tests and questionnaires and collaborative lessons with the teacher/researcher and a teachers' aide actively participating in the lessons. The lessons were observed by the teacher/researcher and teachers' aide and audio taped. Discourse between the teacher/researcher and teachers' aide allowed evaluation of each of the collaborative lessons which in turn affected the direction of subsequent lessons. Finally reflection on the completed sessions provided the opportunity for the teacher/researcher to plan further activities for the students.

This section identified the problem (thematic concern) as attitudes towards and achievement in Mathematic. A theoretical framework involving cognitive, affective and social domains was identified from the literature and then the focus was refined to word problems and cooperative groups prior to the plan being developed.

DATA COLLECTION METHODS

This section describes the process employed by the teacher/researcher for this inquiry. It comprises four data collecting methods, which include tests, questionnaires, audio–taping of class sessions and observation notes. A number of methods of data collection were used to maximize the reliability and validity of the research. The range of methods also provided an opportunity to investigate in detail the extent of the students' progress in their attitudes towards and achievement in Mathematics when involved in a cooperative learning program to improve their decoding of word problems.

In order to provide an overview of the data collecting process a timeline has been provided. This will be followed by a description of the process. Finally in this section each of the data collection methods will be described.

Timeline

The initial data was collected over a seven week period. A further test based on the questions asked in Week One and Week Seven was conducted after the Christmas holiday break to determine the extent of retention. Table 3.1 provides an overview of the activities which occurred during weeks one to seven and eight weeks after the initial collecting period. These are described in detail in the next section.

Table 3.1 Overview of the data collecting period.

Week	1	2	3	4	5	6	7	15
			Cooperative Learning Program 1 (CL1)	Cooperative Learning Program 2 (CL2)	Cooperative Learning Program 3 (CL3)	Cooperative Learning Program 4 (CL4)		
Activity	Questionaire Test Introduce audio-tape	Cooling off period	Word Matching	Squaresaw	One-step Word Problems	Two –step Word Problems	Questionnaire Test	Test

Data Collecting Process

The data-collecting period consisted of five stages. The first stage involved a questionnaire and test (See Appendix B), administered during one classroom period. The questionnaire was developed from two sources, the Fennema – Sherman Mathematics Attitude Scales (Fennema & Sherman 1976) and the Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn 1972), to evaluate the students' attitudes towards Mathematics. The mathematics test, devised by the teacher/researcher, assessed the students' initial and final achievement regarding word problems. Neither the questionnaire nor the test was outside the common classroom practice.

The second stage was a one week familiarisation period. During this time students continued with the normal classroom routine following the program devised from the syllabus. The only variation involved the introduction of a tape recorder during the lessons. The information gathered from the tape recordings did not become part of the data collection. This stage allowed the students to become accustomed to the audio-taping of the lessons.

The third stage consisted of a four-week period where one teaching period each week allowed the teacher/researcher to actuate a cooperative learning lesson to develop word

problem skills. This followed usual group work procedures with specific word problem teaching strategies. The students were divided into two groups with the teacher/researcher observing one group and the teacher's aide observing the other, alternating each lesson. A Year Ten student who was familiar to the students participated in the final lesson. During this stage the groups' discussions were audio-taped and observations noted by both the teacher/researcher and the teacher's aide.

The fourth stage consisted of re-administering the original questionnaire and test immediately after the teaching intervention.

The final stage involved the administration of the original test, approximately eight weeks after the end of the teaching sequences, after the Christmas break. The questionnaire was not administrated again because it was felt that the students were now in different classes and that this would be likely to affect their responses.

Instruments

Questionnaires

The questionnaire implemented in the research was developed from two scales: Fennema-Sherman Mathematics Anxiety Scale (Fennema & Sherman, 1976) and Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972).

The Fennema-Sherman Mathematics Anxiety Scale (Fennema & Sherman, 1976) is a scale consisting of nine components for evaluating feelings of anxiety.

Confidence in Learning Mathematics
Attitude towards Success in Mathematics
Usefulness for Mathematics

Mathematics Anxiety
Mother
Father
Teacher
Mathematics as a Male Domain
Effective Motivation in Mathematics.

The scale is intended to assess "feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics" (Fennema & Sherman, 1976, p.4). The responses used a Likert scale.

The Mathematics Anxiety Rating Scale (Richardson and Suinn 1972) was targeted initially at adults, therefore many of the questions focused on non-school situations. This scale also used a Likert format.

When developing the questionnaire for this study the teacher/researcher selected particular aspects of these scales, such as questions relating to confidence, attitude, usefulness, anxiety and motivation as they reflected the intent of this study. The teacher/researcher focused initially on the Fennema-Sherman Mathematics Anxiety Scale as confidence, attitude, usefulness, anxiety and motivation related directly to five of the nine components of the scale. Having made the selection of questions from this scale the teacher/researcher then compared these questions with similar questions in the Mathematics Anxiety Rating Scale-MARS. The teacher/researcher considered it necessary to keep the questions to a minimum, short and concise in length, as the subjects had a short attention span and could easily lose motivation if the questionnaire became too laborious. The questions were rephrased to form complete statements. For example, "Walking into a maths class" (Richardson & Suinn 1972, p.554) was rephrased by the teacher/researcher as 'I enjoy walking into a mathematics class' (Appendix B - Instruments). The final questionnaire consisted of twenty three questions. The questions comprised seven in the cognitive

domain, ten in the affective domain and six in the social domain. The domains were random in placement. Even though the questionnaire only consisted of a small number of questions there was the opportunity to use cross-checking responses by including some questions worded in different ways, including negatively. For example, Question Thirteen of the questionnaire states 'I feel good about Mathematics' (Appendix B - Instruments), while Question Ten states 'Mathematics makes me feel uneasy and confused' (Appendix B - Instruments).

A four-point Likert scale was employed to gauge the subjects' responses. In order to obtain a definite result, undecided was omitted. The responses to each question in the questionnaire required one of four alternatives: Strongly Agree, Agree, Disagree, and Strongly Disagree.

Test

The word problem test (Appendix B - Instruments) administered during the research was developed by the teacher/researcher. The teacher/researcher's extensive prior experience in formulating word problems based on the operations of addition, subtraction and multiplication along with their associated synonyms formed the questions for the word problem test. The questions devised by the teacher/researcher were similar to mathematical word problems the students would encounter in their normal classes. Thus questions were relevant to the students' normal experiences and adjusted to the students' level of cognitive development. Initially there were fifteen questions, thirteen consisting of one operation and two consisting of two operations. The word problems comprised four additions, four subtractions, five multiplications, one with two multiplication operations and one with a multiplication and a subtraction. Division was omitted by the teacher/researcher as she believed this would only result in added difficulty for the students. The initial test was marked shortly after it was administered to the students. The teacher/researcher became aware that a number of the students managed the one operation questions but found

difficulty with the two operation questions. The teacher/researcher, acting on this revelation, decided to further test the two operational word problems by adding some additional two-step problems in order to extend the students' capacities, as the initial test appeared too easy and did not give a true indication of the students' ability. The new composition of two-step problems consisted of two multiplications and subtraction problems, two multiplications and addition problems and one double subtraction problem.

Cooperative Learning Program

The teaching intervention consisted of a four-week period where one teaching period each week was utilised to administer a cooperative learning program to develop word problem skills. This followed usual group work procedures with specific word problem teaching strategies. The students were divided into two groups with the teacher/researcher observing one group and the teacher's aide observing the other, alternating each lesson. During this stage the groups' discussions were audio-taped and observations noted by both the teacher/researcher and the teacher's aide. Student's work samples and comments were also collected as part of the data. Each lesson took a different focus as described below.

* Cooperative Learning Program 1 (CLP 1) – Word Matching

The teacher/researcher initially introduced the students to targeted words, synonyms for the arithmetic operations, by placing the symbols +, -, ×, ÷ at the top of four columns and showing these on the overhead projector. Each word was then displayed for the students to read, and then indicate to which column (first, second, third or fourth) the word belonged. (Appendix C - Activities) The teacher/researcher practiced these targeted words until the students became familiar with the process.

The teacher/researcher then explained how the students were to divide into groups. Each group was given their own set of 76 word cards, which were divided evenly between each member of the group. Each student in turn placed a card on the appropriate symbol. When

they completed this task, the teacher/researcher then allowed the group to play a game of dominos placing similar words together.

Cooperative Learning Program 2 (CLP 2) – Square-saw

A square-saw is a word matching activity where a grid has questions and matching solutions are placed on adjacent sides of the squares (tiles). The grid is cut out and shuffled. The students are required to reassemble the grid, so that the questions match the answers. The students were shown by the teacher/researcher on the board how to complete a square-saw with students discussing where to put the tiles. The students then divided into groups and worked together to complete the square-saws. (Appendix C - Activities)

Cooperative Learning Program 3 (CLP 3) – Word Problems

In this lesson the teacher explained to the students that each group would be given an envelope containing a number of word problems and a table for recording the answers to the word problems (Appendix C - Activities). It was stressed to the students that the aim of the exercise was to decide on the operation used in each question rather than answering every question quickly. This operation was first to be recorded for all problems, and then students could use their calculators to work out their answers.

Cooperative Learning Program 4 (CLP 4) – Two–Step Word Problems

This lesson was similar to CLP3, except that the problems consisted of two steps. Both operations had to be identified before the students attempted to work out the answers.

Audio-tape

Audio-tapes were employed by the teacher/researcher in this study to obtain a record of the discussions occurring in the class work at the beginning of each session and the group work for each session, following the process used by Chick and Watson (2002). The lessons analysed were audio-taped to identify the indicators that relate to the impact of cognitive,

affective and social interaction when resolving word problems in Mathematics. The students were introduced to this method of data collection, initially by incorporating an audio recorder into four normal classes, during the cooling off period, prior to the actual audio-taping and after the administration of the initial test.
The students were told that these initial tape recordings would not become part of the data analysis, and further, no one would listen to these tapes, including the teacher/researcher. During the actual data collecting period one audio recorder was employed for the class discussion at the beginning of each period. Then since the class was then divided into two groups for cooperative learning, two audio recorders were employed. Each audio-tape was clearly identified with the date, the lesson number, the group and the absent students at the conclusion of each recording.

Observation notes

Observation notes were recorded at the conclusion of each lesson following discussion between the teacher/researcher and the teachers' aide.

This section described the data collecting methods, specifically questionnaires, tests, audio–taping of class sessions and observation notes selected by the teacher/researcher in order to investigate the research question. The next section will describe the context, participants and procedures involved in this inquiry.

CONTEXT, PARTICIPANTS AND PROCEDURES

This section has been divided into five parts. The first part discusses the context of the investigation, while the second, third and fourth parts provide a detailed description of the students, teacher/researcher and teachers' aide who were participants in the project. The final part provides an overview of the procedure to ensure ethical issues were observed.

The Context

As described in Chapter One, this investigation was conducted in a government comprehensive high school located in the lower Blue Mountains, about 80km west of Sydney, NSW. The school at the time of the investigation had a student enrolment of 709. The culture of the school would be considered conservative and the mathematics faculty mostly employs a teaching strategy of 'chalk and talk'. As an initiative of the NSW Department of Education and Training, funding was provided for students targeted as requiring special attention as they progressed from primary school to secondary school. The teacher/researcher was appointed by the Principal to teach the class comprising of these students.

The Subjects

The students chosen for the study were aged eleven or twelve. Of the ten students, six were boys (Jo, M, B, Tr, A, S) and four were girls (K, Je, E, N) and all were of white, Anglo-Saxon origin.

At the time of the data collection, the students' mathematical achievement ranged from lower Stage 1 to upper Stage 2. The Board of Studies NSW (2002) refers to Early Stage 1 to Stage 6, where the Stages relate to "the level of knowledge of mathematics learning rather than to the stages of schooling" (p. 8). Students enter the New South Wales education system in Kindergarten at Early Stage 1 and may complete their secondary education at Stage 6. At Early Stage 1, students should be developing an understanding of numbers to ten, while upper Stage 2 should be able to operate numbers to 100. N, who performed at a lower Stage 1, has a congenital intellectual impairment and it was believed by her family that she would benefit by attending the comprehensive school to broaden her social interaction. Socially well adjusted with a bright personality, N worked at all her class work at the level she understood. K, Je, A and S performed at lower Stage 2 while Tr, Jo, M, B and E performed at an upper Stage 2. Tr tended to be very outward going, constantly

commenting in an incoherent manner to draw attention to himself. Jo though talkative, was interested in impressing the teacher and his peers with correct answers to questions which were presented to him. A, also talkative with a happy disposition, always tried to answer questions but rarely thought before answering and just said what came into his head. K and Je sat very quietly. K displayed apprehension in answering questions and when she did speak, spoke very quietly. Je sat quietly, answering questions in her work book. When questioned, her answers were wrong and she displayed no motivation to correct the incorrect answers, accepting the answers she gave as correct. B appeared to be shy and avoided any recognition from the teacher. E displayed determination in her work, was outspoken in class discussion and irritated by others if things didn't go the way she wanted. M could be outspoken, but was nevertheless shy and would bend under authority. He tended to be very funny, fully realising this potential.

The Teacher/Researcher

The teacher/researcher who conducted the inquiry was the classroom teacher and thus the participant observer. A number of prior studies have taken this approach (Hannula 2002; Williams and Ivery 2002). Having taught the class for approximately nine months prior to the data collecting period, a positive and trusting relationship had developed with the students. Since the teacher/researcher had developed this positive and trusting relationship with the students it was possible to become part of the group without intimidating the other members of the group.

The teacher/researcher had been teaching for fifteen years as a mathematics teacher in the NSW comprehensive secondary school system. Even though the culture of teaching Mathematics at the school where the data was collected had been teacher centred the teacher/researcher had explored using cooperative learning and therefore had some experience in the strategy. Since the inclusion of intellectually and behaviourally challenged students into the main stream comprehensive system, the teacher/researcher

found it necessary to teach a wide range of learning abilities in one class. Where many students in Year 7 would be working at a Stage 3 or a Stage 4 level it had become increasingly necessary to teach students at a Stage 1 or Stage 2 level. The teacher/researcher had developed a particular interest in the strategy of cooperative learning, considering the students' attitudes and achievement in relation to their engagement.

Teacher's Aide

The teacher's aide was an auxiliary staff member with little experience in Mathematics. She had been assisting the teacher/researcher during the year and had displayed a caring and gentle nature especially towards lower ability students. This compassion led the teacher/researcher to invite this teacher's aide to participate in the investigation. Her role was to facilitate one of the groups during the cooperative learning sessions.

Procedures

Ethics permission was sought via the University of New England processes, with confidentiality assured for the participants. In order to administer the research, permission was sought from the New South Wales Department of Education and Training as well as the Principal of the school where the investigation was to be conducted. The letters (See Appendix A) provided a synopsis of the intent of the inquiry, the interest and position of the teacher/researcher, the subjects of the research, how the research would benefit the involved students and other students in the New South Wales school system, how the school would be involved and the timeline of the research and finally specific ethical questions regarding confidentiality for the students and the school.

The principal arranged a meeting with the teacher/researcher to discuss specific aspects of the preparation for the research, especially the contact with the parent/caregiver and the

permissions requested from both the parent/caregiver and the student. It was suggested, the Principal would become a reader and the Head Teacher of Mathematics would also be closely involved.

The letter was formulated to both the student and the parent/caregiver (Appendix A - Administration), similar to the letter presented to the New South Wales Department of Education and Training and the Principal. A consent form was enclosed. The letters were posted to the student's addresses. After one week, the time by which the parents/caregivers and students were to return the consent forms, the teacher/researcher personally contacted the remaining parent/carers and gained agreement.

This section described the context, participants and the procedures involved in this investigation. The following section will outline the methods of presentation of the results of the data analysis.

DATA ANALYSIS

The findings of data collected for the investigation into a program of targeted intervention using cooperative learning strategies will be presented and described in Chapter Four. This section provides a brief description of the tables and figures used to interpret this data. The section has been divided into four parts, definitions of terms, questionnaires, tests and audio-tapes transcripts and coding.

Definition of Terms

Beginning refers to the period prior to the cooperative learning program.
End refers to the period at the end of the cooperative learning program.
Later refers to approximately eight weeks after the end of the teaching sequences, following the Christmas break.

Questionnaires

The questionnaire was presented to the subjects at the Beginning and the End of the cooperative learning period. Since the data for the questionnaire was collected over a period of time the information has been displayed using a time-ordered matrix (Miles and Huberman, 1984).

Analysis of the Questionnaires

The results of the questionnaire are presented as line graphs as depicted in Figure 3.1. The figures provide the results for the questionnaire administered at the beginning of the cooperative learning program and at the end of the cooperative learning program. This figure displays how the results of the cognitive domain will be displayed in Chapter 4 – Research Analysis and has provision for eight (8) responses. Further figures are provided in the results, with the affective domain allowing ten (10) responses, while the social domain allowing six (6) responses. The questionnaire questions were written in both negative and positive formats using a four-point Likert scale strongly agree, agree, disagree, and strongly disagree, however when displayed on these graphs the results were interpreted so as to give a one-directional response. The figures will indicate in Chapter 4 how the students scored on the response continuum by their initials.

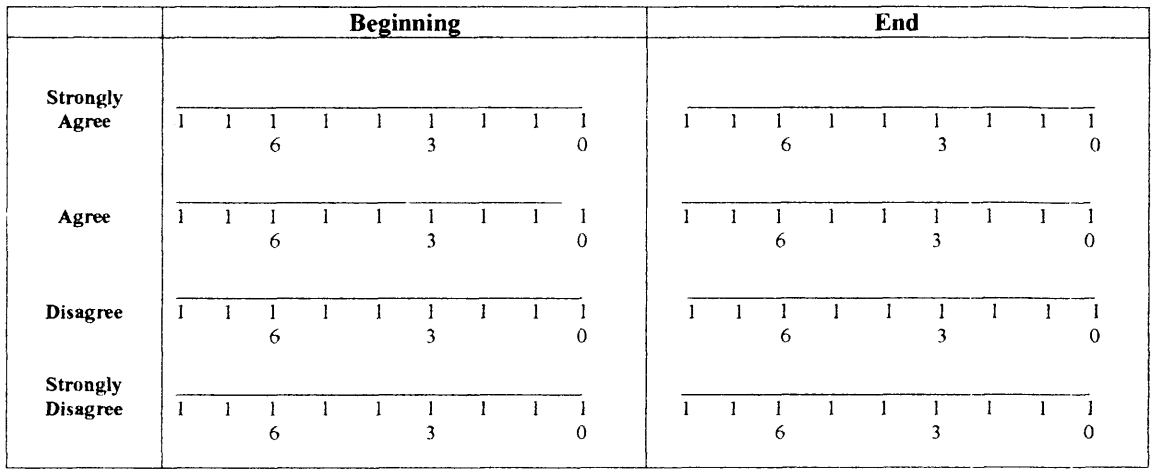

Figure 3.1 Results of the Questionnaire – Cognitive

Tests

The test was presented to the subjects at the beginning and the end of the cooperative learning period and approximately eight weeks after the end of the teaching sequences, following the Christmas break. Since the data for the test was collected over a period of time the information has been displayed using a time-ordered matrix (Miles and Huberman, 1984).

Analysis of the Test

The results, of the beginning Word Problem Evaluation Test, are presented in Figure 3.2. As in the questionnaire, the numbers on each line provide the correct scores for each student, depicted by their initial.

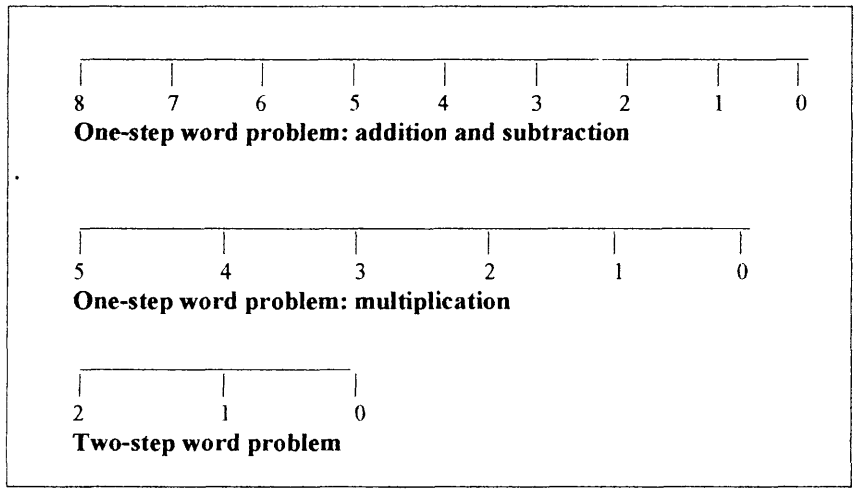

Figure 3.2 Results for initial Word Problem Evaluation Test

Figure 3.3 describes the presentation of all the results for the One-step operation: addition and subtraction at different points in time. It uses a similar type of display to that used for the overall results shown in Figure 3.2. Similar figures are presented in Chapter 4 for One-step operation: multiplication and Two-step operation: combining addition, subtraction and multiplication.

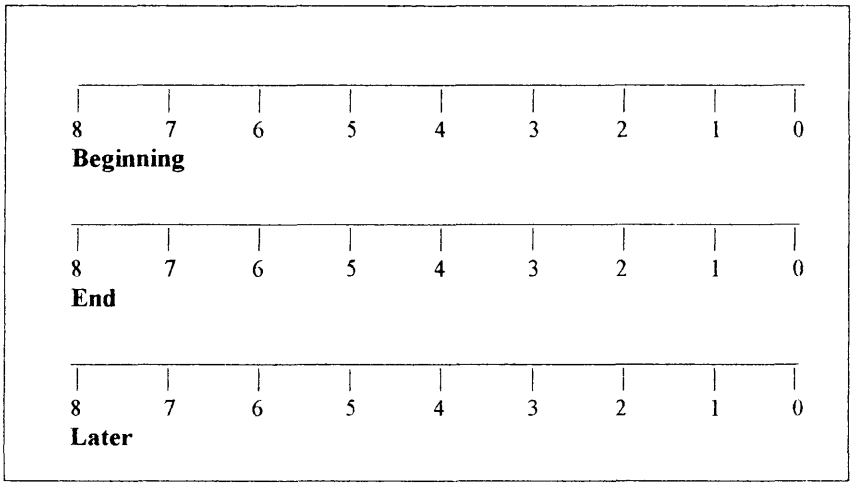

Figure 3.3 Results for One-step operation: addition & subtraction

Audio-tapes Transcripts and Coding

Table 3.3 provides an example of the group configuration of the Cooperative Learning Program. It displays the week in which the program takes place and the students involved in the particular group.

Table 3.3 Example of Group configuration for Cooperative Learning Program – Specifically CLP1

Cooperative Learning Program 1 (CLP1) Word Matching Week 3			
Group One		**Group Two**	
Students	**Facilitator**	**Students**	**Facilitator**
A Je K N Tr (absent)	T	B E Jo(absent) M S	T

Table 3.4 provides an example of the presentation of the results of the number interactions within each group during the Cooperative Learning Program, in particular Cooperative Learning Program 1. Here, each of the domains, are displayed in relation to the group and the participants. The scoring is displayed according to the legend. The P refers to a positive response, the C refers to a constant response and the N refers to a negative response. These responses will be further described in Table 3.5. For clarity the percentiles in the actual results have been presented as decimals to clearly distinguish between the totals.

Table 3.4: Example of Results of the verbal interactions for Cooperative Learning Program – Specifically CLP1

Group	Participant	Cognitive			Affective			Social			Task		
		P	C	N	P	C	N	P	C	N	O	N	Total
1	A Je K N Tr												
Group Totals													
Percentile													
2	B E Jo M S												
Group Totals													
Percentile													
Lesson Totals													
Percentile													

Number of verbal interactions: ○ ⇒ **0,** ◒ ⇒ **1 – 5,** ◓ ⇒ **6 – 10,**
● ⇒ 11-15, * ⇒ **> 20**

When analysing the transcribed audiotapes of the cooperative learning program, cognitive, affective and social interaction were identified as indicators. Each of these three categories was further divided into positive, negative and constant as sub-categories. A positive comment occurred when a comment was affable and intelligent and a negative comment would be discourteous or unreasoned. A constant comment displayed, neither affable or discourteous nor intelligent or unreasoned. Table 3.5 defines the coding descriptors used in the analysis of the transcripts of the audio-tapes.

Table 3.5 Coding Descriptors for the analysis of transcripts of audio-tapes

Coding Descriptors		
Code	**Descriptor**	**Example**
CP	Cognitive positive	* answering a word problem correctly * positive ideas about a word problem
CC	Cognitive constant	* reading a word problem
CN	Cognitive negative	* answering a word problem incorrectly * coping other students without thinking
AP	Affective positive	* making a positive comment about oneself * exclamations of enjoy and contentment
AC	Affective constant	* an exclamation which displays no feeling
AN	Affective negative	* making a negative comment about oneself * avoiding answering a question for fear of making a mistake
SP	Social positive	* giving support, agreement to other students * sharing information * asking permission of other to do something * asking for help * acknowledgement of others positive input * including group members * affirmative answer, showing positive involvement
SC	Social constant	* referring to someone by title. * polite interaction when on task but not clear on complete discourse. * hand over question to someone else
SN	Social negative	* not wishing to be involved in the group work * pressure on one student to answer a question * giving instructions in an argumentative way * rudeness * swearing * display of annoyance or irritation put down
PT	Procedural on task	* discussing an issue related to the task
PFT	Procedural off task	* discussing an issue which is unrelated to the task * changing the direction of the discussion to a topic which is unrelated to the task

Chapter Five provides case studies of three students chosen to further illustrate findings related to the investigation. The following describes the outline of the tables and the figures use by the teacher/researcher to analyse the data collected.

Table 3.6 displays an example of the data results for the responses for the cognitive questionnaire. This particular example is for B, however the display relates to each of the case studies. The same display is used for affective and social domains and also the end results. In the cognitive domain, two questions [illegible] unskilled and very unskilled and four questions required a response of strongly positive, positive, negative and strongly negative. The number indicated in the table is the number of the question on the questionnaire. In the related tables the initial two questions shown here do not appear as they did not relate to the affective and social domains.

Table 3.6 Example for Questionnaire results for Cognitive - beginning Specifically - B

Cognitive – Beginning			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
2	1		
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	14 18	5 22	

Table 3.7 provides an example of the display of the data collected for the Word Problem Evaluation Test, specifically at the beginning of the cooperative learning program and B. It shows the questions B answered correctly. Similar displays are used for the end and later tests. The number relates to the question on the test.

Table 3.7 Word Problem Evaluation Test results for Beginning Specifically - B

	Beginning
+ -	1 2 3 5 6 8 10 13
× ÷	4 9 11 12
Combination	15 18
Total	**14/20**

Figure 3.4 provides an example of the group work interactions, in particular the cognitive interactions of B. Again this example is relevant to the affective and social domains. This is a line graph and the legend displays the number of responses for positive, constant and negative comments during the cooperative learning sessions..

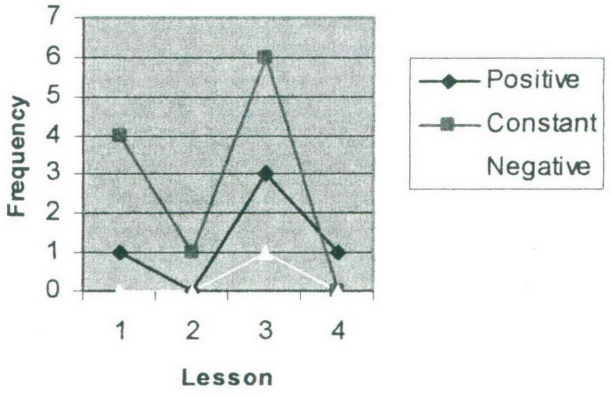

Figure 3.4 Example of Group work interactions Specifically – Cognitive for B

The previous section described examples for the analysis of the questionnaire, tests and audio-tapes for the cooperative learning program. The final section of this chapter will consider the reliability and validity if the data collecting methods.

EVALUATION OF THE RESEARCH DESIGN

All research methods have limitations. This section considers aspects of the reliability and validity of the data collection and analysis process used in the study, to identify the study's limitation.

Reliability

For research to have value, it is imperative the findings possess reliability. Punch (2001) defines reliability in quantitative research as consistency and maintains consistency has two aspects, one being consistency over time and the other internal consistency. Consistency over time:

> means the stability of measurement over time, and is usually expressed in the question: if the same instrument were given to the same people, under the same circumstances, but at a different time, to what extent would they get the same scores?
>
> (Punch 2001, p.99)

Internal consistency "concerns the extent to which the items are consistent with each other, or all working in the same direction" (Punch 2001, p.99). Cohen, Manion and Morrison (2000) extend the criteria of reliability to include "fidelity to real life, comprehensiveness, detail, honesty, depth of response and meaningfulness to respondents" (p.120).

LeCompe and Goetz (1984) define reliability as the "extent to which studies can be replicated" (p.35). They distinguish between external reliability where if the research was to be repeated by other researchers then the same conclusions would follow and internal reliability whereby these researchers would match the data in the same way as the original researcher given the same constrains.

External reliability

The nature of action research places the study within a specific context of time and space. As such, it would not be expected to be totally replicated elsewhere. Since this is a very small and specific subject group, external reliability is not relevant.

Internal reliability

Since external reliability is not relevant due to the nature of the sample, internal reliability is important.

It is crucial that the observers have similar understandings of the criteria for the description of the events observed in order to arrive at the same conclusions (LeCompe and Goetz 1984). These researchers identify five strategies to reduce the threat to internal reliability: low-interference descriptors, multiple researchers, participant researchers, peer examination and mechanically recorded data.

Low-interference descriptors refer to the format, structure and focus of the observation notes. In this study, the observation notes of each cooperative learning session were supported by the audio-tapes. At the end of each lesson the teacher/researcher and the teachers' aide discussed their observations and were able to modify any discrepancy which occurred in the interpretation of the observations. Hence the opportunity was provided to focus on specific areas in the next lesson, in line with the continuous improvement nature of action research, and also to provide criteria for the observation of the next lesson for both the parties.

Multiple researchers enable many view points for discussion of the findings and conclusion of the data. Due to the small scale nature of the research as discussed earlier the internal reliability of the findings could have been put at risk. Nevertheless, for the small scale the teacher/researcher and the teachers' aide provided an adequate forum.

Participant researcher. Since the teacher/researcher was the participant observer in the investigation and the teachers' aide was well known to the subjects, this provided an opportunity for the data to be collected in a trustworthy environment. Students were involved in the early discussion about the project and informed about the nature of the lessons at all stages.

Peer examination. As stated previously the collected data and findings were discussed with the Principal and Head Teacher in a discreet manner.

Mechanically recorded data. Audio-tapes were used in the data collecting process providing a good record of the discourse between participants throughout the cooperative learning lessons. These audio-tapes complemented the observation notes collected by the researcher and the teachers' aide.

Validity

"Validity necessitates demonstration that the propositions generated, refined, or tested match the causal conditions which obtain inhuman life" (LeCompe and Goetz 1984, p.43). Again, like reliability, validity can be divided into internal validity and external validity. Internal validity questions whether the researchers actually measure what they believe they are measuring (LeCompe and Goetz 1984). External validity addresses the question "to what extent are the abstract constructs and postulates generated, refined, or tested by scientific observing or measuring?" (LeCompe and Goetz 1984, p.43) This dichotomy is generally employed to experimental methodologies but LeCompe and Goetz (1984) have

extended this analysis of the strength and weaknesses of an inquiry to a much wider range of research situations.

Internal validity

LeCompe and Goetz (1984) when defining internal validity nominate five threats: history and maturation, observer effects, selection and regression, mortality and spurious conclusions.

History and maturation involves changes which may occur in the social setting, considered history, and changes in the progressive development of the individuals, regarded as maturation (LeCompe and Goetz 1984). Since this study occurred over a reasonably short period of time, there were no major changes to either the history or the maturation that would invalidate the research. Any small changes which were observed by the teacher/researcher or the teachers' aide were documented in the observation notes or analysis from the transcripts.

Observer effects refer to the reactivity which may occur between the teacher/researcher as a participant observer and the informants (LeCompe and Goetz 1984). Since the teacher/researcher was the classroom teacher and had been teaching the students for nine months, positive rapport had developed. The students related comfortably with the both the teacher and the teachers' aide which may have positively effected the internal validity. This familiarity nevertheless could have had a negative effect to the interpretation by the teacher/researcher of the abundant amount of the data obtained in the transcripts. This was avoided by discussions with the Teacher's Aide who was less familiar with the students.

Selection and regression refer to distortions which may occur "in data and conclusions created by the selection of participants to observe and informants to interview" (LeCompe and Goetz 1984, p.48). The participants for the inquiry were the members of a class which

had been formed from information from their feeder school of the previous year. This information formed the basis for developing a group of students who would benefit from individual attention in order to make their transition from primary to secondary school smoother by providing intense learning programs on basic skills. This was in accordance with the policy of school and the New South Wales Department of Education and Training. Since the group were considered to be of similar needs and the intent was to assist in basic skills there was no threat to validity caused by the selection of participants for this particular study.

Mortality relates to the way the group changes over time (LeCompe and Goetz 1984). Since it was anticipated that the group would remain constant and any changes to be typical of changes which would occur in a normal school year, treat to validity was unlikely. Two students did not complete all of the tests, questionnaires or the cooperative learning program; however the group of students basically remained the same, as the remaining students provided an adequate sample for this small section.

Spurious conclusions refers to conclusions not being what they purport to be. The use of multiple data collecting methods such as the tests, questionnaires, observation notes and especially the classification of the coding of the audio-tapes, strengthened the internal validity and reduced the risk of the researcher observer drawing false conclusions.

External validity

LeCompe and Goetz (1984) identify four threats to external validity: selection effects, setting effects, history effects and construct effects.

Selection effects refer to the uniqueness of the groups, making it difficult to compare across groups. The group chosen, due to its character, provided a limitation to the possibility to generalise the findings. However, many schools have similar classes which make the relevance of the findings important.

Setting effects refer to the investigator affecting the outcome in some way. The context of the setting and the procedures of the investigation have been described in detail to make comparisons possible.
History effects refer to the effects of unique historical experiences of the groups when making comparisons. Each student in the group carries their own unique history. This has been considered by the teacher/researcher and a detailed description has been included. This description shows that the group is comprised of different personalities but typifies a class of this model in any school.

Construct effect is defined as the extent to which abstract terms, generalisations, or meanings are shared across times, settings and populations. The teacher/researcher, by the use of triangulation, aimed to avoid where possible construct effects to address this threat to external validity.

SUMMARY

This chapter began by discussing the research methodology in board terms, quantitative and qualitative research methods, and more specifically action research as the primary research method.

The chapter continued with a detailed description of the multiple data collecting process used in the investigation. Due to the multiple data collecting methods used validity and reliability of the research was improved.

The third section of this chapter detailed the context, the participants and the procedures of the investigation. This provided the information for replication, and to justify the validity and reliability of the research.

The fourth section of this chapter described the analysis design and strategies employed by the researcher to classify the information collected to develop patterns in order to develop findings and conclusions. The major strategy described was coding and pattern coding. This was used in the interpretation of the transcripts. The use of a time-ordered matrix was described and discussed to tabulate the results of the questionnaires and tests.
The final section evaluated the research design. Validity and reliability were discussed in detail considering the possible threats to internal and external validity and internal and external reliability. The main threat to the research was found to be in the external reliability relating to the small size of the sample selected. A threat was also found in the internal validity where the researcher familiarity could have a negative effect on the interpretation of the findings.

In Chapters Four and Five, the data collected will be analysed according to the data analysis methods described in this chapter. The findings will present patterns which will provide the basis for the conclusions.

Chapter 4

RESEARCH ANALYSIS

Introduction

Chapter Three presented a description of the research design implemented to investigate cooperative learning as a communication strategy to facilitate the decoding of word problems to positively influence student achievement in Mathematics. This chapter presents the results of the data collected for this research. It will analyse the findings of the data collected from the tests, the questionnaire and transcripts of the cooperative learning program, together with the observations recorded by the teacher/researcher. This information, together with the findings in the following chapter which considers the progress of three students as case studies will provide the findings which will be discussed in Chapter Six.

Prior to the Data collecting period

Four weeks prior to Week 1 the teacher/researcher introduced the students to the study by giving the students the consent letter for the research (Appendix A - Administration). The teacher/researcher explained that the project had emerged from the requirements of a Masters Degree and was of a particular interest to her. The teacher/researcher approached this in a non-confrontational manner, appealing to the students for help by participating in the study and she explained that the positive outcome for them would be an improvement in the understanding of word problems. In the subsequent weeks, three students A, S and Je showed enthusiasm by asking the teacher/researcher when the 'fun stuff' would begin. E was more curious, enquiring about the structure and displaying reservations regarding working with students she may not wish to work with. The teacher/researcher endeavoured to ease her fears. B, Tr and M inquired when the study

would start and what they were going to do. These questions were answered by the teacher/researcher in a positive manner.

OVERVIEW OF THE DATA COLLECTING PERIOD

As presented in Chapter 3, Research Design, Table 4.1 provides an overview of the data collecting period. The data collection occurred over a fifteen week period. In Week One and Week Seven a test and questionnaire (Appendix B - Instruments) was presented to the students to assess the effect of a cooperative learning program which occurred during the period between Week Three and Week Six, inclusive. A further test using the questions asked in Week One and Week Seven was conducted after the Christmas holiday break to determine the extent of the students' retention.

Table 4.1 Overview of the data collecting period.

Week	1	2	3	4	5	6	7	15
			Cooperative Learning Program 1 (CL1)	Cooperative Learning Program 2 (CL2)	Cooperative Learning Program 3 (CL3)	Cooperative Learning Program 4 (CL4)		
Activity	Questionaire Test Introduce audio-tape	Cooling off period	Word Matching	Squaresaw	One-step Word Problems	Two -step Word Problems	Questionnaire Test	Test

PRE & POST TESTS AND QUESTIONNAIRES

The students were presented with a questionnaire that addressed aspects of the cognitive, affective and social domains at the beginning and end of the cooperative learning program. The students were also given a word problem test at the beginning and end of the cooperative learning period and subsequently in Week 15 of the study.

The questionnaire and the test were presented to the students in the first week of the data collecting period. A normal week of lessons consisted of one period (38 minutes) on Monday, Tuesday and Friday with a double period on Thursday. The questionnaire

was read to the students on the Monday. The students were given adequate time to consider each question and all the students exhibited a serious approach. On the Tuesday the word problem test was presented to the students. They were given 15 minutes to complete the questions. All students completed the questions in the given time. M and Tr finished the test in about ten minutes. Jo was absent for both the test and the questionnaire. He was given both the test and questionnaire when he returned to school on the Thursday, during a preparation period of the teacher/researcher.

Questionnaires

The questionnaire (Appendix B – Instruments) was presented to the students at the beginning of the data collecting period, the day prior to administering the word problem test. The same questions were again presented to the students after the cooperative learning period, a day after administering the test. The results were tabled, distinguishing between the cognitive, affective and social domains (Appendix D – Results Summary), by recording the question and the students' response of very skilled, skilled, unskilled and very unskilled for the first two questions and strongly agree, agree, disagree and strongly disagree to the subsequent questions. These questions were further analysed, again according to the cognitive domain (Figure 4.1), the affective domain (Figure 4.2) and the social domain (Figure 4.3). Each student's response was tabulated, recording the frequency of each category for each of their responses. Some questions were designed with either a positive or negative bias, and when tabulating it was necessary to reverse the response for the negative questions. These results are displayed for the cognitive domain (Table 4.2), the affective domain (Table 4.3) and the social domain (Table 4.4), showing the frequency of choice of each category by every student.

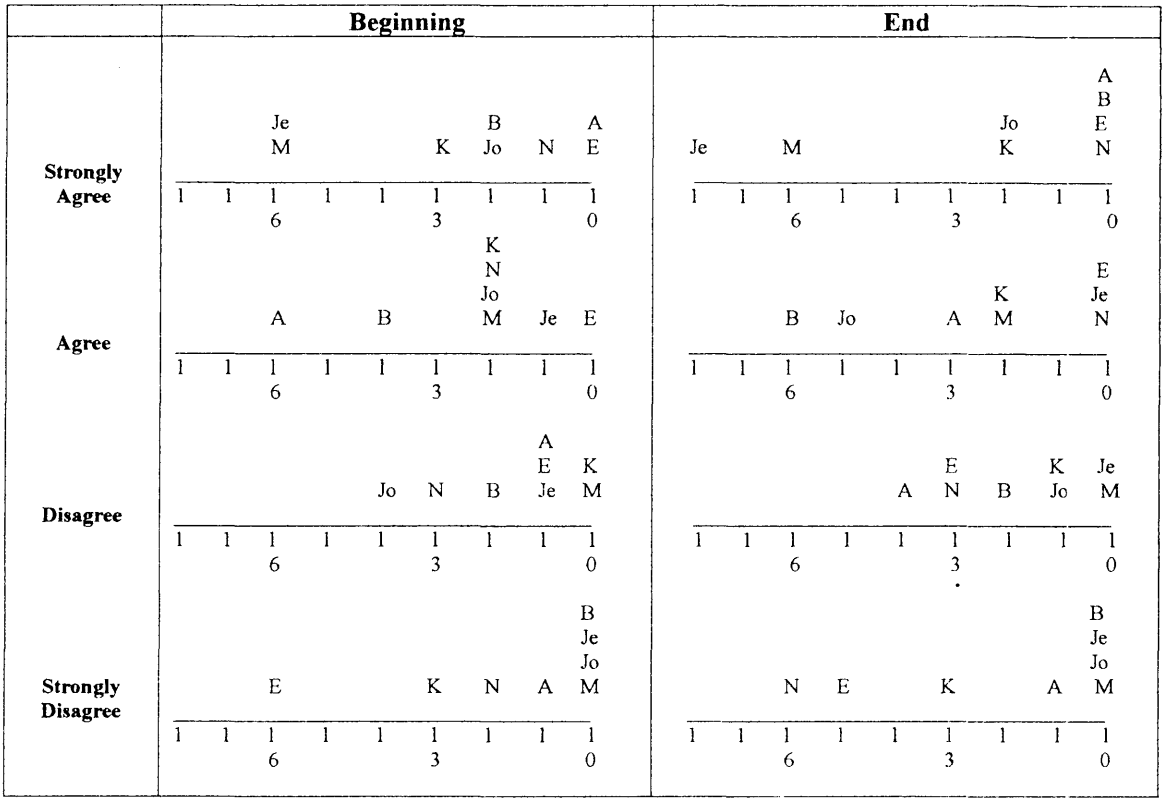

Figure 4.1 Results of the Questionnaire – Cognitive

These results were further analysed to give a score for each student. Very positive was given a score of four (4), positive was given a score of three (3) and negative and very negative were given scores of two (2) and one (1) respectively. Table 4.2 provides an overall summary of the results of the cognitive responses to the questionnaire of the students at the beginning and the end of the cooperative learning program.

Table 4.2 Overall summary of the Results of the Questionnaire - Cognitive

Student	Beginning	End	Movement
A	21	18	↓ 3
B	24	22	↓ 2
E	9	11	↑ 2
Je	30	32	↑ 2
Jo	22	25	↑ 3
K	21	19	↓ 2
M	30	30	-
N	20	12	↓ 8

When comparing the response of the students as a group as displayed in Figure 4.1 there appears to be little overall changes, apart from N who became strongly negative after the cooperative learning program.

To examine this further, pre- and post-questionnaire for the cognitive student responses were summarised for each student as shown in Table 4.2. The overall mean scores were compared for the pre- and post-test questionnaires for the cognitive domain using a two-tailed t-Test. The findings indicated no significant difference ($t = -0.78$, $p = 0.49$), and this was also true when the outlier of N's score was removed.

Figure 4.2 displays the results of the students' self-perception of their affective domain recorded at the beginning and end of the cooperative learning program.

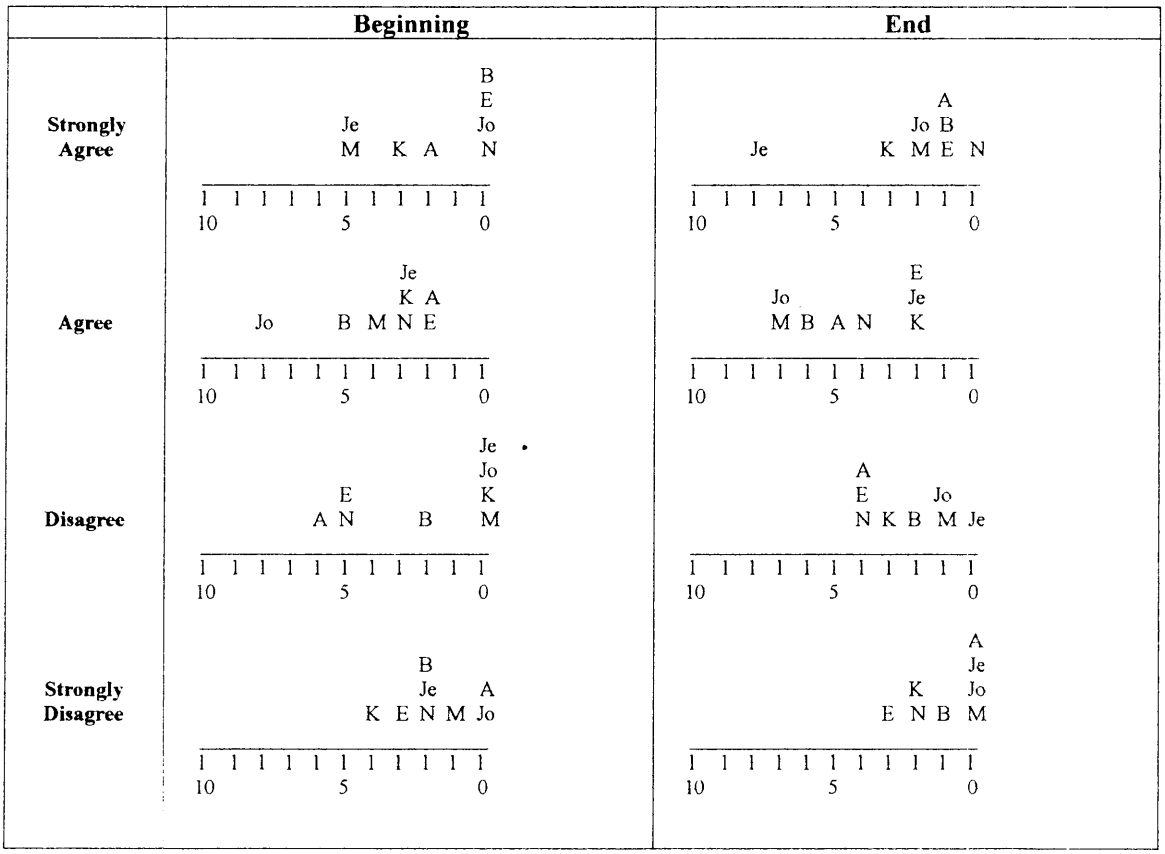

Figure 4.2 Results of the Questionnaire – Affective

Table 4.3 provides an overall summary of the results of the affective responses to the questionnaire of the students at the beginning and the end of the cooperative learning program.

Table 4.3 Overall summary of the Results of the Questionnaire - Affective

Student	Beginning	End	Movement
A	26	27	↑ 1
B	21	27	↑ 6
E	19	21	↑ 2
Je	31	38	↑ 7
Jo	24	31	↑ 7
K	25	26	↑ 1
M	33	31	↓ 2
N	21	22	↑ 1

When comparing the response of the students as a group as displayed in Figure 4.2, there appears to be a positive shift. This included a small positive change for N, despite her very negative cognitive responses. To examine this further, pre- and post-questionnaire for the affective student responses were summarised for each student as shown in Table 4.3. The overall mean scores were compared for the pre- and post-test questionnaires for the affective domain using a two-tailed t-Test. The findings indicated a significant difference ($t = 2.42$, $p = 0.046$) suggesting that students' attitudes had changed.

Figure 4.3 displays the results of the students' self-perception of their social domain recorded at the beginning and end of the cooperative learning program.

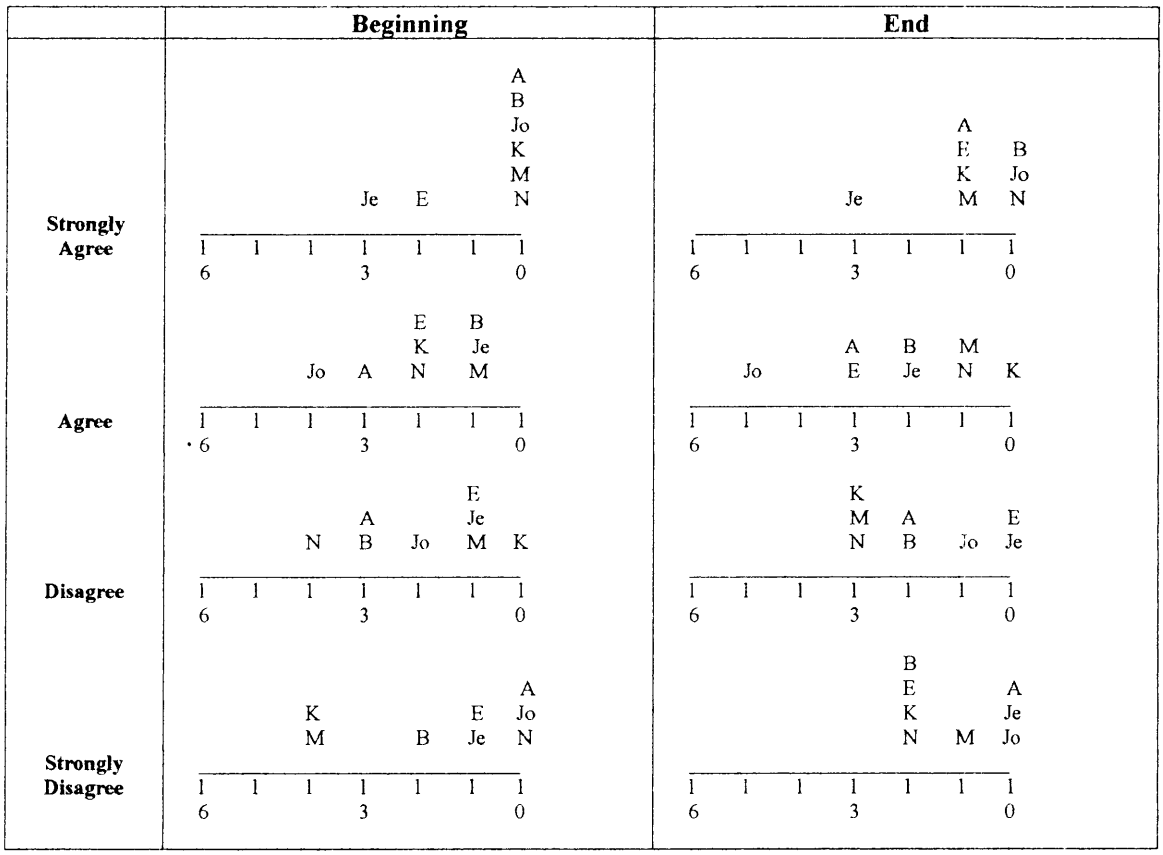

Figure 4.3 Results of the Questionnaire - Social

Table 4.4 provides an overall summary of the results of the social responses to the questionnaire of the students at the beginning and the end of the cooperative learning program.

Table 4.4 Overall summary of the Results of the Questionnaire - Social

Student	Beginning	End	Movement
A	15	17	↑ 2
B	11	12	↑ 1
E	17	15	↓ 2
Je	18	18	-
Jo	16	17	↑ 1
K	10	12	↑ 2
M	9	14	↑ 5
N	14	11	↓ 3

When comparing the response of the students as a group as displayed in Figure 4.3 there again appears to be a positive shift. To examine this further, pre- and post-questionnaire for the social student responses were summarised for each student as shown in Table 4.4. The overall mean scores were compared for the pre- and post-test questionnaires for the social domain using a two-tailed t-Test. The findings indicated no significant difference ($t = 0.85$, $p = 0.42$).

Word Problems Evaluation Test

Initially the students attempted a fifteen question conventional pencil and paper test, the Word Problems Evaluation Test, (Appendix B – Instruments) as a basis to determine the students' achievement prior to the commencement of the four cooperative learning lessons and to determine the direction of these lessons. This test comprised three categories, the first part consisting of eight one-step word problems of addition and subtraction, the second part consisting of five one-step word problems of multiplication and finally two two-step mixed operation word problems. It was decided by the teacher/researcher not to include division in the word problem test as this operation required a higher cognitive knowledge and through her experience with the students, the teacher/researcher believed this thinking would be too difficult for the students.

The test was marked by the teacher/researcher and the scores of the students, according to each category, were presented in the form of a distribution graph (Figure 4.4). Each letter or pair of letters on the graph represents one student and the number on the continuum represents the number of questions each student scored correctly for each category.

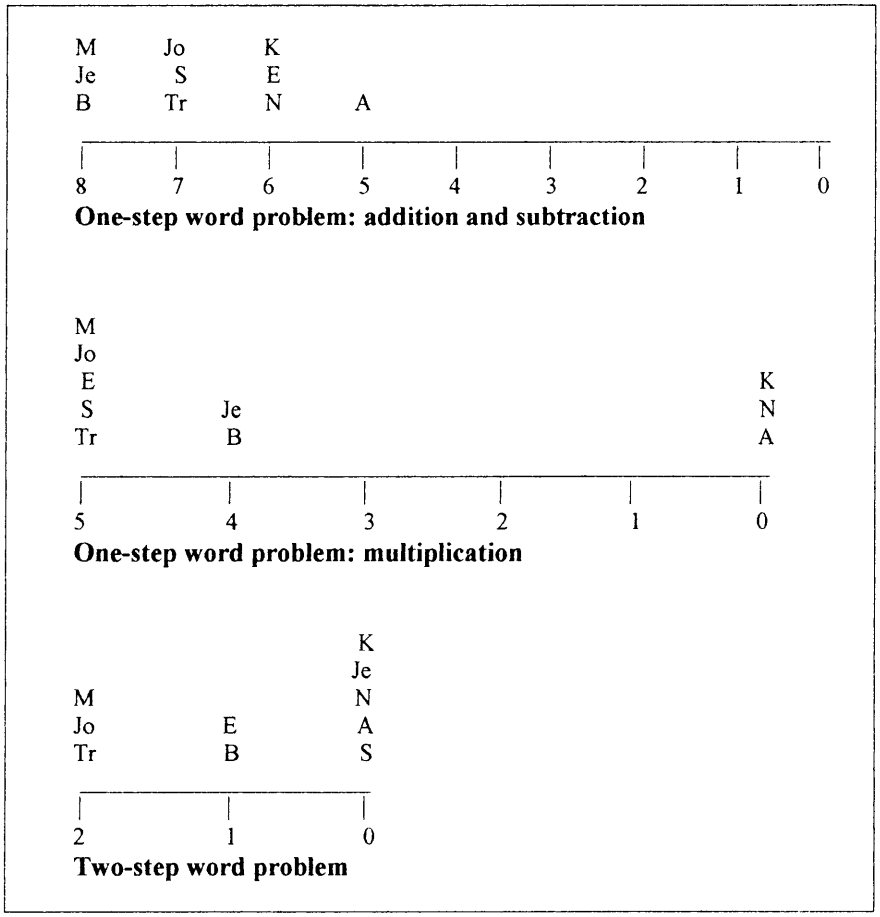

Figure 4.4 Results for initial Word Problem Evaluation Test

It was determined at this stage that a number of the students displayed a reasonable competency in one-step word problems, especially in the category of addition and subtraction. Consequently, the teacher decided to extend the test by adding a further five two-step word problem questions to gain a more complete assessment of the students' achievement at the initial stage. This amended test was conducted on a further two

occasions, once at the end of the cooperative learning program (End) and again eight weeks later (Later).

The scores for the amended test versions are presented according to the type of operation: one-step operation: addition & subtraction (Figure 4.5), one-step operation: multiplication (Figure 4.6) and two-step mixed operation (Figure 4.7). The letters represent the students and the numbers as their raw score. Results are presented in a time-ordered matrix showing the change in student performances from Beginning to End to Late.

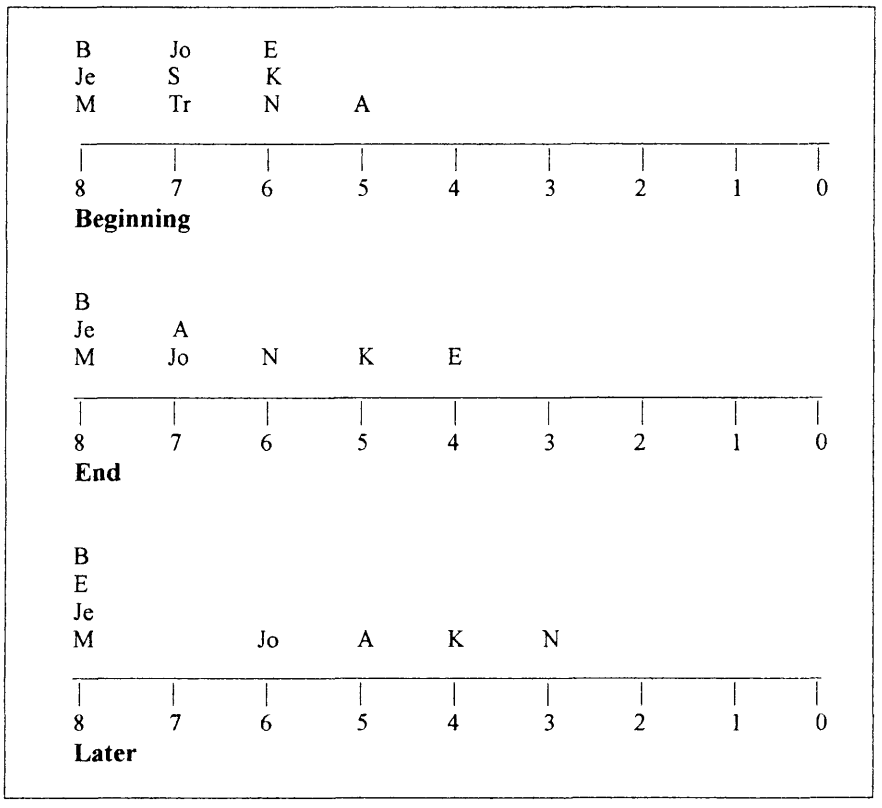

Figure 4.5 Results for One-step operation: addition & subtraction

In the one-step operation of addition and subtraction, all the students scored five correct or above in the Beginning test, with three students completing all eight questions correctly.

In the end test five students (B, Je, Jo, M, N) remained on their Beginning score, while one student (A) improved by two marks from five correct to seven. Two students' marks (E, K) decreased from six correct to four and six correct to five respectively.

In the Later test three students (B, Je, M) remained on a score of eight correct. One student (E) improved by one mark from the Beginning test and from four correct to eight in the End test. Another student (N) scored three less when compared with the Beginning and End tests from six correct to three. One student (A) scored similar to the Beginning test and another (K) scored two marks less than the Beginning test.

In summary when comparing the Beginning and End test, four students scored the same, one student (A) improved by two, another (E) regressed by two and one student (K) regressed by one mark.

Figure 4.6 provides the results of the one-step multiplication operation for the word problems.

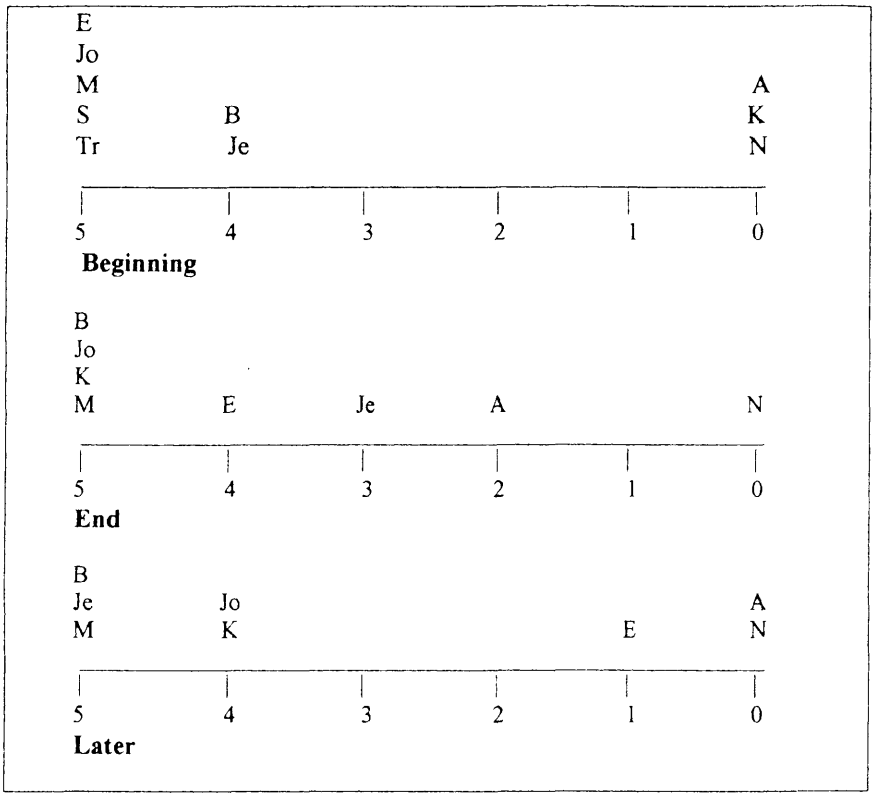

Figure 4.6 Results for One-step operation: multiplication

In the one-step operation of multiplication, five students (E, Jo, M, S, Tr) scored five out of five correct in the Beginning test, with two students (B, Je) scoring four out of five correct. Three students (A, K, N) did not score.

In the End test, one student (K) made a strongly positive improvement, scoring all five questions correct as compared with a zero score originally. One student (A) made a two score improvement from a score of zero. Another student (B) made a one score improvement from a score of four correct. Two students (Jo, M) remained on a top score of five correct, while two students (E, Je) did not score as well by one score, a score of five correct to four and a score of four correct to three respectively.

In the Later test, two students (B, M) continued to score well. One student (Je) improved from a score of four correct in the Beginning and a score of three correct in the End, to a score of five correct. Two students (Jo, K) regressed by one score from

five correct to four, while one student (E) who had initially scored very positively in the Beginning test and scored four on the End test, only scored one correct in the Later test.

In summary, when comparing the Beginning test with the End test, one student (K) made a substantial improvement, one student (A) improved by two scores, while two other students (E, Je) regressed by one score.

Figure 4.7 provides the results of the two-step mixed operation for the word problems.

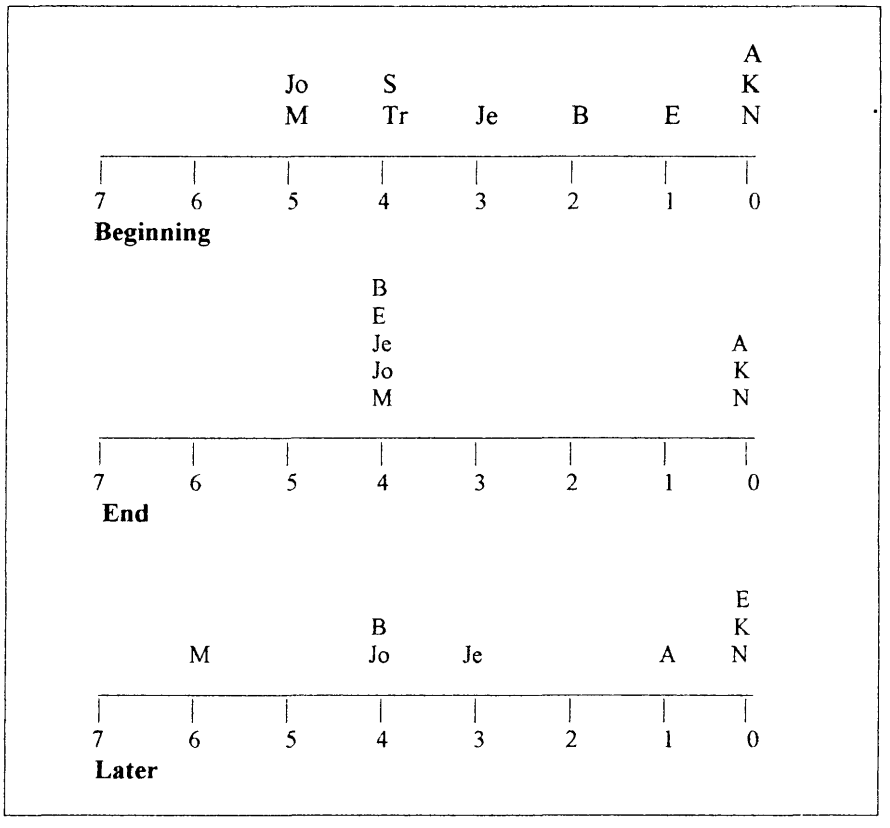

Figure 4.7 Results for Two-step mixed operation

In the two-step mixed operation, no students scored more than five out of seven correct in the Beginning test. Two students (Jo, M) scored five correct out of seven, while two students (S, Tr) scored four correct answers. Three students (A, K, N) who had not scored in the one-step operation of multiplication, also did not score in this part of the test.

In the End test there were no students who scored more than four correct although five students (B, E, Je, Jo, M) obtained this score. One student (E) improved by three marks, a score of one correct to a score of four. One student (B) improved by two marks from two correct to four and one student (Je) improved by one mark from three correct to four. Two students (J, M) regressed by one mark from a score of five correct to a score of four. Three students (A, K, N) remained on a score of zero.

In the Later test, one student (M) who had scored five correct in the Beginning and four correct in the End tests attained a score of six correct. Another student (E) who had improved by three marks from the Beginning to the End test scored zero in the Later test.

When considering the two-step mixed operation test, there was little improvement except for one student (E) who improved from one correct in the Beginning test to four correct in the End test, but who nevertheless regressed to zero in the Later test.

For all sub-groups and overall, t-tests were conducted between mean scores on Beginning/End, Beginning/Later and End/Later. No statistically significant findings were observed, although, as indicated above, there appeared to be some qualitative improvement for some students. Overall, there seemed to be a small improvement of the participants in the cooperative learning program, addressing the decoding of word problems in the interpretation of the four operations of addition, subtraction and multiplication. The improvement was inconsistent, however, across participants and tests. The following section considers the results of the interactions between students during the cooperative learning program.

COOPERATIVE LEARNING ACTIVITES

All the activities were presented to the students by the teacher/researcher during the double period on the Thursday of each week. It was decided by the teacher/researcher to utilize this double period so the lesson would not be rushed and the students would have

ample time to organize themselves at the beginning of the period and also time at the end of the period to complete the task or tasks.

Week 3: Cooperative Learning Program 1 (CLP1) – Word matching.

As described earlier in Chapter 3, the teacher initially introduced the students to targeted words by placing the symbols +, -, ×, ÷ on the over head projector (OHP). She then displayed each word for the students to read, then the students were encouraged to indicate to which column (first, second, third or fourth) the word belonged (Appendix C Activities). The teacher practiced these targeted words till students became familiar with this process. She then explained how the students were to be divided into groups. Each group was given their own set of 76 word cards and their task was to divide the cards evenly between each member of the group and each student, rotating clockwise round the group would place their card on the appropriate symbol. When they had completed this task, the group were to play a game of dominos placing similar words together.

Table 4.5 provides the students and facilitator configuration of the two groups for the first cooperative learning program (CLP1). T refers to the teacher/researcher.

Table 4.5 Group configuration for Cooperative Learning Program 1 (CLP1)

Cooperative Learning Program 1 (CLP1) Word Matching Week 3			
Group One		**Group Two**	
Students	**Facilitator**	**Students**	**Facilitator**
A Je K N Tr (absent)	T	B E Jo(absent) M S	T

Table 4.5 describes the composition of the two groups which were determined by the teacher/researcher for the first lesson of the cooperative learning program. The groups were selected, by cognitive and social determinants, according to the teacher/researcher's prior knowledge of the students. The groups were organised before the word problem tests were marked and before the questionnaires were analysed, as the teacher/researcher did not wish this data to influence the combinations of the groups and subsequently the interactions of the groups. A, Je, K and N were considered of low cognitive ability when compared with B, E, Jo, M and S. E was placed in Group 2, as she often had 'tiffs' with Je, K and N who generally worked well together. When formulating the groups prior to the lesson, the teacher/researcher decided to place Tr in Group 1, even though he generally displayed a higher cognitive level. The teacher/researcher believed the boys Tr, B, M and S would provide a poor socio-dynamic relationship, and thus needed to be separated. Tr was chosen, as he was considered the most disruptive and would possibly respond to a quieter, more structured group. In the event, Tr was absent for the lesson, so no data was obtained to test this assumption.

The lesson began well, with the students positively involving themselves in the class work part of the lesson. As the teacher's aide was unexpectedly absent from this lesson, the teacher/researcher found the group work part of the lesson very challenging. The students were excited and demanded to know what they were going to do even though it had been explicitly explained to them during the class work part of the lesson. The teacher/researcher began by organising Group 1 and asking Group 2 to arrange themselves around the tables. Group 1 settled to the task quite well with Je taking control. Group2 were unable to organise themselves, with B being very disruptive. Both groups required a considerable amount of the teacher/researcher attention.

Table 4.6 tabulates the number of verbal interactions of each student during the first cooperative learning program (CLP1). The legend provides a group display of the interactions, eg. ○ ⇒ 0 ie. ○ indicates zero responses. It provides a summary of the verbal interaction within each of the three major categories of cognitive, affective and social domains and the sub-categories of positive, constant (neither positive nor negative) and negative.

Table 4.6: Results of the verbal interactions Cooperative Learning Program 1 (CLP1)

Group	Participant	Cognitive			Affective			Social			Task		Total
		P	C	N	P	C	N	P	C	N	O	N	
1	A	○	◓	○	◒	◓	○	○	◒	◒	○	○	32
	Je		◒	○	◒	◒	◒	◒	○	◒	*	○	41
	K	○	○	○	○	○	○	○	○	○	○	○	0
	N	○	◒	○	◒	◒	◒	◒	◒	◒	◒	○	24
	Tr	-	-	-	-	-	-	-	-	-	-	-	-
Group Totals		3	13	0	9	13	6	6	6	9	23	0	
Decile		0.03	0.15	0.00	0.10	0.15	0.07	0.07	0.07	0.10	0.26	0.00	
2	B	◒	◒	○	◒	○	◒	◒	○	●	○	◒	30
	E	◒	◒	○	◒	○	◒	◒	◓	◓	○	○	25
	Jo	-	-	-	-	-	-	-	-	-	-	-	-
	M	◒	◒	○	◒	◒	○	◒	◒	◓	◒	●	44
	S	◒	◒	○	◒	◒	○	◒	◒	◒	◒	◒	27
Group Totals		12	12	0	12	6	6	12	13	29	9	18	
Decile		0.09	0.09	0.00	0.09	0.05	0.05	0.09	0.10	0.23	0.07	0.14	
Lesson Totals		15	25	0	21	19	12	18	19	38	32	18	
Decile		0.07	0.12	0.00	0.10	0.09	0.05	0.08	0.09	0.17	0.15	0.08	

LEGEND

Number of verbal interactions: ○ ⇒ **0,** ◒ ⇒ **1 – 5,** ◓ ⇒ **6 – 10,** ● ⇒ **11-15,** * ⇒ **> 20**

In this table and subsequent similar tables the decile provides the group or lesson totals as a proportion of the total responses. Hence Affective Positive comments, provide 10 percent of Group 1, 9 percent of Group 2 and 21 percent of the overall comments for the lesson.

The teacher found that the students applied themselves to the two tasks, although they required close supervision which was difficult since there was only one facilitator.

The total interactions of each student were small over a twenty minute period. B, Je and M made the most utterances, while there was no record for K. It was noted that the type

of activity chosen at this point did not lend itself to positive cognitive verbal interaction. The student picked up a card and placed it in the appropriate position with little, if any discussion.

B displayed negative social interactions with E and while M and B at times refused to cooperate.

E But B won't share.
T But you've got to put them out.
B Shut up
T You've got to put them out the front .....
B Shut up
T Come on, are you two boys going to have a go?
M Maybe. (CLP1, G2, 30-36)

At one point B endeavoured to undermine the activity by taking one of the leading operational cards.

T What happened to it?
B Gone.
T Pass me .....
M Wait, I can do it. Haaaaaa can I say something?
T Did you pinch the minus?
B No (T goes to get another minus) (CLP1, G2, 39-43)

E became very frustrated with the group, showing a mismatch of group dynamics.

E Miss, I don't won't to be in this group. (CLP1, G2, 65)

The lesson became dysfunctional at the end of the lesson with interactions between M, E and B.

M Hi Bro.
E This game sucks.

M Haha Haha

B This is boring. Boring.

E A lot, a lot.

B Boring, boring. (CLP1, G2, 162-167)

More positively, Je, who the teacher/researcher had believed to be a quiet and unassuming student, showed very positive organisational skills.

Je Okay, we have to put them into groups. Okay what have you got?

A Total

Je Okay, I've got times. No, you've got to put it there.

N I've got none of them.

Je Okay.

N I've got none of them. I've only got these ones.

Je Okay, you have to get one out. Okay you go first A. (CLP1, G1, 2-8)

At the completion of this lesson the teacher/researcher was disappointed. Over the twenty minutes of the group work section of the lesson the teacher/researcher spent a considerable amount of time moving between the two groups, keeping the students on task. She had decided in her own mind what she expected, students being engaged and interested, and the students did not conform to this expectation. A in Group1 and B and M in Group 2 proved to be the influences that caused the groups to deviate from an on task situation.

Week 4: Cooperative Learning Program 2 (CLP2) – Squaresaw

As a result of the observations in the first lesson of the cooperative learning program the teacher/researcher decided to move Tr into Group 2 and concentrate on Group 1. Her intent was to observe Je's organisational skills, encourage K and N to be more active in their discussion as well as keep A more on task. If this proved to be successful this would give her time to observe Group 2 to which she had allocated the teacher's aide as facilitator.

Table 4.7 provides the students and facilitator configuration of the two groups for the second cooperative learning program (CLP2). T refers to the teacher/researcher and TA refers to the teacher's aide.

Table 4.7 Group configuration for Cooperative Learning Program 2 (CLP2)

Cooperative Learning Program 2 (CLP 2) Squaresaw Week 4			
Group One		**Group Two**	
Students	**Facilitator**	**Students**	**Facilitator**
A Je K N	T	B E Jo(absent) M S(absent) Tr	TA

The lesson was devised to reinforce vocabulary skills learnt in the previous lesson. The teacher/researcher showed the students on the overhead projector an example of a square-saw, using the previously practised words. The students were then divided into groups to work together to complete a square-saw identical the one displayed on the overhead projector as well as two similar square-saws. (Appendix C - Activities)
Table 4.8 tabulates the number of verbal interactions of each student during the second cooperative learning program (CLP2). The legend provides a group display of the interactions, eg. ○ ⇒ **0** ie. ○ indicates zero responses.

Table 4.8: Results of the verbal interactions Cooperative Learning Program 2 (CLP2)

Group	Participant	Cognitive			Affective			Social			Task		
		P	C	N	P	C	N	P	C	N	O	N	
1	A	◒	◓	◒	◒	◒	○	○	○	○	○	◒	22
	Je	◒	◒	○	◓	○	○	◓	◒	◒	○	◒	32
	K	○	○	○	○	◒	○	○	○	○	○	○	0
	N	○	◒	○	◒	◓	◒	◒	◒	◒	○	◒	28
Group Totals		6	13	3	13	13	3	10	6	6	0	9	
Decile		0.07	0.16	0.04	0.16	0.16	0.04	0.12	0.07	0 07	0.00	0.11	
2	B	○	◒	○	○	○	◒	◒	◒	*	○	◒	35
	E	*	*	◒	●	◒	◒	◒	◒	◓	◒	○	77
	Jo	-	-	-	-	-	-	-	-	-	-	-	-
	M	○	◒	○	○	◒	○	◒	◒	*	○	*	52
	S	-	-	-	-	-	-	-	-	-	-	-	-
	Tr	◒	◓	◒	◒	◒	◒	◒	◒	●	○	○	40
Group Totals		26	33	9	18	9	9	12	12	59	3	23	
Decile		0.12	0.15	0.04	0.08	0.04	0.04	0.05	0.05	0.27	0.05	0.11	
Lesson Totals		32	46	12	31	22	12	22	18	65	3	32	
Decile		0.10	0.16	0.04	0.11	0.08	0.04	0.08	0.06	0.22	0.01	0.10	

Number of verbal interactions: ○ ⇒ **0,** ◒ ⇒ **1 – 5,** ◓ ⇒ **6 – 10,** ● ⇒ **11-15,** * ⇒ **> 20**

The students found the concept difficult. The size of the square-saw was too large. A smaller size may have made the task look less intimidating. The students remained on task however, except for a small number of off task interactions. As the concept was difficult the teacher was unable to circulate between the two groups, as intended, and remained with Group 1. The group required substantial input by the teacher/researcher to remain on task. Je managed to understand the concept but was unable to explain what she was doing to the others in the group. K worked quietly with no interactions and solved the puzzle. This was outside the teacher/researcher's expectation of K. When asked privately later, why she was able to solve the problem, K just shrugged her shoulders and said she didn't know. The teacher/researcher surmised K functioned at a

higher level when exposed to visual spatial stimuli. N and A were given the solution to copy and they were content with their contribution to the groups.

Group 2 had a considerably larger number of verbal interaction compared to Group 1. Negative social interactions score high especially between B, M and Tr and towards E.

M	Next to E, I'm not sitting there.
TA	Now I want you to sit there.
E	(singing to herself, working quietly by herself)
M	Sit next to B?
TA	I thought you ..... What are you going to be?
Tr	I'm going to be two.
M	But if she doesn't sit next to B, I'm not going to work on this.
B	I'm not working either.
M	Hey B, have a seat. (CLP2, G2, 7-19)

The teacher's aide had a difficult time with this group. E is the only student who endeavoured to stay on task. She tried very hard.

TA	How are you going E.
E	Not bad.
Tr	Just easy.
TA	Did you find out where you are going wrong?
E	Yes.
TA	Good. (CLP2, G2, 67-72)

E persisted, even though the other students were not involved in the tasks and in the presence of Tr, as shown in Table 4.9, who made disruptive comments, such as reading the words on the tiles over and over again or deliberately incorrectly.

TA Does that help at all?

E No.

TA You've got adds and saves, the same.

E Yeah, but I've got product there.

Tr Shhhhhh shhhhhh

E Unless this goes this way.

Tr I slipped.

E (muttering to herself) total, decrease, times. (CLP2, G2, 106-113)

Eventually, Tr, B and M decide it is too hard and choose to play something else.

Tr This is too hard.

TA Okay.

B This is gay, I don't like this game.

M Haaaa, let's play UNO. (CLP2, G2, 118-121)

At the end of the lesson the teacher/researcher and the teacher's aide discussed their observations. Even though the teacher/researcher realised the unit of work was difficult and the lesson could have benefited by smaller sized square-saws, the teacher's aide believed E progressed well. She handled the interference of the other members of her group and successfully completed the tasks. The teacher/researcher was disappointed that A, B, M and Tr were not successful in actively involving themselves in the task, however Je and K presented positively to the tasks, while N appeared to be involved, enjoying the interaction.

Week 5: Cooperative Learning Program 3 (CLP3) – One-step Word Problems

The teacher/researcher was apprehensive about maintaining the group structure of the previous lesson, considering the negative social behaviour, especially between E and B, and M and Tr. However, since Tr and S were absent, the groups maintained the same structure, except for the facilitators who were allocated to the opposite group to which they had been assigned in the previous lesson. The teacher/researcher considered the teacher's aide would work more positively with Group 1, which was less demanding

socially, while she would observe the social dynamics of Group 2, with the aim of positively involving B and M in the activities, and actively encouraging improved interaction between B, M and E.

Table 4.9 provides the students and facilitator configuration of the two groups for the third cooperative learning program (CLP3). T refers to the teacher/researcher and TA refers to the teacher's aide.

Table 4.9 Group configuration for Cooperative Learning Program 3 (CLP3)

Cooperative Learning Program 3 (CLP3) One-step Word Problems Week 5			
Group One		**Group Two**	
Students	**Facilitator**	**Students**	**Facilitator**
A Je K N	TA	B E Jo M S(absent) Tr(absent)	T

In this lesson the teacher/researcher explained to the students that each group would be given an envelope containing a number of word problems (Appendix C - Activities). Each group would also be given a table for recording the answers to the word problems (Appendix C - Activities). It was stressed to the students that the aim of the exercise was less to answer the word problem than to decide on the operation used in each question. This was first to be recorded for all the problems then calculators could be used to obtain their answers.

Table 4.10 tabulates the number of verbal interactions of each student during the third cooperative learning program (CLP3). The legend provides a group display of the interactions, eg. ○ ⇒ **0** ie. ○ indicates zero responses.

Table 4.10 Results of the verbal interactions Cooperative Learning Program 3 (CLP3)

Group	Participant	Cognitive			Affective			Social			Task		
		P	C	N	P	C	N	P	C	N	O	N	
1	A	●	◒	◓	◓	◓	◒	◒	◒	◒	○	◓	64
	Je	*	●	◒	◓	◒	○	●	◒	◒	◓	○	73
	K	◓	◓	○	◒	◓	○	○	◒	○	○	◒	27
	N	◓	*	◒	◒	◒	○	◒	◒	◒	○	◒	48
Group Totals		46	51	13	20	20	3	18	12	9	7	13	
Decile		0.22	0.24	0.06	0.09	0.09	0.02	0.09	0.06	0.04	0.03	0.06	
2	B	◒	◓	◒	◒	◒	○	◒	○	◒	○	○	25
	E	◒	◒	◒	○	◒	○	○	◒	◒	◒	◒	24
	Jo	*	◓	○	◒	◒	○	◒	◒	○	○	◒	42
	M	◓	◓	◒	◒	◒	○	◒	◒	*	◒	◒	55
	S	-	-	-	-	-	-	-	-	-	-	-	
	Tr	-	-	-	-	-	-	-	-	-	-	-	
Group Totals		33	24	9	9	12	0	9	9	26	6	9	
Decile		0.23	0.17	0.06	0.06	0.08	0.00	0.06	0.06	0.18	0.04	0.06	
Lesson Totals		79	75	22	29	32	3	27	21	35	13	22	
Decile		0.22	0.21	0.06	0.08	0.09	0.01	0.07	0.06	0.11	0.03	0.06	

Number of verbal interactions: ○ ⇒ **0,** ◒ ⇒ **1 – 5,** ◓ ⇒ **6 – 10,** ● ⇒ **11-15,** * ⇒ **> 20**

In Lesson 1 of the cooperative learning program (CLP1) for Group 1 there were a total of 97 interactions with A and Je uttering the most and N less, while K uttered no discernable interactions. In Lesson 2 (CLP2), interactions totalled 82 with A, Je and N producing approximately the same interactions and again K did not interact. In this third lesson, however, there were 212 interactions with both A and Je recording a high interaction level, N again fewer, while K recorded significantly. The interactions for Group 2 were not noticeably increased as compared with the first and second lessons in the cooperative learning program. M remained a high recorder, while E became quieter.

In each of the domains, positive and constant interactions recorded higher than the negative interactions. In the affective domain, the only negative comments were made by A and this was when he yawned loudly, for no apparent reason. The cognitive constant results can be attributed to the students reading the problems. The highest scoring cognitive positive results are due to students verbally recording their answers, rather than placing the tiles in the appropriate positions without comment, which occurred in the previous two lessons.

The students in both groups focused well at the beginning of the lesson. Observation suggested the more competent students were more comfortable with this traditional lesson structure. This lesson required them to problem solve, rather than game playing with bits of tiles as in previous lessons which appealed to the less competent students. They worked positively.

B	What is six less than ten?
M	Take away.
T	Mmmmm, good boy.
E	Find the difference between 15 and 10.
T	Good girl.
Jo	Find the sum of 24 and 36.
T	Sum, good, thought we would get around to you quickly. (CLP3, G2, 53-59)

Toward the end of the lesson students began to become confused, losing concentration, implying the lesson was too long.

N	What is the different between 25 and 15?
A	Times.
TA	No, how did you get times? Difference?
N	Plus.
Je	No, divide.
TA	Difference, difference?
N	Plus.

TA No difference is?

Je Divide.

A Take away.

TA Yes, take away. (CLP3, G1, 145-155)

TA That's nine lots of two. So it has to be?

A Divided.

Je .....

A Great one Je.

TA Multiply, because.....

All (Off task)

TA Come on, you're losing concentration. (CLP3, G1, 214-220)

This confusion led the students to make inane and childish comments.

N Mum made two dozen cakes for the school fete. If Jim ate two them, how many were left?

A Oooooo did he? 210.

Je 350.

A 280. (CLP3, G1, 158-161)

This lesson confirmed need for a practised facilitator, the teacher/researcher. At this stage, when the students had become distracted from the task, the facilitator, the teacher/researcher, was required to encourage students to reapply themselves.

T Come on, if we pace it up, quickly, we can get onto the next step.

B Eighteen jellybeans are to be shared amongst three children. How many should each child receive?

T So what might that one be? I thought we were going to do that?

B Share.

T What do you think it is?

E I don't know, he keeps kicking me.

M No, I don't.

E Yes you do.

M Thhhhhhh (CLP3, G2, 70-78)

The facilitator, the teacher's aide, was also shown to be useful in directing the students to self correct.

A That would be divide.

TA Read it again N.

N Eight people have already arrived at the party. If another five

A Oh, oh, that's plus. (CLP3, G1, 54-57)

A In a month Dianne saves $24 and Max saves $49. How much do they save between them?

TA Okay

Je That's divide.

TA Between them, it says how much...

Je Oh plus. (CLP3, G1, 99-103)

M Twenty guests at the party were seated at five tables. How many people were at each table.

T Multiply?

M Oh, yeah, divide. (CLP3, G2, 49-51)

During this lesson A and N show they have not progressed in their understanding that multiplication is an easier way of addition. A actually became frustrated.

A Daniel has six pairs of shoes. How many shoes does he have to polish altogether?

TA Right there are eight pairs of shoes.

A Plus.

TA There's eight pairs of shoes and how many in a pair?

N Three.

TA Two, we have eight lots of...

A&Je Times. (CLP3, G1, 59-65)

Je Told ya. Okay. In a game, Steve threw a six three times in a row. How many places did he move forward?

A 21

TA How did you work that out? 6 x 3

N 6 plus 6 plus 6 equals.

Je Plus

A Times. (CLP3, G1, 234-239)

N There are three lines of children. If there are eight children in each line, how many children are there altogether?

A Plus, plus.

N Shhhhhosh, when I'm talking.

A Times.

Je Give me take away.

K Times.

TA No.

A Give me a plus.

TA Listen.

A Equals.

TA There are three lines of children. If there are eight children in each line, how many children are there altogether?

K Times.

A Times.

Je Times, times, times.

TA Three lots of times. (CLP3, G1, 179-193)

However the students became more comfortable with expressing themselves, especially K.

TA So if he gave them away, what is he doing?

K Take away. (CLP3, G1, 114-115)

The students especially responded to familiar situations in the problems, particularly when their names were included in the questions. A pseudonym is used here to protect anonymity.

N Nancy has one dozen apples and takes away four apples to give to her grandparents.
Je (Giggles)
N How many apples has Nancy now?
Je (Laughs) (CLP3, G1, 194-197)

Students especially enjoyed putting the numbers in the calculator, however they did not employ methods to check whether the operation or answer were correct,

E 52 is 25. (Where 52 is the question and 25 the answer)
Jo 23 is 3.
T Once you finish it, put it in the middle.
M 10 is 41.
Jo 19 is 9.
E 51 is 4. (CLP3, G2, 157-162)

Jo at one point takes the opportunity to correct a mistake.

Jo I think this is plus?
T A plus is it? Yes, I think it might be. Someone put it in the wrong spot. (CLP3, G2, 165-166)

At the conclusion of the lesson the TA and the teacher/researcher discussed the lesson. They agreed the students responded well to the structure and content of the lesson, although they also believed the number of questions was excessive and the lesson could have benefited by a smaller number of questions. The calculating of the answers at the end of the lesson became disorganised however this process was not considered the aim

of the lesson. The students worked well in their groups with K beginning to respond well.

Week 6: Cooperative Learning Program 4 (CLP4) – Two-step Word Problems A

Table 4.11 provides the students and facilitator configuration of the three groups for the fourth cooperative learning program (CLP4). T refers to the teacher/researcher, TA refers to the teacher's aide and Mi refers to a Year Ten student who was allocated to the teacher/researcher's lessons providing an opportunity to create a third group.

Table 4.11 Group configuration for Cooperative Learning Program 4 (CLP4)

Cooperative Learning Program 4 (CLP4) Two-step Word Problems A Week 6					
Group One		**Group Two**		**Group Three**	
Students	**Facilitator**	**Students**	**Facilitator**	**Students**	**Facilitator**
A B K(absent) N	TA	Je Jo S	T	E M Tr	Mi

The final lesson in the cooperative learning program had three facilitators. The teacher's aide and the teacher/researcher were joined by a Year 10 student who had been allocated by the Deputy Principal, to the teacher/researcher's classes till the end of the year for mentoring. This presented the opportunity for the groups to be divided into a further group. Mi was assigned to the group who displayed a higher cognitive level, to complement their ability. The teacher/researcher wished to observe Je, to assess her leadership role against Jo who was displaying discriminative thinking. S had returned to the class after being absent from the last two lessons and was allocated to this group as his cognitive level resembled Je and Jo and the teacher/researcher considered she would contain his possible negative behaviour in her group. The TA had responded well with A, K and N so she was assigned to Group1 with B who had proved to be very negative

toward the lessons and could influence the other two groups while it was felt by the teacher/researcher that A, K and N would continue with their work regardless.

In this lesson the teacher/researcher explained to the students that similar to the previous lesson each group would be given an envelope containing a number of word problems (Appendix C - Activities), however instead of one operation, in this lesson there would be two operations. Each group would also be given a table for recording the two operations and the answers to the word problems (Appendix C - Activities). It was stressed to the students that the aim of the exercise was to decide on the two operations used in each question. These were first to be recorded, then the students could use their calculator to record their answer.

Table 4.12 tabulates the number of verbal interactions of each student during the fourth cooperative learning program (CLP4). The legend provides a group display of the interactions, eg. ○ ⇒ **0** ie. ○ indicates zero responses

Table 4.12 Results of the verbal interactions Cooperative Learning Program 4 (CLP4)

Group	Participant	Cognitive			Affective			Social			Task		
		P	C	N	P	C	N	P	C	N	O	N	
1	A	●	◒	◓	◒	◒	○	○	◒	○	○	○	31
	B	◒	○	○	○	○	◓	○	○	◒	○	◒	16
	K	-	-	-	-	-	-	-	-	-	-	-	-
	N	◓	◓	◓	◒	○	○	◒	○	◒	○	◒	33
Group Totals		22	10	14	6	3	7	3	3	6	0	6	
Decile		0.26	0.12	0.18	0.07	0.04	0.09	0.04	0.04	0.08	0.00	0.08	
2	Je	◓	◒	◒	◒	○	○	○	○	◒	○	◒	22
	Jo	*	◒	◒	◒	◒	○	○	○	◒	○	◒	38
	S	◒	◓	◒	○	○	◒	○	○	○	○	◒	19
Group Totals		10	13	9	6	3	3	0	0	6	0	9	
Decile		0.17	0.21	0.15	0.10	0.05	0.05	0.00	0.00	0.10	0.00	0.15	
3	E	●	◒	◒	◓	◒	◒	◒	◓	◓	◒	●	63
	M	●	◓	◒	◒	◒	◒	◒	◒	◓	○	●	56
	Tr	●	◓	◒	◓	◒	◒	◒	◓	●	○	*	77
Group Totals		56	17	9	17	9	9	9	17	26	3	44	
Decile		0.26	0.08	0.04	0.08	0.04	0.04	0.04	0.08	0.12	0.02	0.20	
Lesson Totals		88	40	32	29	15	19	12	20	38	3	59	
Decile		0.25	0.11	0.09	0.08	0.04	0.05	0.03	0.06	0.11	0.01	0.17	

Number of verbal interactions: ○ ⇒ **0,** ◒ ⇒ **1 – 5,** ◓ ⇒ **6 – 10,** ● ⇒ **11-15,** * ⇒ **> 20**

In this lesson the students in both Group 1 and Group 2 did not score as high in their verbal interactions as compared to their individual scores in the previous lesson. When considering the transcripts of this lesson, the facilitators score an increased level of input. The facilitator in each group read the questions, which were more complex as they consisted of two operations and often needed to repeat the question a number of times, in part or whole.

S Jenny asked Mary to count the money for the day's collection for the talent quest. There were 30 five-cent coins, 20 ten-cent coins and 50 twenty-cent coins. How much money did Mary have to count?

T So what do you think the first thing you're going to have to do?
S Plus?
T Plus what?
S Wellllllll
T Well 30 five-cent pieces, what are you going to have to do there?
S Times.
T That's it. You're going to have to times all these. Them once you've times them all, what do you think you have to do then?
S Add'm up.
T That's right. So the second operation is add. Good. (CLP4, G2, 16-25)

The students in Group 1 took a while to apply themselves to the task.

TA How would you work out how many students are not going to the concert?
A Eeeeeeeeee feeeeee poo poo.
B What are you talking about?
N Why don't you listen?
B Nuowwwww
TA If you read it, if you've got 385 students, of which 175 are in ...
B This is boring. (CLP4, G1, 43-49)

The students' off task behaviour emphasised the benefits of a facilitator.

TA Year 7 and 160 students are in Year 8 have paid their money. How many are going to the concert? So if you have this many Year 7 and 8 students altogether, what operation is that?
B What are the operations? I don't know. So I can't tell ya.
A 15
TA We'll write that down. Now tell me, how did you get that answer?
A Take away.
TA Good. So the first operation is to take away. No. Well that's your answer.
A Doooooooooo

TA I think the first operation might be to add these two together. You did take away.

A Mmmmmmmm

TA You can actually take away. You can take away, 5 take away 175 first then 160. What did you get?

A 132. (CLP4, G1, 50-60)

All the students in Group3 presented a positive cognitive attitude as compared with the previous lessons. The students related well with Mi who worked at a slightly higher level than the students in the group. During the problem solving discourse there occurred off task banter which was ignored by Mi who preformed a substantial amount of the problem solving and calculation.

Mi On Saturday night there were fifteen rows of eight people at the Springwood High School Theatre Company production. At the Sunday matinee there were twelve rows of six people. (noise while Mi reads) How many people attended the production on these two days? Tr your turn.

Tr What do I have to do?

Mi On Saturday night there were fifteen rows of eight, 15 times 8.

M Clear.

E Mimimimeeerrrrmimi..

Tr 15 times 8 equals.

Mi 120.

M We writing this?

Mi 120. Then at Sunday there were 12 rolls of 6. So 12 times 6.

Tr Rolls, rolls.

Mi&E 72

Tr&M Rolls, rolls.

Mi 120, 120 and 72 together, and what do you get?

Tr 120.

M 120 and 9.

E 192.

Mi Kinder obvious. Hello. Mr Butthead. (CLP4, G3, 77-94)

Toward the conclusion of the lesson there was a shift from Tr's positive participation to M. E became frustrated with the other students and decided to work on her own.

Mi	A transport vehicle weighs 5 tonnes by itself. If three containers each weighing two tonnes are loaded onto the vehicle, what would be the total mass of the vehicle with its load? Derrrr. 7 tonnes!
Tr	..... six for?
Mi	Guys.
Tr	Yep.
Mi	times 3. What's 3 times 2.
Tr	3 2's are 4.
Mi	No.
M	6.
Mi	Yeahhhhh. Then times 6 times 5, 6 plus 5?
M	11.
Mi	Yeahhhhh. 5 11 11 tonnes.
Tr	That was sooo easy. I didn't even need much .... 11 times 6 plus 5

(CLP4, G3, 270-281)

During the off task discourse some learning occurred between Tr and M. Mi, although the facilitator, instigated most of the problem solving.

At the conclusion of the lesson the teacher's aide and the teacher/researcher discussed the lesson. They agreed that the students found this lesson considerably more demanding than the previous lesson and required a large amount of direction. It was felt that the students could have benefited from more activities incorporating one-step problems before presenting the more complex two-step problems.

A general observation discussed between the teacher/researcher and the teacher's aide at the end of the cooperative learning program was the different response to group work between the boys and girls. Of the six boys, only two Jo and A responded well, however all four girls were actively involved during the program. E at times preferred to work on her own, however this was when she was being distracted by the boys.

SUMMARY

Chapter Four provided an analysis of the data collected during a fifteen week period which included a questionnaire, a test of word problems and a four week cooperative learning program to assess the impact on the achievement in and attitudes to Mathematics.

The questionnaire composed of questions focusing on the cognitive, affective and social domain. The analysis of the responses showed a significant positive change in the affective domain, while the cognitive and the social domains showed no significant change.

The word problem test concentrated on the operations of addition, subtraction and multiplication. The analysis showed the students had a good knowledge of the one operation involving either addition or subtraction. Both the operation of multiplication and the two mixed operations of addition, subtraction and multiplication showed a short term improvement, although this was not statistically significant.

The cooperative learning program centered on four activity lessons analysed by reference to audio-tapes of the lessons and observations of the teacher/researcher and the teacher's aide, who assisted the teacher in the group work, activity lessons. It particularly showed, the students responded well to activities which they perceived as the more traditional mathematics lesson.

The analysis also demonstrated interesting aspects of individual students which led the researcher to consider three students as case studies. These are presented in Chapter Five.

Chapter 5

CASE STUDIES

Introduction

The methodology of the research was described in Chapter Three, with a description of the context, participants and procedures as well as a brief synopsis of the analysis. In this chapter, case studies of three students are presented who were selected specifically from the group of participants because of their very different responses to the cooperative learning program. The first case study will introduce B, for whom the cooperative learning program appeared to make little difference. The second case study will profile Je, who benefited from the program. The final case study will consider N, who did not perform well under the cooperative learning conditions.

CASE STUDY OF B

Prior to Data-collecting

Prior to the data-collecting period, B was observed to be a quiet worker who completed his work. He was inactive in class discussions and seldom answered, even when prompted. B appeared to have difficulty focusing on the work presented in class but when his work book was examined he displayed an acceptable understanding.

Initial Self-perspective – Cognitive

Table 5.1 displays B's results for the cognitive aspect of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions. Q1 and Q2 relate to B's belief in his ability to do mathematics, requiring a very skilled, skilled, unskilled and very unskilled response. The subsequent questions refer to B's attitude to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.1 Questionnaire results for B
Cognitive – beginning

Cognitive – Beginning			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
2	1		
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	14 18	5 22	

Cognitively, B's responses to the initial questionnaire were decisive. He responded positively to Q14, enjoying adding numbers in his head and Q1 and Q2, his ability to solve word problems. But B was clear in his mathematical direction: from responses to Q5 and Q22, he did not wish to attempt more complicated mathematics.

Initial Test

Table 5.2 demonstrates B's correct responses, indicated as numbers in the table, to the word problem test conducted at the beginning of the cooperative learning program.

Table 5.2 Word Problem Evaluation Test results for B
Beginning

	Beginning
+ -	1 2 3 5 6 8 10 13
× ÷	4 9 11 12
Combination	15 18
Total	**14/20**

B scored well in the one operation initial word problem test. He only miscalculated Q7, where he questioned the phrase 'long distance'. B displayed difficulty, however, with

the combination questions. He answered correctly both Q15 and Q18 which related to money. Q14 required 'doubling' and multiplication. B doubled but failed to multiply by 5. Q16 required multiplication and then subtraction, $4 \times 8 - 5 = 27$, B's solution was 17. This answer could be the result of adding the three numbers together, $4 + 8 + 5 = 17$ or he could have made a miscalculation of ten, caused by a misunderstanding of place value. His response showed little understanding of the problem. In Q17, B attempted the question by translating the number words to a written numeral but failed to subtract the three students with the flu, the second part of the problem. B began by translating the numeral in Q19 but did not complete the question and Q20 he did not appear to attempt.

Initial Self-perspective - Affective

Table 5.3 displays B's results for the affective component of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions targeting B's feeling towards his ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.3 Questionnaire results for B
Affective - beginning

Affective – Beginning			
Strongly Positive	Positive	Negative	Strongly Negative
	7 11 12 15 19	6 13	4 23

In relation to the affective domain questions of the survey, B did not record a 'strongly agree' response in the initial administration. He responded 'agree' to five questions. He would, be happy to do well in mathematics (Q7), mathematics (Q11) and mathematics' tests (Q12) did not scare him and (Q19) he did not feel anxious about mathematics' tests the day before the test. Interestingly though, he put a question mark against the question asking whether he liked getting mathematics tests back (Q21) making no response. He also had no problems putting his hand up in class (Q15). This last response contradicted the initial observations of B. He admitted to trying hard in mathematics but found it

hard (Q6), making him feel uneasy and confused (Q13). In relation to feeling good about mathematics (Q4) and enjoying his homework (Q23), B gave a strong negative response.

Initial Self-perspective – Social

Table 5.4 displays B's results for the social section of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions relating to B's feeling about his ability to relate towards his peers in mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.4 Questionnaire results for B
Social - beginning

Social – Beginning			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	8	10 16 20	9 17

In the social domain B does not mind other students thinking he is smart in mathematics (Q8). B's responses to the initial questionnaire foretell his dislike of doing mathematics in a group situation. He responded with a dislike of helping his friends (Q16), is bothered by not understanding the explanation of a student in his mathematics class who does understand (Q20) and strongly dislikes walking into a mathematics' classroom (Q17). He also believed he would have very little use for mathematics when he leaves school (Q10) and definitely believed mathematics to be unnecessary and not worthwhile (Q9).

Performance in Groupwork - Cognitive

Figure 5.1 displays B's cognitive interactions during the cooperative learning program.

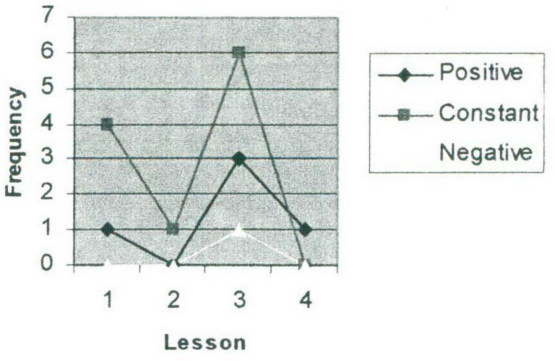

Figure 5.1 Group work interactions for B
Cognitive

In the cognitive domain, during group work, B verbalised seventeen comments. Initially in CLP1 he was disruptive, taking and hiding cards, especially provoking E. Once the teacher/researcher had focused the group, B was observed to comprehend the required operations a number of times, by placing the card in the appropriate position, without comment. His one positive comment occurred at the end of the session after the teacher/researcher had devoted a substantial amount of time encouraging the group to be cooperative and expressive. His three constant comments in CLP1 involved reading what he saw on the cards. In CLP2 his single cognitive constant comment referred to his understanding of the teacher's aide's organization of the game.

TA What number do you want B.

B I only want one. (CLP2, G2, 33-34).

B verbalized the majority of his cognitive comments in CLP3. His group was again facilitated by the teacher/researcher. Two of B positive comments occurred early in the discourse.

T …… your go B. Read it out.

B Orrr, why?

T Because we would like to know what you are doing. I'll help you with the hard words.

B No, they're just names.

T All right, go.

B Mario, *(mumble)* Vince are going to buy a present. How much will each child pay if the gift costs $12?

T So what are you going to do with that?

B Ummmmm, it's not that.

T No.

B It's not minus. (CLP3, G2, 14-23)

Here B showed his understanding indirectly by defining the operation that was not correct. During this session, the teacher/researcher encouraged the students to read the word problems and this was why B scored six cognitive constant comments.
B's positive comment in CLP4 was a correct answer to a word problem.

Performance on Groupwork – Affective

Figure 5.2 displays B's affective interactions during the cooperative learning program.

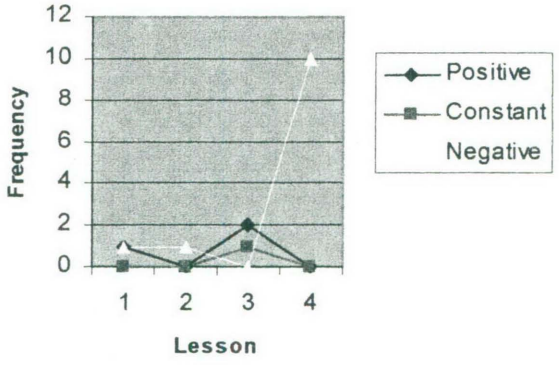

Figure 5.2 Group work interactions for B
Affective

B provided very few affective domain comments except in CLP4 where he presented ten negative comments. Seven of these occurred in the opening stages of the group work session.

TA All right, first of all we have to work out what the first operation would be.

B I'm not doing this, Miss.

TA All right I'll do this one.

B Nu I'm not doing it, Miss.

TA There are six rows of pine trees in each row, that's the first part. Okay, looking A. There are six rows of pine trees, there are ten pines trees in each row. At the moment, how many are there?

B What on earth is this for?

TA That's our first operation.

B Can I draw on it?

TA What do we do first?

B I don't want to do this.

TA Coooome on, coooome on, B, you can do it.

B It's boring.

TA What would the first operation be?

B Zero. (CLP4, G1, 1-14)

Here B showed he didn't want to be involved in the activity. He believed it was boring. The teacher's aide's persistence involved B and eventually he made a cognitive positive comment. This involvement however, was soon reversed.

TA Right, there you go. Number two. I'll get B to do this one.

B No (CLP4, G1, 33,34)

He continued to state that the activity was boring throughout the lesson:

B This is boring. (CLP4, G1, 49)

B Gee, this is boring. (CLP4, G1, 94)

B also displayed no fear of appearing foolish as shown by this exchange in CLP4.

TA ... So if you have this many Year 7 and 8 students altogether, what operation is that?

B What are operations? I don't know. So I can't tell ya. (CLP4, G1, 50,51)

This was the fourth group work lesson on operations. B had clearly shown an understanding of the word previously. B was not only appearing unintelligent to his peers but also taunting the teacher's aide.

Performance in Groupwork – Social

Figure 5.3 displays B's social interactions during the cooperative learning program.

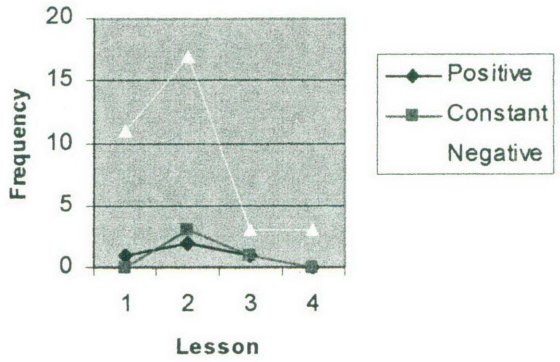

Figure 5.3 Group work interactions for B
Social

Initially in the first two group work lessons CLP1 and CLP2, B made a total of 34 comments, 28 of which were negative comments. These generally were simple statements, such as, "Shut up!" (CLP1, G2, 32 & 34), "Yeah!" (CLP1, G2, 58), "Dominos are boring!" (CLP1, G2, 131), "He's a bore." (CLP2, G2, 43) and "This is gay!" (CLP2, G2, 64). At the conclusion of CLP1, B used the word "boring" on its own and yelled it into the audio recorder. His social positive comments were responses to teacher's aide with "Sorry" for bad behavior. In CLP3, B does not wish to participate in the group work activity.

M … Your go.

B I don't want to read it.

T Okay, put it down so other people can read it.

M There you go.

B I don't want to read it but I won't put it down.

T All right, you don't want to read it, so just put it down so other people can read it.

B No, why? (CLP3, G2, 105-110)

CLP4 provides an example of B participating in a silly anti-social dialogue with the other members in his group.

A Eeeeeee feeee poo poo.

B What are you talking about?

N Why don't you listen?

B Nuowwwwww. (CLP4, G1, 44-47)

B does not like working with N and A, the students in his group. The teacher/researcher decided to place him with these students as it was felt they would not intimidate him and he might become more assertive. It obviously had the opposite effect, where he became more assertive but in a negative way.

Performance in Groupwork – Procedural

Figure 5.4 displays B's on and off task interactions during the cooperative learning program.

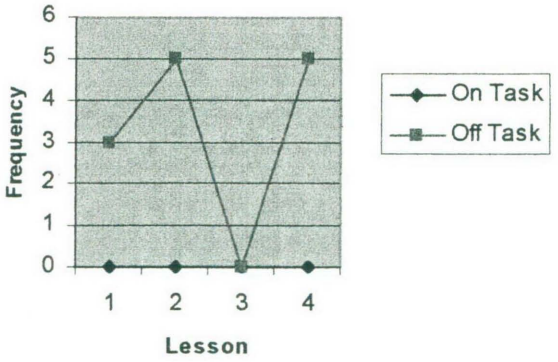

Figure 5.4 Group work interactions for B
Procedural

B takes no initiative in directing his groups procedurally. He makes 13 off task comments, 10 were during CLP2 and CLP4 which were facilitated by the teacher's aide. In CLP2, B's off task comments were directed toward M, both were planning to play snap with the tiles, rather than solve the square-saw puzzle. In CLP4, B asks to the teacher's aide about her children. CLP3 was facilitated by the teacher/researcher who kept B focused by encouraging his involvement in the task. Here B recorded no on or off task comments. The teacher/researcher's sense that B was less likely to misbehave with her, than with the teacher's aide, appeared justified.

End Self-perspective – Cognitive

Table 5.5 displays B's results from the cognitive aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions. Q1 & Q2 relate to the B's belief in his ability to mathematics, requiring a very skilled, skilled, unskilled and very unskilled. The subsequent questions refer to B's attitude to his ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.5 Questionnaire results for B
Cognitive - End

Cognitive – End			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
	1 2		
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	14 18	5 22	

B's responded to the cognitive questions at the end of the group work lessons showed little change. In Q2 his response to his ability to solve word problems shifted from very positive to positive. This shift agreed with his response to Q18 which was written in the negative and implied an inconsistency in his response in the initial questionnaire.

End Test

Table 5.6 demonstrates B's correct responses, indicated as numbers in the table, to the word problem test conducted at the end of the cooperative learning program.

Table 5.6 Word Problem Evaluation Test results for B
End

Beginning	End
+ -	1 2 3 5 6 8 10 13
× ÷	4 7 9 11 12
Combination	14 15 17 19
Total	**17/20**

An improvement in B's test results was noted when his end test scores were compared with his initial results. In the end test he scored 17 out of 20 against his initial results of 14 out of 20. B answered Q7 correctly where previously he had questioned the phrase 'long distance'. He answered Q14, Q17 and Q19 correctly after incorrect answers in the initial test. Q18 was correct in the initial test where he showed his working by writing

the conversion of each number of coins to the actual amount above the words in the question and then adding them. In the end test there were no written calculations, just the answer $2 instead of $3. This suggests he either tried to recall the answer from the initial test or he mentally miscalculated. In Q19 B wrote fifteen lots of eight and twelve lots of six, then added in pairs, then grouped and finally added three numbers together to obtain the final answer. In analysing B's calculations it was found he made two small miscalculations which cancelled each other out. Rather than multiplying fifteen by eight and twelve by six, then adding, B's method for a relatively complex calculation proved laborious, resulting in miscalculation.

End Self-perspective - Affective

Table 5.7 displays B's results from the affective aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions targeting B's feeling towards his ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.7 Questionnaire results for B
Affective - End

Affective – End			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
21	7 11 12 15 19 13	6 4	23

Where B questioned Q21 regarding getting Mathematics tests back in the initial questionnaire by responding with a '?', in this questionnaire he was very positive in his response. His response shifted positively by one in his feeling uneasy and confused (Q13) and feeling good about Mathematics (Q4).

End Self-perspective – Social

Table 5.8 displays B's results from the social aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions relating to B's

feeling towards his ability to relate towards his peer in mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.8 Questionnaire results for B
Social - End

Social – End			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	8 20	10 16	9 17

In the social domain B continued to score low when compared with his initial responses. He made a shift of one with an improvement in his attitude to being bothered by other students not understanding his explanations (Q20).

Later Test

Table 5.9 demonstrates B's correct responses, indicated as numbers in the table, to the word problem test conducted approximately eight weeks after the end of the teaching sequences, following the Christmas break.

Table 5.9 Word Problem Evaluation Test results for B
Later

	Later
+ -	1 2 3 5 6 8 10 13
× ÷	4 7 9 11 12
Combination	14 15 16 18
Total	**17/20**

B's score of 17 out of 20 for the later test was similar to the end test. In Q18, he again scored correctly after an incorrect answer in 'End', placing a '1' under each calculation of the coins, indicating $1. In Q17 where he scored correctly in 'End', he returned to his

incorrect answer in the beginning, where he only subtracted the paying students. B did not attempt either Q19 or Q20. When the teacher/researcher questioned him, he explained, he could not be bothered.

Summary of the Case Study of B

B displayed reservations at the beginning of the data collecting period. His responses showed he was happy working the way he was in mathematics. He did not want to work at more difficult mathematics and he did not want to share his understanding with others. This attitude showed minimal change after the cooperative learning program. B made some improvement in his test results between the beginning and the end of the cooperative learning program, which had little effect on his self perception. B's discourse in the cooperative learning period showed a definite dislike of working in a group situation. Overall, the cooperative learning program had made little difference to B's attitudes, and only a small difference to his achievement.

The previous section focused on B who displayed a resistance to the cooperative learning teaching strategy. This section of Chapter Five will consider Je, who displayed a positive response to group work.

CASE STUDY OF JE

Prior to Data-collecting

Je had been observed by the teacher/researcher, as her classroom teacher, for nine months prior to the data collecting period. In the traditional classroom environment this student sat quietly, contributing little discourse during classroom discussions. Her mathematical ability had been assessed at an early Stage 2.

Initial Self-perspective – Cognitive

Table 5.10 displays Je's results for the cognitive aspect of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions. Q1 and Q2 relate to Je's belief in her ability to do mathematics, requiring a very skilled,

skilled, unskilled and very unskilled response. The subsequent questions refer to Je's attitude to mathematics, requiring a strongly positive, positive, negative and strongly negative response.

Table 5.10 Questionnaire results for Je
Cognitive - beginning

Cognitive – Beginning			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
2 1			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
5 14	22	18	

Je's initial responses to the cognitive questions in the questionnaire (Appendix 3.2) were principally positive with four of the six questions scoring the most positive response and one scoring the second positive response. She only recorded one negative response. Je displayed a very good feeling about her mathematical ability and expressed an enjoyment of counting numbers in her head. In describing how Je thinks she solves word problems, in Q2 she responded with a very positive score, whereas later in the questionnaire, in Q18, a similar question to Q2 but written in the negative, Je responded "disagree". This contradiction caused the teacher/researcher concern, but may have been caused by Je's low literacy skills when responding to a negatively phrased question. Likewise, in Q5, when describing how she believed she could handle more difficult mathematics, Je responded "strongly agree", while in Q22 she responded "agree". A possible explanation for these contradictions could be Je's decrease in her cognitive belief as she progressed through the questions.

Initial Test

Table 5.11 demonstrates Je's correct responses, indicated as numbers in the table, to the word problem test conducted at the beginning of the cooperative learning program.

Table 5.11 Word Problem Evaluation Test results for Je
Beginning

	Beginning
+ -	1 2 3 5 6 8 10 13
× ÷	4 7 9 12
Combination	16 17 18
Total	**15/20**

Je scored correctly in all of the addition and subtraction one-step word problems in the test at the beginning of the data collecting period. Of the six multiplication and division one-step word problems she scored five. In Q11 Je subtracted instead of multiplied. Of the seven combination two-step word problems Je scored three. In Q14 she failed to allow for traveling to and from school. In Q15 she made a miscalculation $10-(3\times 2)=3$. In Q19 she multiplied correctly twice but then subtracted rather than added and finally Je made no attempt at Q20. These results show that Je's initial positive cognitive attitude to her ability to solve word problems is realistic as she scored 15 out of 20.

Initial Self perspective – Affective

Table 5.12 displays Je's results for the affective component of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions targeting Je's feeling towards her ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.12 Questionnaire results for Je
Affective - beginning

Affective – Beginning			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
6 7 11 15 21 23	4 12		13 19

Of the ten questions referring to the affective domain in the initial questionnaire Je responded positively to eight questions with six questions very positively. She only responded negatively to two questions but her responses were very negative. Je believed at the time of the initial questionnaire that she tried hard in mathematics and did not find it hard (Q6). She was happy to do well in mathematics (Q7) and it did not scare her (Q11). Je had no problems raising her hand in mathematics' classes (Q15). She enjoyed homework (Q23) and receiving test back (Q21). At the time she felt good about mathematics (Q4) and test did not really scare her (Q12). Je, nevertheless in Q19 admitted she becomes very worried the day before a test. This, the teacher/researcher believed posed a contradiction. Finally, a further contradiction to all her positive comments occurred with Je's strong negative response to mathematics making her uneasy and uncomfortable in Q13.

Initial Self perspective – Social

Table 5.13 displays Je's results for the social section of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions relating to Je's feeling about her ability to relate towards her peers in mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.13 Questionnaire results for Je
Social - beginning

Social – Beginning			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
8 16 17	9	20	10

In the social domain Je responded positively to four of the six questions. She was very positive about how other students responds to her smartness in mathematics (Q8). She especially enjoyed walking into her mathematics' classroom (Q17) and helping other students work out mathematic problems (Q16). She agreed mathematics is a worthwhile and necessary subject (Q9). Je felt she become bothered when she did not understand the explanation of a student in her mathematics class who did understand (Q20). Even though Je had a positive attitude to mathematics and her mathematics classroom, she strongly felt mathematics would be of little use to her when she left school (Q10).

Performance in Groupwork - Cognitive

Figure 5.5 displays Je's cognitive interactions during the cooperative learning program.

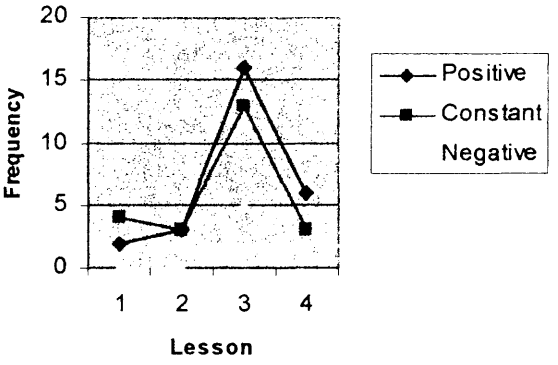

Figure 5.5 Group work interactions for Je
Cognitive

Cognitively Je made only six comments in the first group work lesson (CLP1) and six comments in the second group work lesson (CLP3). In the third group work lesson (CLP3) Je made 36 cognitive comments while in the final lesson (CLP4) she made 10 cognitive comments. Since CLP1 required the students to match cards with synonyms related to the four mathematical operations of addition, subtraction, multiplication and division, the teacher/researcher noted that much of the cognitive verbal demonstration was not evident, as students placed their card on the relevant stack of cards without comment. Similarly in CLP2, students were observed to work quietly by themselves, making very few cognitive comments. CLP3 encouraged more discussion, requiring the students to decide on the appropriate operation for the one-step word problems. It also required students to read the problems and the teacher/researcher coded these discourse as cognitive constant (CC) as it required the students to be able to read, however it do not display mathematical cognitive. In the first three group work lessons (CLP1, CLP2, CLP3) Je's peer group consisted of the same members A, K and N while in CLP4 the groups were changed and Je was grouped with Jo and S. It was observed that Jo dominated the discourse in this lesson.

In CLP1 Je's cognitive positive comments (CP) were simple responses

T Start please, by taking them out and putting them .....

Je Okay, we have to put them into groups. (CLP1, G1, 1-2)

She listened to the teacher/researcher's directions, understood and interpreted to the group. She also questioned A's comment:

A Share.

Je Is that right?

A Share.

Je Each ..... okay (CLP1, G1, 23 - 26).

Again CLP2 Je's CP comments were of low order.

Je I've got a middle! (CLP2, G1, 6)

Je I've got 2 again. (CLP2, G1, 55)

All Je's CP comments in CLP3 were short and defined an operation,

Je That's divide. (CLP3, G1, 19)

Je Oh plus. (CLP3, G1, 103).

When Je was placed in a group which required a higher level of thinking in CLP4, she had to compete with Jo's constant discourse with the teacher/researcher and her answers became more complex by not only describing the operation but expanding it by combining the operation with the value required for the solution.

T All right, 80. Put 80 down. So that's 80 what?

Je Litres.

T 80 litres. So how much is each litre?

Jo 83 cents.

T 83 cents. So what are you going to do with...?

Je Times 80. (CLP4, G2, 75-79)

Here Je followed a procedure directed by the teacher/researcher that involved Jo and she displayed a link between number and units.

T ..... What happened to 286 divided by 26?

Jo I got 11?

T That's good. Okay, now what are you going to do with the 11? One is 11. What's 2?

Je 22.

T That's right, 22. You actually multiplied. (CLP4, G2, 102-106)

Je displayed the ability to interpret a more complex procedure and double.

At the cognitive constant (CC) level, Je read words and questions such as

Je Okay, I've got times. (CLP1, G1, 4)

Je Mary adds $5 to her savings of $15. How much has she now? (CLP3, G1, 143)

She anticipated the teacher/researcher's directions:

T Now what you've got to do is fiddle with them until they start to um ...

Je Go together. (CLP2, G1, 9-10)

Je also asked relevant procedural questions

Je Does it matter if it's upside down? (CLP2, G1, 17).

Je made six detectable cognitive negative (CN) comments during the group work lessons. Five of these occurred during CLP3 and one during CLP4. The comments

involved inaccurately determining the appropriate algorithm for a particular word problem. Je was able to self correct when prompted.

A In a month Dianne saves $27 and Max saves $49. How much do they save between them?

TA Okay.

Je That's divide.

TA Between them, it says how much.

Je Oh, plus.

TA Altogether.

Je Altogether. (CLP3, G1, 99-105)

In one case Je becomes quite determined about her decision concerning the operation in a relatively simple word problem and involves A and N. She appears to make a game of the misconception revealed in the inflections in the taped conversations rather than in the words used.

N What is the difference between 25 and 15.

A Times.

TA No, how did you get times? Difference.

N Plus.

Je No, divide.

TA Difference, difference!

N Plus.

TA No, difference is ....

Je Divide.

A Take away.

TA Yes, take away. (CLP3, G1, 145-155)

Performance on Groupwork – Affective

Figure 5.6 displays Je's affective interactions during the cooperative learning program.

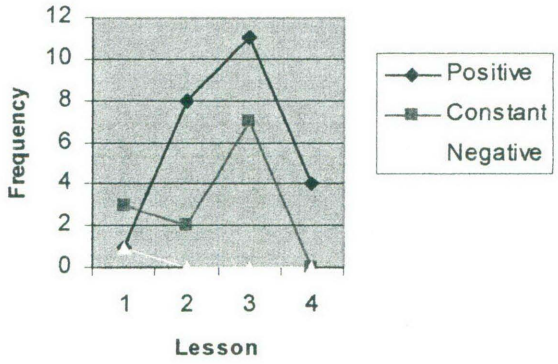

Figure 5.6 Groupwork interactions for Je
Affective

In the affective domain, of J's 37 comments she only made one negative comment, which occurred in the first cooperative learning lesson.

Je Miss, I really need a question now. (CLP1, G1, 96)

Here she is appealing to the teacher/researcher's for attention and shows no initiative to solve her problem of what to do, as she had run out of cards.

Her positive and constant affective comments reflect her positive interaction with the teacher/researcher, which is developed in CLP2 and continues into CLP3 and her feeling of success.

Je I won. (CLP2, G1, 109)

Je I'm a champion. (CLP2, G1, 113)

She also often expressed her enjoyment with giggles and strange sounds.

Je Uggggggg. (CLP3, G1, 82)

Performance in Groupwork – Social

Figure 5.7 displays Je's social interactions during the cooperative learning program.

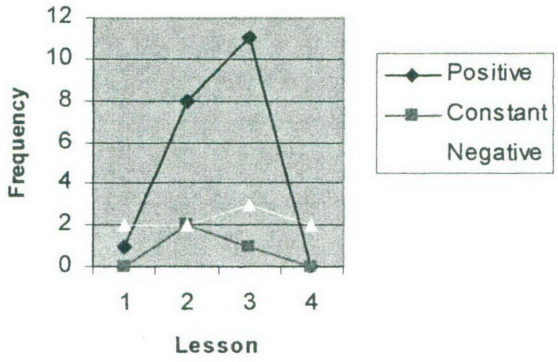

Figure 5.7 Groupwork interactions for Je
Social

In the social domain Je made 32 comments, 20 of which were positive and of these 19 occurred in the second and third cooperative learning lessons. All these positive comments were addressed to the teacher/researcher or the teacher's aide, by answering question politely.

Je I'm a champion?
T Yes.
Je Thank you, Miss. (CLP2, G1, 115)

Here Je thanks the teacher/researcher, when she agrees that Je is a champion.

The negative comments occurred at the beginning of the lessons and were addressed to the microphone, with comments like "Dork" (CLP2, G1, 2) and "Pregnant" (CLP2, G1, 4).

These comments did not appear to refer to anyone and seemed totally irrelevant to the lesson.

Performance in Groupwork – Procedural

Figure 5.8 displays Je's on and off task interactions during the cooperative learning program.

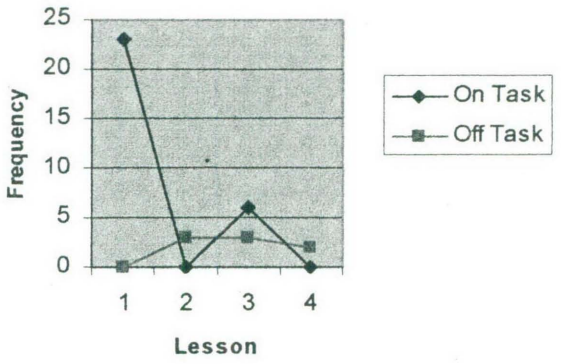

Figure 5.8 Groupwork interactions for Je
Procedural

All of Je's procedural on task comments refer to her directing her peers of their turn, either to place cards in CLP1 and CLP2 or read the problem in CLP3 and CLP4. She enjoyed taking control of the lesson and displaying leadership.

Her off task comments involved discussion with the members in her group. The subject of these discussions was impossible to decipher from the audio-tapes and occurred when the lesson appeared to be too long for all the students' concentration. It was necessary for the teacher/researcher and the teacher's aide, as facilitators, to redirect the students' attention.

End Self-perspective – Cognitive

Table 5.14 displays Je's results from the cognitive aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions. Q1 & Q2 relate to the Je's belief in her ability to mathematics, requiring a very skilled, skilled, unskilled and very unskilled. The subsequent questions refer to Je's attitude to her ability to do mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.14 Questionnaire results for Je
Cognitive - End

Cognitive – End			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
1 2			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
5 14 18 22			

Je continued with her positive cognitive beliefs in the questionnaire at the end of the cooperative learning program. Where previously she responded 'agree' to being able to handle more complicated mathematics (Q22), here she responded 'strongly agree'. It was suggested previously, that her cognitive belief may have decreased as she read the questionnaire; however, it appears here, she has become assured of herself. Similarly she shifted from a negative position, when asked whether she had difficulty with word problems (Q5) to a 'strongly positive' response. This shows Je improved in her cognitive belief after the cooperative learning program.

End Test

Table 5.15 demonstrates Je's correct responses, indicated as numbers in the table, to the word problem test conducted at the end of the cooperative learning program.

Table 5.15 Word Problem Evaluation Test results for Je End

	End
+ -	1 2 3 5 6 8 10 13
× ÷	4 7 9
Combination	15 16 17 18
Total	**15/20**

In the Beginning test Je also scored fifteen correct out of twenty. As with the Beginning test Je scored all of the addition and subtraction one step word problems correctly. Of the five multiplication one step word problems, Je scored three correctly. She again miscalculated Q11, where in the Beginning test it was possible to assume she had multiplied rather than subtraction, in the End test her answer of zero did not provide any clues as to her method of calculation. In Q12, where Je had scored correctly in the Beginning test she again proved no obvious reason for her calculation of 750. For the combination word problems, Je continued with the same error of only calculating one way to school. She realized there were five days in a school week and to obtain the correct solution she must multiply the distance and the time. So Je was capable of the concept of multiplication with this question, where in Q11 and Q12, she had difficulty.

End Self-perspective - Affective

Table 5.16 displays Je's results from the affective aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions targeting Je's feeling towards her ability to mathematics, requiring a strongly positive, positive, negative and very negative response

Table 5.16 Questionnaire results for Je
Affective - End

Affective - End			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
4 6 7 11 23 12 19 21	13 15		

In the affective domain, all of Je's responses moved into the positive. When considering her beginning responses, the negative responses to Q13 relating to mathematics making her feel uneasy and confused and Q19 referring to feeling anxious about a mathematics test the day before the test, were questioned as they contradicted positive responses to the other questions. Here Je displays no contradiction.

End Self-perspective – Social

Table 5.17 displays Je's results from the social aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions relating to Je's feeling towards her ability to relate towards her peer in mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.17 Questionnaire results for Je
Social - End

End			
Positive		Negative	
Strongly Positive	Positive	Negative	Strongly Negative
8 16 17	9 20		

Je's positive social responses continued at the end of the cooperative learning program. She differed with one positive shift to Q20, where she became less bothered regarding other students' attitudes toward her understanding mathematical questions. Also she was strongly negative regarding her use of Mathematics in the future (Q10), in this questionnaire she does not respond, the only question to which she does not respond.

Later Test

Table 5.18 demonstrates Je's correct responses, indicated as numbers in the table, to the word problem test conducted approximately eight weeks after the end of the teaching sequences, following the Christmas break.

Table 5.18 Word Problem Evaluation Test results for Je Later

	Later
+ -	1 2 3 5 6 8 10 13
× ÷	4 7 9 11 12
Combination	15 17 18
Total	**16/20**

In the later test Je scores well in all the one step word problems, however where she scored correctly for Q16 in the previous test, here her answer of 45 implies either an incorrect multiplication or a substitution of addition for subtraction. Again, questions Q19 and Q20 proved to be too complicated for Je at this stage.

Summary of the Case Study of Je

Je began the program with a contradictory opinion of her ability. However, Je appeared to enjoy and benefit from the small groups and especially the close interaction with the teacher/ researcher and the teacher's aide. Where previously in the traditional classroom environment, Je provided very little participation in classroom discussions, here Je became active and displayed strong leadership qualities. Je responded to the group composition, working at a simpler cognitive level with students at that level and rising to a more complex level when grouped with students of that level. Even though Je did not display a marked increased positive shift in the tests and questionnaire when

comparing beginning and end, Je from her positive dialogue in the cooperative learning lesson, benefited from this teaching strategy.

The previous section focused on Je who displayed a positive response to the teaching method of cooperative learning. This section of Chapter Five will consider N, who found group work exposed her weakness in mathematics to other students and became intimidated by the process.

CASE STUDY OF N

Prior to Data-collecting

N had been part of the teacher/researcher's mathematics class for the nine months prior to the data collecting period. Due to N's disability, rendering her mathematically challenged, the teacher/researcher and teacher's aide had devoted a considerable amount of time on the operations of addition and subtraction. The use of the calculator had been employed to facilitate N's understanding. N had come to the class with little ability to add or subtract. By the data collecting period N could deal with basic addition and subtraction work. She presented as a happy student who related well with her peers. Her parents had encouraged N to be involved in a normal classroom environment for social interaction.

Initial Self-perceptive – Cognitive

Table 5.19 displays N's results for the cognitive aspect of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions. Q1 and Q2 relate to N's belief in her ability to do mathematics, requiring a very skilled, skilled, unskilled and very unskilled response. The subsequent questions refer to N's attitude to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.19 Questionnaire results for N
Cognitive - beginning

Cognitive – Beginning			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
	2	1	
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
22		14	5 18

In the initial self-perspective questionnaire N rated herself about average in her understanding of mathematics against the students in her Year Six class (Q1). She believed she would score about 14 out of 20 in a simple word problem test, given the example of a one-operation multiplication word problem (Q2). In the questionnaire Q5 and Q22, referred to the ability to do more complicated or difficult mathematics. In Q5 N responded strongly negative while in Q22 she responded strongly positive. In Q22 the word 'complicated' was used as against 'difficult' in Q5. N may have misunderstood the meaning of the word 'complicated'. Also in Q18 she again appears to contradict herself by her strongly negative response to her ability to working out word problems, where earlier in the questionnaire she rated her ability at 14 out of 20, considered a reasonable score. In Q14 she admitted she did not like adding numbers in her head.

Initial Test

Table 5.20 demonstrates N's correct responses, indicated as numbers in the table, to the word problem test conducted at the beginning of the cooperative learning program.

Table 5.20 Word Problem Evaluation Test results for N Beginning

	Beginning
+ -	1 3 5 6 8 10
× ÷	
Combination	
Total	**6/20**

In the initial test N scored correctly for the four one-operation addition problems and two out of four for the one-operation subtraction problems. For the two incorrect subtraction problems N added. In each of the one-operation multiplication problems she added. In each of the two-operation word problems N took either two or all of the numbers and randomly either added or subtracted. With Q18 she added twenty five-cent coins, ten ten-cent coins and five twenty-cent coins as 205 +10+520.

Initial Self perspective – Affective

Table 5.21 displays N's results for the affective component of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions targeting N's feeling towards her ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.21 Questionnaire results for N
Affective – beginning

Affective – Beginning			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	7 11 21	6 4 13 15 23	12 19

In the affective domain N would be happy to do well in mathematics (Q7). She admits mathematics does not scare her at all (Q11) and she likes to get mathematics tests back (Q21). N says that even though she tries hard in mathematics she finds it hard (Q6), so she does not feel good about her mathematics (Q4) and further mathematics makes her feel uneasy and confused (Q13). She is frightened to raise her hand in mathematics classes to ask questions (Q15) and she dislikes mathematics homework (Q23). Her strongly negative responses refer to tests where she appears to contradict her positive response to mathematics tests. She confesses mathematics tests scare her (Q12) and she feels anxious about mathematics tests one day prior to the test (Q19).

Initial Self perspective – social

Table 5.22 displays N's results for the social section of the questionnaire at the beginning of the cooperative learning program. The numbers refer to the questions relating to N's feeling about her ability to relate towards her peers in mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.22 Questionnaire results for N
Social - beginning

Social – Beginning			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	9 17	8 10 16 20	

In the social domain N initially believes Mathematics is a necessary and worthwhile subject (Q9) but she will have little use for it when she leaves school (Q10). N enjoys walking into a mathematics classroom (Q17) nevertheless she does not like people to think she is smart in Mathematics (Q8) and she does not like helping her friend work out mathematics problems (Q16). She becomes bothered when she does not understand the explanation of a student in her mathematics class who does understand (Q20).

Performance in Groupwork - Cognitive

Figure 5.9 displays N's cognitive interactions during the cooperative learning program.

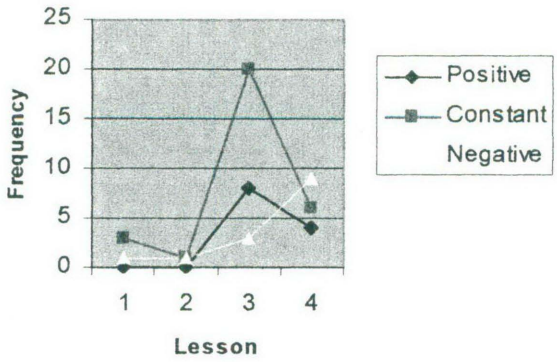

Figure 5.9 Group work interactions for N – Cognitive

N made 56 comments when totaling her cognitive participation in the 4 group work sessions. Of these almost half were cognitive constant components requiring N to read word problems. N became more active in her cognitive discourse in the third and fourth cooperative learning lessons, with eight and six positive responses respectively and three and nine negative responses respectively. In CLP3 all of N's positive responses refer to answering a problem requiring plus as the answer, while her negative responses occur when she answers 'plus' and she is incorrect. In CLP4 N's positive comments relate to the teacher's aide directing her to use her calculator.

TA Take away, that's our second operation. We had 60, if eight pine trees died, how many pine trees would be left? Can you work this one out N. We've got 60, and now we are going to say 60 take away 8 that died to get our answer.

N 55

TA No

N 52

TA 52, okay, that's our first one done. (CLP4, G1, 27-31)

Where she has been directed by the teacher's aide, she again makes a positive comment.

TA On Saturday night there were 15 rows of 8 people, so how do you work out how many people then? Fifteen rows of eight people, how would you get the total amount of people? What operation would you use? Would you plus them all or would you multiply them, take away?

A Times.

TA Right that's a quick way of doing it, times-ing. So we'd say 15 times....

N 8 (CLP4, G1, 110-113)

Her negative comments are the result of guessing.

TA Six times ten, so we would say six times ten first. You do that A. So we say six times ten or ten times six, that's our first bit up to here. If eight pine trees died, how many pine trees would be left? So if we've got 60 and eight pine trees die, what operation, plus, times, divide or minus?

A I know, it's 58, 7

N 6

TA No

N 59

TA What are you doing to get that answer?

N You're plussing. (CLP4, G1, 19-25)

Performance in Groupwork – Affective

Figure 5.10 displays N's affective interactions during the cooperative learning program.

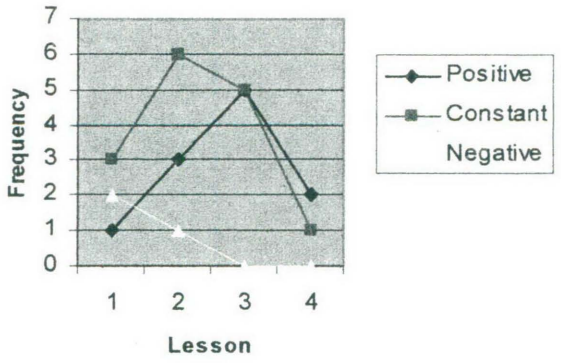

Figure 5.10 Groupwork interactions for N – Affective

During the group work lessons N displayed a relatively positive attitude, in the affective domain, with eleven positive comments against a total of three negative comments. She made fifteen comments which were neither positive nor negative. Her positive comments involved being happy when she understood a concept.

T When you've done those I'll go and get you purple. Start with these ones here. I'd start with these ones and link them up with those. (pause). Divide. Remember, altogether can be a multiply .....

N There you go, now I get it. (CLP2, G1, 14-15)

Also she was assertive, with comments such as 'Shhhhhosh, when I'm talking!' (CLP3, G1, 181) and 'My turn' (CLP3, G1, 223).

In CLP3, N became more involved, encouraged by the teacher's aide to read the questions. This resulted in her becoming more assertive.

N	John has 365 beef cows on his farm. He increases this number of cows by 230. How many cows has he now?
TA	What's increase?
N	Plus, plus, plus!
Je	Hoooooo
TA	That's right, increase means plus. (CLP3, G1, 88-92)

Performance in Groupwork – Social

Figure 5.11 displays N's social interactions during the cooperative learning program.

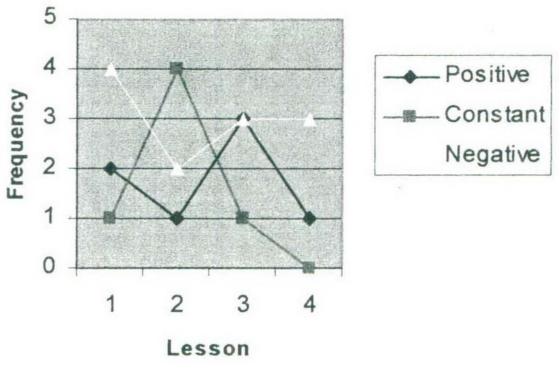

Figure 5.11 Group work interactions for N – Social

The teacher/researcher was surprised by the number of social negative comments made by N. Even though only twelve comments occurred, this was unexpected, as N presented as an extremely polite student. When analysed, these comments were again assertive and not necessarily impolite.

N shows frustration and impatience towards A and also B.

TA	There are six pine trees and ten pine trees in each row.
A	Oooooo, oooooo, plus, plus, plus, plus.

TA Six rows of ten, what would the operation be?

N Stop yelling out, put your hand up. (CLP4, G1, 15-18)

TA How would you work out how many students are not going to the concert?

A Eeeeeeeee Feeeeeeee pooo poo.

B What are you talking about?

N Why don't you listen? (CLP4, G1, 43-16)

N's positive social comments occur when she agrees with her peers answers giving them encouragement and support.

TA How many were left? Does that tell you what sort of sign it might be?.

A Take away.

N That's take away. (CLP3, G1, 163-166)

Further to obtain help from one of her peers.

N In a month Danni Dannniel, what ever it is!

Je Daniel.

N Yeah, Daniel saves $27 and Max saves $49. How much do they save between them? (CLP3, G1, 95-97)

Also, showing interest in including others, 'You have to sit there.' (CLP2, G1, 1) and 'Let's start ...' (CLP2, G1, 116).

Performance in Groupwork – Procedural

Figure 5.12 displays N's on and off task interactions during the cooperative learning program.

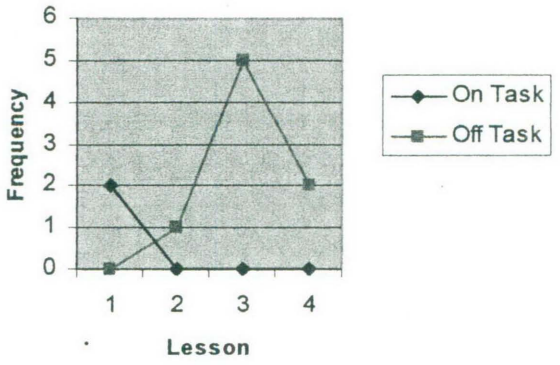

Figure 5.12 Group work interactions for N – Procedural

N's procedural on task comments, only occurred in CPL1 and referred to telling the facilitator, she had finished her task. Her off task comments involved discourse with her peers when the group had lost concentration and needed to be redirected by the facilitator.

End Self-perspective – Cognitive

Table 5.23 displays N's results from the cognitive aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions. Q1 & Q2 relate to the N's belief in her ability to do mathematics, requiring a very skilled, skilled, unskilled and very unskilled. The subsequent questions refer to N's attitude to his ability to mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.23 Questionnaire results for N
Cognitive - End

Cognitive – End			
Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**
			2 1
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
		5 14 22	18

N's self-perspective responses at the completion of the group work sessions of the cognitive domains have all moved into the negative. Her feeling about her mathematical ability (Q1) has now moved from five out of ten to two out of ten and her predicted score in a simple word problem test shifted from 14 out of 20 to 3 out of 20 (Q2). Her strongly negative response to her ability to handle more complicated Mathematics (Q5) has shifted to a negative response which coincides with her response to Q22 referring to complicated Mathematics which posed a contradiction in the initial questionnaire. N believes she has great difficulty working out complicated Mathematics (Q18).

End Test

Table 5.24 demonstrates N's correct responses, indicated as numbers in the table, to the word problem test conducted at the end of the cooperative learning program.

Table 5.24 Word Problem Evaluation Test results for N
End

	End
+ -	1 3 5 6 8 10 13
× ÷	
Combination	
Total	**6/20**

In the test at this end of the group work sessions, N only improved in one question, Q13. This question required a subtraction, and in the initial test N added. N did not score for the one step multiplication or division questions or the two step combination questions.

End Self-perspective - Affective

Table 5.25 displays N's results from the affective aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions targeting N's feeling towards her ability to do Mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.25 Questionnaire results for N
Affective - End

Affective – End			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	4 7 21 23	11 12 15 19	6 13

In the End self-perspective questionnaire for the affective domain there were quite a number of shifts of the ten responses. Three remained constant (Q7, Q21, Q15), four made a positive one step shift (Q4, Q23, Q12, Q19) and three made a negative one step shift (Q11, Q6, Q13). N remains happy to do well in Mathematics (Q7), liking to get mathematics test back (Q21) and continues to be frightened to put her hand up in a mathematics class to ask a question (Q15). The responses in which she made a positive one step shift were feeling good about Mathematics (Q4), enjoying mathematics homework (Q23), mathematics tests scaring her (Q12) and thinking about mathematics tests one day before the test (Q19). The responses which resulted in a negative one step shift related to a strong negative for Q6, where even though she tries hard in Mathematics, she finds it hard and now Mathematics makes her feel very uneasy and confused (Q13) which confirms Q11 where now N feels Mathematics scares her.

End Self-perspective – Social

Table 5.26 displays N's results from the social aspects of the questionnaire at the end of the cooperative learning program. The numbers refer to the questions relating to N's feeling towards her ability to relate towards her peers in Mathematics, requiring a strongly positive, positive, negative and very negative response.

Table 5.26 Questionnaire results for N
Social - End

End			
Strongly Positive	**Positive**	**Negative**	**Strongly Negative**
	17 9 10 16		8 20

Of the six self-perspective social domain responses only one response remains in the positive area. N still enjoys walking into the mathematics classroom (Q17). Mathematics as a worthwhile and necessary subject (Q9) has shifted from the positive to the negative area. N still expects to have little use for Mathematics when she leaves school (Q10) and she still does not like helping her friends work out mathematics problems (Q16). Her response to Q8, not liking people to think she is smart and Q20, being bothered when she does not understand an explanation of a student in her mathematics class who does understand, have shifted from negative to strongly negative.

Later Test

Table 5.27 demonstrates N's correct responses, indicated as numbers in the table, to the word problem test conducted approximately eight weeks after the end of the teaching sequences, following the Christmas break.

Table 5.27 Word Problem Evaluation Test results for N Later

	Later
+ -	3 5 8
× ÷	
Combination	
Total	3/20

In the Later test N performed the operation of addition in all the word problems, even to the extent that she added all the numbers. In Q1 - There are 22 students in 7G and 26 in 7O. How many students altogether? N added the 22, 26 and also the 7's which referred to the G and O of the class names. In Q9 – A box contains 6 bars of soap. If the mass of each bar is 20 grams, what is the mass of the six bars? – N performed the operation $6 + 20 + 6 = 32$.

Summary of the Case Study of N

N began the program with a positive attitude towards her ability in mathematics. She enjoyed mathematics and believed her achievement was similar to her peers. During the program, N became frustrated and her results at the end of the program showed she felt negative in her achievement and her attitude. This negative behaviour of Natalie in each of the cognitive, affective and social domains was greater in the CLP3 and CLP4 group activities and these activities focused on problem solving. The cooperative learning program provided an opportunity for N to intact with her peers as an equal. This did not, however, improve her self perceptions or her achievement.

SUMMARY

This chapter has discussed three case studies to illustrate some different responses to the cooperative learning program. The first case study introduced B, who did not wish to work in a group work situation. The second case study profiled Je, who benefited from the program. The final case study considered N, who did not perform well under the cooperative learning conditions. The next chapter will discuss these findings presented in Chapter 4 and Chapter 5. It will also consider implications for teachers employing a cooperative learning program as a strategy in the classroom and possible future direction for research closely associated to this study.

Chapter 6

CONCLUSION AND IMPLICATIONS

Introduction

The previous two chapters presented the findings provided by each of the data collecting methods employed to investigate the ways a program of targeted intervention using cooperative learning strategies to aid the decoding of word problems could influence students' achievement in tests of mathematical word problems and attitudes towards Mathematics in the cognitive, affective and social domains. This chapter presents the conclusions reached from this study and suggests implications for teaching and future research.

The research questions for this study arose from a review of the literature and the teacher/researcher's experience with teaching low ability students in the lower secondary years. The study aimed to answer the questions:

> **In what ways does a program of targeted intervention using cooperative learning strategies to aid the decoding of word problems influence students'**
>
> 1. **achievement on tests of mathematical word problems; and**
> 2. **attitudes to Mathematics in the cognitive, affective and social domains?**

The two aspects of pedagogy that were the focus of this study are achievement and attitudes directly related to mathematics. The teacher/researcher's aim was to observe and evaluate a cooperative learning program focusing on the decoding of word problems and the extent this focus would influence the students' achievement on mathematical word problem tests and attitudes to mathematics in the cognitive, affective and social domains. These two aspects of achievement in mathematics and

attitudes towards mathematics as discussed in the literature review formed the systematic framework for the conclusions that resulted from this study. The framework was further elaborated to incorporate the cognitive, affective and social domains.

The cognitive domain relates to the ways students think, learn and develop their understanding. Achievement is a result not only of cognitive development (Piaget & Inhelder, 1969), but is also influenced by affective factors (Bruner 1968; Skemp 1971, 1979). The cognitive domain is examined usually by testing or assessing the way in which students answer questions which are directed to their understanding of mathematical concepts, in this study, word problems.

The affective domain considers in particular students' anxieties, beliefs, feelings and moods. Bruner (1968) and Skemp (1971, 1979) included the affective domain in discussion of the acquisition of knowledge and levels of understanding in the cognitive domain. The affective domain was assessed by considering students' responses to questionnaires and analysing discourse recorded during the cooperative learning lessons.

Finally, the social domain refers to students' interactions with other students, teachers and also themselves. The review of the literature showed general agreement that collaborative learning is a positive strategy for improving the classroom climate by providing students with opportunities for verbalization, allowing students to resolve conflicts in understanding, and giving students increased responsibility (Davidson 1985; Lindquist 1989; Phelps & Damon 1989; Yackel, Cobb, Wood, Wheatley, & Merkel 1990). In this study, findings about the social domain were found in the analysis of the discourse in the cooperative learning program and in the responses to the questionnaires.

Findings and Conclusions Related to Achievement in Mathematics

The review of the literature showed that achievement was linked to the cognitive domain. The Board of Studies in the New South Wales Years 7-10 Syllabus (Board of Studies NSW 2002) provides a framework of stages of learning based on outcomes, allowing the student to progress according to their cognitive development, through these stages. Students' achievement is based on this progress. The tests used to measure achievement of word problems were based on the level of outcome appropriate to the students concerned, rather than the expected outcomes for their grade. The testing in the study analysed the change in achievement of students' responses to word problems. The three sets of tests occurred at the beginning and the end of a cooperative learning program as well as some weeks later.

The test was grouped in three levels of word problem operations. It showed there were two distinct levels of competency in the group. those who could calculate one-step word problems and those who displayed difficulty. The first group consisted of those who could manage one-step word problems, and the aim was to concentrate on their improvement in two-step word problems. The second group consisted of those who were having difficulty with one-step word problems with the aim of improving their basic understanding. The small size of the class, however, and the difficult social interactions between some students meant that the teaching intervention was general, targeting all students at an appropriate level.

There was no statistically significant change in the mean scores when comparing the End and Later tests with the Beginning score. The length of the cooperative learning program, being four weeks and only incorporating one lesson per weekly cycle may not have given the students adequate time to enable them to retain the necessary word combinations for the word problems in order to improve in their tests. This arrangement, however, was constrained by the other organisational arrangements in the school. This supports Klein's (1999) research where it was found that for students to have a positive disposition towards numeracy to enable them to achieve; they need to

apply their knowledge over a long period of time. The need to have a longer time to apply their knowledge would have intensified with these students' difficulty in learning, generally.

Although the initial observation was of two groups, the end and later tests demonstrate how erratic the achievement of the students was (see Figure 4.5, Figure 4.6 & Figure 4.7). Some students seemed to make short term gains, which they later lost, while others gained in some aspects but went backwards in other kinds of problems. Consistent growth in mathematics achievement for these students, who were identified as needing extra support, although, apart from N, not categorised as having special needs, appears difficult to achieve.

When the lesson transcripts were examined, however, there appeared to be a small amount of qualitative improvement of some students in the cooperative learning program. In addressing the decoding of word problems in the interpretation of the three operations of addition, subtraction, and multiplication, observation by the teacher/researcher showed some students were able to express themselves more positively cognitively, displaying achievement in a group learning situation. In Figure 5.5 Je improves her cognitive comments in the CLP3. Initially, in CLP1 and CLP2 she was able to refine her understanding of the synonyms of addition, subtraction and multiplication and thus transfer this understanding to simple word problems. However, when Je was confronted with more complex problems in CLP4, she found she had not developed adequate skills on the simple problems to transfer to the more complex problems. That this did not transfer to a testing situation is not altogether surprising, given the general ability of these students, and their reliance on verbal cues given by their peers and teachers in the group situation.

When considering the results of the questionnaires, which were presented to the students before and after the administration of the cooperative learning lessons, we consider student's attitudes to their achievement. The findings of the cognitive questions, as seen in Table 4.2, when considering the movement column, produces a

zero mean when the outlier of one student, N, is removed. This student, with a specific mental impairment initially had a positive attitude towards her achievement, however after the cooperative learning program this student had developed a very negative attitude to her achievement. This finding will be discussed further below.

Findings and Conclusions related to Attitudes towards Mathematics in the Cognitive and Affective Domains

The second aspect of attitudes towards mathematics used the results of the questionnaires and also the transcripts of the cooperative learning program. The literature showed a focus towards the affective and social domains when considering attitudes toward mathematics, however the cognitive domain was also considered relevant in how students felt they achieved in mathematics.

As discussed earlier, the cognitive domain was analysed by examining the results of the testing of the word problems. The results of the questionnaires and the transcripts of the cooperative learning program provided an insight into how the students thought about their ability to achieve. A review of the literature showed there is a positive correlation between confidence and achievement in mathematics (Reyes 1984). As described earlier the test showed little movement in students' measured achievement in the cognitive domain. However, when considering their attitudes to their achievement of the cognitive and affective domains in the questionnaires most students showed a more confident belief in their achievement, although two students became less confident.

The transcripts of the cooperative learning lessons showed positive progression of most students. The students generally responded well to these lessons; however one student B, refused to respond to prompting by the facilitator, requiring intensive encouragement. This will be discussed more fully in the social domain findings. It was also found, as reported in Chapter Four in section - Week 5: Cooperative Learning Program 3 (CLP 3) – One-step Word Problems, relating to the CLP3 that the cognitively competent students, E, Je, Jo, M and to a certain extent Tr and even B,

responded more positively to the third and fourth cooperative learning lessons which were directed to the solving of word problems, while the less cognitively competent students appeared to enjoy the game playing of the first to lessons. Below is an example of a positive dialogue where the students are all actively involved.

B What is six less than ten?
M Take away.
T Mmmmm, good boy.
E Find the difference between 15 and 10.
T Good girl.
Jo Find the sum of 24 and 36.
T Sum, good, thought we would get around to you quickly. (CLP3, G2, 53-59)

The New South Wales Years 7-10 Syllabus (Board of Studies NSW 2002) is very determined in its commitment to the affective domain when teaching mathematics using phrases such as 'a positive self concept ..... enjoyment from mathematics .....self-motivated learners' (Board of Studies NSW 2002, p.7). The literature review cited the document Principles and Standards for School Mathematics (National Council of Teachers of Mathematics 2000) as condemning parents' and the media's negative attitudes towards mathematics in affecting students' beliefs. However, research shows that confidence can be gained by interacting with peers, relying on each others' confirmations of their self worth (Foster 2002). In considering the transcripts, it was found that with these students, caution need to be applied and the facilitator had to be very vigilant in listening to students' comments, as students as well as being supportive in their comments to their peers, could be very brutal.

The questionnaire provided a significantly positive result in the affective domain, with students responding well to the cooperative learning lessons. However, on closer consideration, one student, N, who was learning impaired, became very negative towards her ability and how she felt about mathematics. By comparing Table 5.19 with Table 5.23, N's belief in her ability in the cognitive domain seen through her responses to the questionnaires at the beginning and end of the cooperative learning program has

become negative. In the affective domain, N's negative shift describes how even though she tries hard in mathematics she still can not understand it, making her uneasy and confused, to the extent that mathematics scares her. In this particular instance the cooperative learning sessions have made her more aware of her inability to understand mathematics.

Findings and Conclusions related to Attitudes towards Mathematics in the Social Domain

In this study, aspects of the social domain considered, focussed on collaborative learning. The transcripts of the four cooperative learning lessons provided significant findings relating to the social domain. It became evident that the students required close supervision in their groups, to remain on task and self correct, as shown in the transcripts presented in Chapter 4, section – Cooperative Learning Activities.

The facilitator needed to become an integral part of the group's composition. The need for an experienced facilitator provides a further dimension to the research which cites collaborative learning to be a positive strategy for improving the classroom climate. It also became apparent that the facilitator required a good understanding of basic mathematical concepts. As reported in Chapter Four – Cooperative Learning Program, it was necessary to understand that some students had not progressed from addition to multiplication. In this study, although the teacher aide was not mathematics trained, she had considerable experience with students, and worked very closely with the teacher/researcher to identify specific problems of mathematical understanding. It is unreasonable, however, to expect a teachers' aide to pick up all the subtleties of students' mathematical understanding as shown in the following excerpt.

A Daniel has six pairs of shoes. How many shoes does he have to polish altogether?

TA Right there are eight pairs of shoes.

A Plus.

TA There's eight pairs of shoes and how many in a pair?

N Three.
TA Two, we have eight lots of...
A&Je Times. (CLP3, G1, 59-65)

This could have been an excellent time to develop the concept of "adding groups of numbers is the same as 'lots of'".

A general observation by the teacher/researcher and the teacher's aide in this study found that the girls applied themselves more actively to the collaborative learning while the boys found it a time to socialise and divert from the tasks. Referring to the girls, E worked very seriously, ignoring the boys' disruptive behaviour, while Je was very keen to participate, interact with the facilitator and help other students. K worked very quietly, with few interactions, however succeeded in what she did. N, even though she believed her ability waned, tried hard and worked actively. Referring to the boys, Tr persistently disrupted his group, making inane comments, requiring a substantial amount of the facilitator's direction to pay attention, which he did rarely. M was distracted by Tr, however he responded better to the facilitator's directions. B showed by his comments and actions he did not want to be involved in group work and A just went along with what was happening at the time, copying answers whether they where right or wrong. This supports the literature regarding girls tending to benefit more positively in Mathematics in a collaborative environment (Peterson and Fennema 1985; Leder 1993; Cordeau 1995; Jacobs 1994; Morrow & Morrow 1996; Solar 1995).

It was also found that the students had a limited and varied concentration level. As these students were low achievers they needed a variety of activities within a half hour period to remain on task. This agrees with the findings of some studies which have presented time spent on task as an important variable in maintaining students' concentration (Good, Mulryan & McCaslin 1992; Johnson & Johnson 1985; Noddings 1989).

The case studies produced some additional insights in the social domain. Of the eight students, B was the most reluctant to work in a cooperative learning environment. From the very start he displayed no interest in being involved, to the extent, he endeavoured

to undermine the lessons by hiding tiles and making inappropriate comments. Most of his social domain comments were negative, ranging from 'shut up' to his peers to 'This is boring' when commenting about the activities. He required a lot of coaxing from the facilitator to answer questions. He generally repeated words or made silly comments, unrelated to the question. This attitude resulted in disrupting the lesson, by unsettling the other students and creating a negative quality to the lessons. He particularly unsettled E who was very keen on doing her best in the activities, to the extent that E had to leave the group and work on her own. Interestingly, E could have quite happily worked in a group situation or on her own, as she seemed to 'switch off' to the others in the group and work by herself or with the facilitator. B's involvement socially did not change throughout the course of the cooperative learning activities. His behaviour demonstrated that this type of learning strategy was not appropriate at this stage for B, or that a different kind of group structure might have been more appropriate.

Je provided the total antithesis to B in the social domain. Having presented herself in the traditional classroom environment as a quiet worker who very rarely made any contribution to classroom discussion, this student excelled. She was keen to organise her group, displaying leadership skills. She worked well with the other students and helped them where she could and also gave them encouragement. At the end of the cooperative learning program her answers to the questionnaires which were focused on the social domain had become more positive. This demonstrates that for some students a cooperative learning program can be positive.

In comparing the responses of the questionnaires, N began the cooperative learning program with a more positive attitude to her social interaction than at the end. Even though N still likes to walk into the mathematics classroom she definitely does not want students to think she is smart or to help her peers. This is interesting since N always appeared to be an outward going student who had plenty to say. The transcripts showed that in the last two cooperative learning lessons, N became quite determined in her responses, displaying irritation with her peers when she could not answer questions

correctly. With N, the cooperative learning program allowed her to see her learning difficulties against the other members of her group.

Although for some students the cooperative learning program allowed them to develop, for example Je, Jo and K, this was not so for all the students. Both B and N did not gain from the program. Especially, for N, this finding questions the research regarding the positive effects on academic self-concept and social self-concept, especially with low achieving students (Ginsburg-Block & Fantuzzo 1998; Campbell & Evans 1997; Cobb et al. 1992; NCTM 1989, 1991, 1995, 2000). E enjoyed working on her own and the cooperative learning program did not impact on her. Tr and M gained to some extent, however it is difficult to say whether it was the result of the program. It is important here to realise, this study involved only a small cohort and as a result can not be applied universally.

Implications for Teaching

This study investigated the ways a program of targeted intervention using cooperative learning strategies to aid the decoding of word problems could influence students' achievement on tests of mathematical word problems and attitudes to mathematics in the cognitive, affective and social domains. Even though the study was small it provided a number of issues which should be addressed when endeavouring to design a cooperative learning program.

This study targeted a group of low ability mathematics students. Therefore, it would be reasonable to suggest that the implications for teaching maybe more specific for classes with students who require development of basic skills and students who have difficulty concentrating on set tasks for periods of time, however aspects can be extended to other levels of ability.

First, adequate time should be allocated to meet the needs of the students. Students should be assessed according to their level of the basic skills, or skills in general. An assessment of the objective anticipated should then be made and the optimum time

needed to obtain these objectives. As this study suggests, a single lesson in a cycle may be insufficient for students to show changes in achievement.

Second, having made this assessment, flexibility is required to make available alternative pathways for students who are not meeting the requirements of the program. These alternatives may include varying the tasks or forming a small group of students with similar needs, to allow them to work on a specific task before moving on to more complex work.

Third, during the program, students should be continually assessed as to the compatibility of the group to which they have been assigned and alternatives provided for students to either join another group or spend 'time out' working on their own. Some students became quite antagonistic towards other members of the group, if the work was not going well, providing classroom issues. Such aspects of cooperative learning with low ability students do not appear to have received much attention.

Fourth, an assessment should be made as to the type of activities the students prefer. Different groups within the class may respond more positively to a particular form of activity, so each group should have the advantage of an activity which best suits their requirements at that specific time.

Fifth, particularly with low ability students, an experienced facilitator is required to curtail inappropriate comments, which may have a negative impact on other students. An experienced facilitator can also be advantageous in assisting with the extension of students' concepts and this can be extended into all levels of cognitive ability. It should not be considered that an experienced facilitator is only required for low ability students.

Sixth, the experienced facilitator is required to maintain students on task. This is especially necessary for low ability students, where students need to be encouraged to respond positively when a question is presented to encourage the students' attention.

Seventh, the experienced facilitator is required to assist students to self correct. Often students do not recognise when their response is incorrect. If the group is inexperienced, this inappropriate response to a question may result in the group being misinformed. It is important that the facilitator is knowledgeable about the concepts addressed in the lessons, and students' learning of those concepts.

Finally, in considering a cooperative learning program, there are a number of different characteristics of students which need to be considered and provision made to met the needs of these students. In particular in this study there were students who were:

- keen to take leadership and respond to the facilitator
- keen, but who did not have the maturity to understand their strengths and weakness
- keen, but who found the work too demanding and as a result developed negatively
- capable of working quietly and competently within the group
- able to work competently but who required direction
- explicit in their wish to work on their own
- not interested in group work and either disrupted others or refused to participate.

This provides some examples of the characteristics which could present in a cooperative learning program, and should be considered.

Future Research Directions

A number of future research directions arise from this study. In particular, five research initiatives stand out as worthy of investigation.

First, as a close extension of this study, a possible area of research would be to extend this research to a larger sample over a longer period of time. This exploration would extend and provide more data on the issues that have emerged from this study.

The second possible area of research would be to consider specifically the descriptors of students participating in cooperative learning in mathematics and develop a framework to benefit to all students.

The third area of research could investigate specific precautions which need to be addressed when implementing cooperative learning in the mathematics classroom. This study indicates that for some students in this group, the generally accepted findings from cooperative learning situations did not hold.

The fourth area of research needs to address the issue of assessment of learning that occurs in cooperative groups. Clearly, for some students in this study, the apparent understanding shown in the cooperative classroom environment did not transfer to a test situation.

Finally, the fifth research direction is an extension of this investigation, with a longitudinal study and a much larger sample. It would involve exploring whether improved achievement in mathematics and attitudes towards mathematics encourages engagement of the students and whether improved behaviour follows.

Concluding Thought

The research discussed in this study has described the ways a program of targeted intervention using cooperative learning strategies to aid the decoding of word problems could influence students' achievement on tests of mathematical word problems and attitudes to mathematics in the cognitive, affective and social domains. This study has drawn attention to the vast and distinctive conditions which must be considered when designing a cooperative learning program in the classroom. More investigation is needed in the achievements and attitudes of students who are mathematically challenged and who have difficulty with the type of collaborative problem solving approaches promoted by educational institutions. If this is done, collaborative problem solving could be of significant value to a much broader school population and not be seen as merely lip service to a departmental initiative.

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Appendix

Appendix A - Administration

Consent- Letter to Parents/Carers and Students

Appendix B - Instruments

Questionnaire

Analysis of Questionnaire

Test – A

Test - B

Appendix C – Activities

Targeted Words (CLP1)

Square-saws (CLP2)

One-step Word Problems (CLP3)

Answers to Word Problems – One-step.(CLP3)

Two-step Word Problems (CLP4)

Answers to Word Problems – Two-step.(CLP4)

Appendix D – Results summary

Results of the Questionnaire – Cognitive

Results of the Questionnaire – Affective

Results of the Questionnaire - Social

Appendix A - Administration

Consent Letter to Parents/Carers and Students

School letterhead

Name of the school
Address of the school
Date

Dear (students, parents/carers name)

I would like to invite you to take part in a project, which I am currently researching, in conjunction with my master's degree at the University of New England. The inquiry involves students' attitudes towards mathematics. I am specifically considering students' success in solving word problems. Many students have the ability to add, subtract, multiply or divide, but are unable to implement these skills when required to apply them to relevant day-to-day problems. This may lead to a negative attitude when students fail to solve word problems in mathematics.

I consider your involvement in this project to be potentially of positive benefit to you, as it involves a more intensified program of learning, which aims to provide you with the necessary skills to understand word problems in the future.

The research, which will be conducted during this term, will involve a short questionnaire and quiz, followed by a specific learning program conducted during one teaching period, each week, over four weeks. This will be followed by another questionnaire and quiz, with a possible follow-up questionnaire and quiz after the December/January school holidays.

I would like to assure you that

* participation in or withdrawal from this research will not adversely affect any future results or outcomes;
* should you not wish to participate, you have the option of joining another class for these periods;
* I will treat all data confidentially;
* information collected as part of this research, will not be used for future placement in year eight;
* no student will be identified in any report of this research; and
* you have a right to withdraw from the project at any time.

Could you please complete the following permission form, and return to me by .....

I do hope you will join me in this exciting project. If you would like any further information, please feel free to contact the Principal or myself.

.....	.....
Teacher/researcher's name	Principal's name
Mathematics Teacher,	Principal
Mathematics Faculty.	
Phone number	

Permission Form

Could you please complete this permission form, and return to me by .....

I understand that all the data will be treated in confidence.
I understand that participation in this project will not affect my results this year or any future results in Mathematics.
I understand that I can withdraw from this project whenever I like.

I, ... the student, agree/disagree to be involved in this program.

Comment:
.....
.....
.....
.....

I, ... the parent/carer, agree/ disagree that ..... (the student' name) may be involved in this program.

Comment:
.....
.....
.....
.....

Please return this permission form, enclosed in the accompanied envelope, to the school office or via the student directly to (teacher/researcher's name).

Appendix B - Instruments

Questionnaire

Part A – Personal details and Self-concept.

1. Name .....

2. Gender (circle one) Male Female

3. Your feeling about your Mathematical Ability

How good do you feel about your understanding of mathematics against all the students in your last year, year six class?
Write a score out of ten. 1 being very low and 10 being very high.

Score .....

4. Your score in a mathematics test on word problems. (see the example below)

If you sat for a mathematics test on answering 20 word problems, what do you think your score would be out of 20?

Score .....

5. Language or Number?

If you were given a word problem in class, which would you find the more difficult? (circle one)

a) reading the problem b) working out how to answer the problem

Example of a word problem – There are six rows of roses with eight rows in each row, how many roses altogether?

Part B – Feelings about mathematics

Answer the following questions by circling the response that best describes your feelings on a scale of strongly disagree to strongly agree. There is no right or wrong answer to these questions. Just answer honestly how you feel about each question.

1. I feel good about mathematics.

Strongly disagree Disagree Agree Strongly agree

2. I think I could handle more difficult mathematics.

Strongly disagree Disagree Agree Strongly agree

3. Even though I try hard in mathematics, I find it hard.

Strongly disagree Disagree Agree Strongly agree

4. I would be happy to do well in mathematics.

Strongly disagree Disagree Agree Strongly agree

5. I don't like people to think I'm smart in mathematics.

Strongly disagree Disagree Agree Strongly agree

6. Mathematics is a worthwhile and necessary subject.

Strongly disagree Disagree Agree Strongly agree

7. I expect to have little use for mathematics when I leave school.

Strongly disagree Disagree Agree Strongly agree

8. Mathematics does not scare me at all.

Strongly disagree Disagree Agree Strongly agree

9. Mathematics test scare me.

Strongly disagree Disagree Agree Strongly agree

10. Mathematics makes me feel uneasy and confused.

Strongly disagree Disagree Agree Strongly agree

11. I like adding numbers in my head.

Strongly disagree Disagree Agree Strongly agree

12. I am frightened to raise my hand in a mathematics class to ask a question.

Strongly disagree Disagree Agree Strongly agree

13. I like helping my friend work out mathematics problems.

Strongly disagree Disagree Agree Strongly agree

14. I enjoy walking into a mathematics class.

Strongly disagree Disagree Agree Strongly agree

15. I have trouble working out word problems in mathematics.

Strongly disagree Disagree Agree Strongly agree

16. I feel anxious thinking about a mathematics test one day before the test.

Strongly disagree Disagree Agree Strongly agree

17. I bothers me talking to someone in my mathematics class who does well in problems and not being able to understand what they are explaining.

Strongly disagree Disagree Agree Strongly agree

18. I like getting mathematics tests back.

Strongly disagree Disagree Agree Strongly agree

19. I do not think I could do more complicated mathematics.

Strongly disagree Disagree Agree Strongly agree

20. I enjoy my mathematics homework.

Strongly disagree Disagree Agree Strongly agree

Questionnaire Analysis
(C – cognitive domain, A – affective domain, S – social domain)

1C Your feeling about your Mathematical ability?

2C How well do you think you solve word problems?

3C If you were given a word problem in class, which would you find more difficult: reading, working out, neither or both?

4A I feel good about mathematics.

5C I think I could handle more difficult mathematics.

6A Even though I try hard in mathematics, I find it hard

7A I would be happy to do well in mathematics.

8S I don't like people to think I'm smart in mathematics.

9S Mathematics is a worthwhile and necessary subject.

10S I expect to have little use for mathematics when I leave school.

11A Mathematics does not scare me at all.

12A Mathematics tests scare me.

13A Mathematics makes me feel uneasy and confused.

14C I like adding numbers in my head.

15A I am frightened to raise my hand in a mathematics class to ask a question.

16S I like helping my friend work out mathematics problems.

17S I enjoy walking into a mathematics class.

18C I have trouble working out word problems in mathematics.

19A I feel anxious thinking about a mathematics test one day before the test.

20S I bothers me talking to someone in my mathematics class who does well in problems and not being able to understand what they are explaining.

21A I like getting mathematics tests back.

22C I do not think I could do more complicated mathematics.

23A I enjoy my mathematics homework.

Test - A

1+. There are 22 students in 7G and 26 students in 7O. How many students altogether?

2 -. There were 10 people waiting for a bus. If 6 were children, how many were adults?

3+. Last year there were 750 students enrolled at our school. This year there are 10 more students enrolled. How many students are enrolled in our school now?

4×. During our holiday Kate used 5 rolls of film. If each roll has 10 photos on it, how many photos did she take?

5+. During Term One Emily scored 10, 15, 12 and 8 in her mathematics tests. What was her total score for the term?

6 -. I have $50 in my bank account. If I withdraw $10, how much will I have left?

7×. During a long distance relay, each of the 5 runners ran 10km. What was the total distance run?

8+. John has already collected $6 from his walkathon sponsors. How much will he have if he still has $8 to collect?

9×. A box contains 6 bars of soap. If the mass of each bar is 20 grams, what is the mass of the six bars?

10 -. At the start of the day there were 50 tickets for the Friday night school concert. If we sold 40 tickets, how many tickets are left?

11×. In a game of Ludo, Trevor threw the dice and four times in a row he threw a 6. How many places did he move?

12×. On each sheet there are 50 stamps. How many stamps are on 10 sheets?

13 -. Lucy's mum sent her to the shop with $10, to buy a loaf of bread that cost $2. How much money should Lucy bring home?

14××. Jack leaves 4km from school. If he walks to and from school each day this week how far will he have walked?

15× -. I went to the newsagent and bought 3 pencils for $2 each, how much change should I have from $10?

Test - B

16× -. There are four rows of roses. Eight roses are in each row. If five roses died, how many roses would be left?

17 - -. Twenty six students were to go to a concert. Twenty two pay their money to go but three of these students came down with the flu. How many students went to the concert?

18×+. The English teacher asked John to count the money for the day's collection for the jellybean guessing competition. There were twenty five-cent coins, 10 ten-cent coins and five twenty-cent coins. How much money did John have to count?

19×+. On Saturday night there were fifteen rows of eight people at the Springwood High School Theatre Company production. On Sunday matinee there were twelve rows of six people. How many people attended the production?

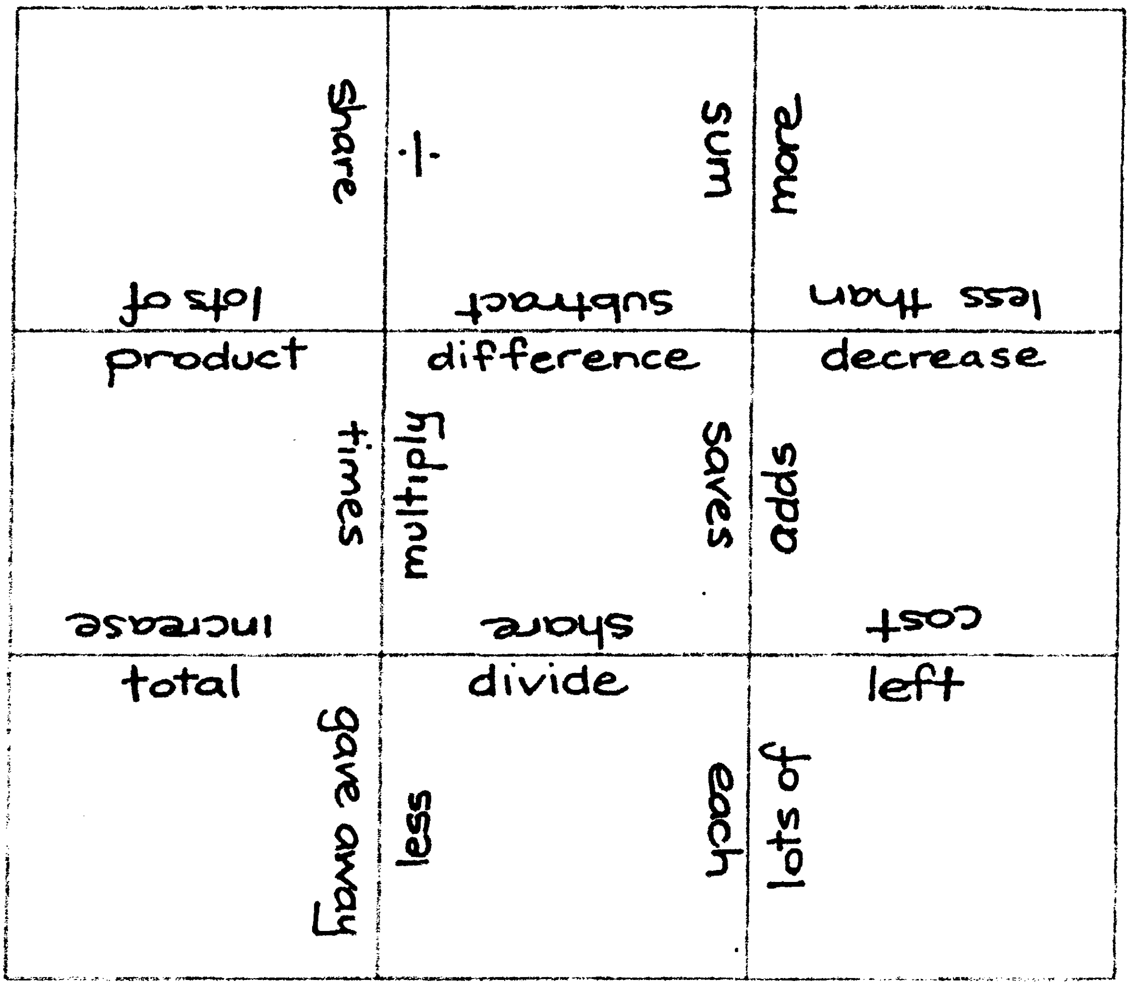
20× -. A horse owner sold 9 mares for $137.50 each. What is his profit if he originally paid a total of $515 for these animals?

Appendix C – Activities

Targeted Words (CLP1)

+	-	×	÷
More	**Subtract**	**multiply**	**share**
Won	**Still**	**times**	**divide**
altogether	**Minus**	**lots of**	
Saves	**less than**	**product**	
Adds	**Takes away**	**each**	
sum	**Decrease**	**altogether**	
total	**Less**		
	difference		
increase	**Left**		
	lost		
	gave away		

Square-saws
(CLP2)


share
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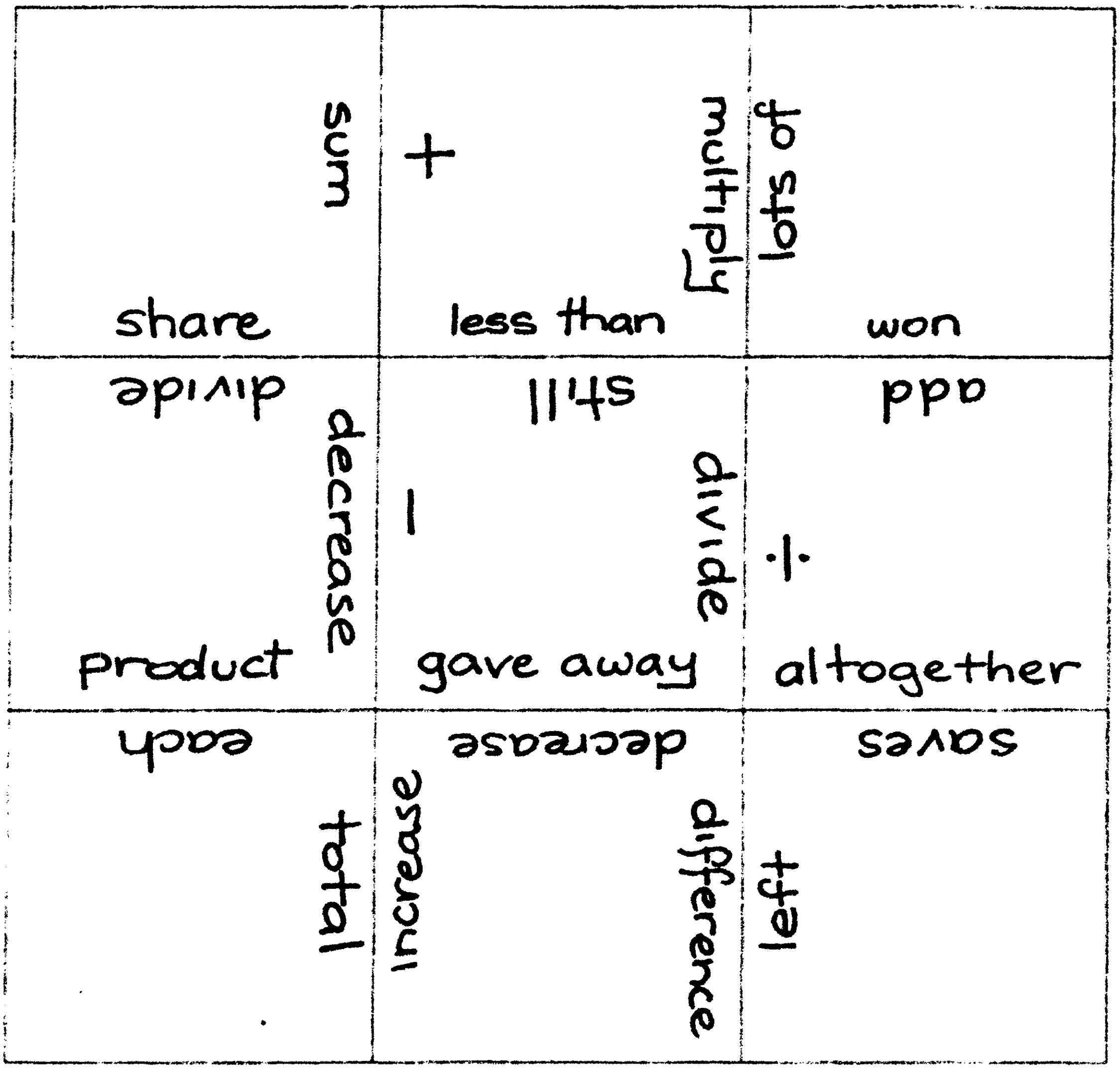
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difference
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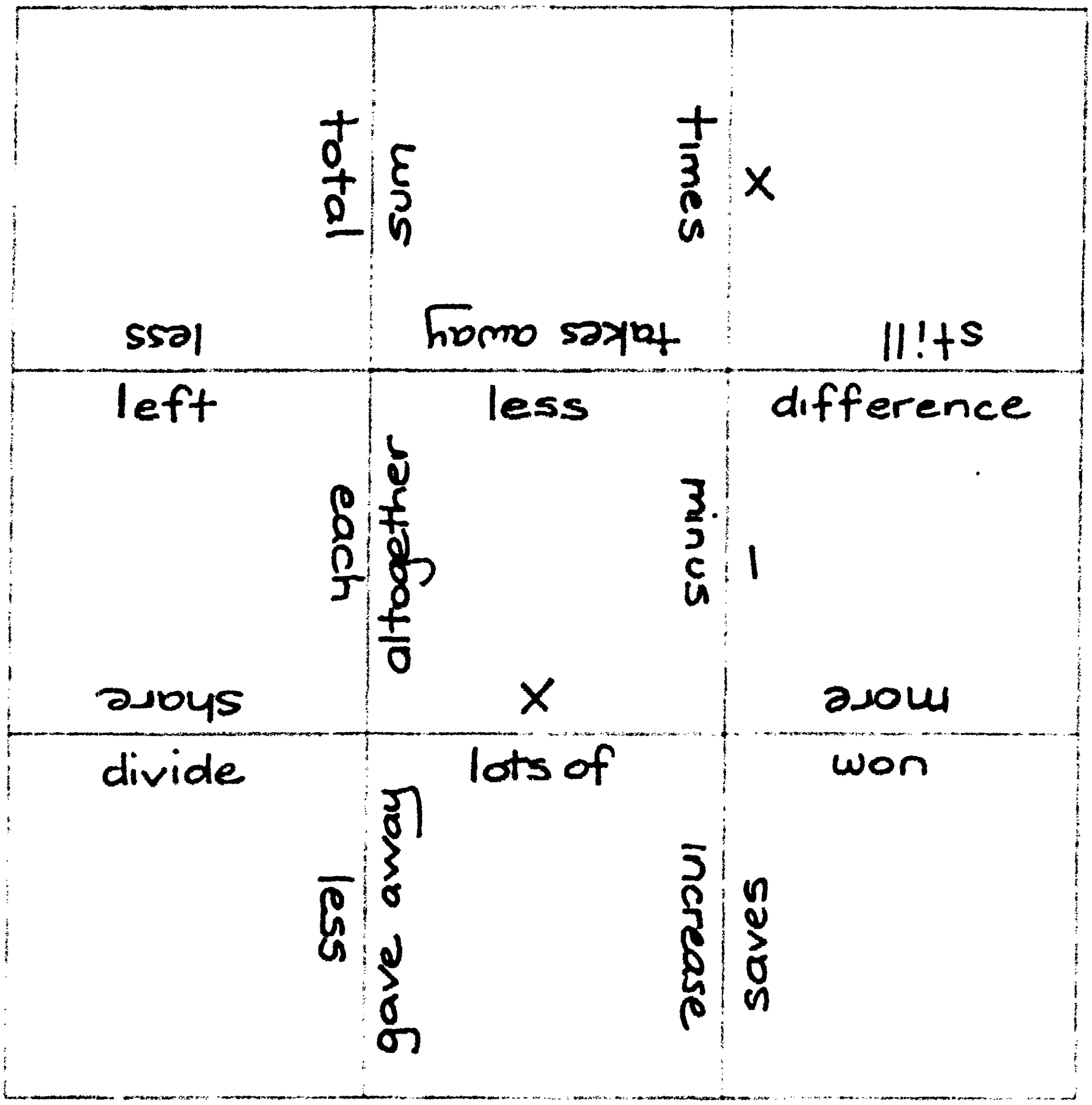
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increase
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One-step Word Problems

(CLP3)

1. The Jones used 30 bottles of milk in 5 days. How many bottles did they use each day?	2. How much would one marble cost if four marbles cost 36 cents?	3. Maria, Hugo and Vince are going to buy a present. How much will each child pay if the gift costs $12?	4. The 20 guests at the party were seated at five tables. How many people were at each table?	5. Tom had 54 trading cards and was given 24 more for his birthday. How many toy cars has he now?
6. A teacher is arranging 30 children into five equal lines. How many children will be in each line?	7. Terry had fourteen marbles and won three. How many marbles has he now?	8. John was at the carnival and won a bear at the clown heads. He tried again and won two more bears. How many bears did he win?	9. There are sixteen trees in our front yard and fifteen trees in our backyard. How many trees are there altogether?	10. Find the sum of 36 and 43.
11. In a month Dianne saves $27 and Max saves $49. How much do they save between them?	12. On the bus there are 14 people downstairs and 27 people upstairs. What is the total number of people on the bus?	13. Find the sum of 24 and 36.	14. Steve has 30 books and collects 40 more books. How many books has Steve altogether?	15. Lisa's swimming coach has asked her to swim 20 metres on Saturday and 30 metres on Sunday. What is the total distance she will swim over the weekend?
16. John has 365 beef cows on his farm. He increases this number of cows by 230. How many cows has he now?	17. The chook yard has fifteen chooks. Jenny increases the number of chooks by four. How many chooks altogether?	18. At the oval there were thirteen children playing touch football and eleven children playing soccer. How many children were at the oval?	19. Eight people have already arrived at the party. If another five are coming, how many people will be at the party?	20. If John has nine cards and adds another five cards, how many cards has he?
21. Mary adds $5 to her savings of $15. How much has she now?	22. Scott was given a set of twenty six cards but gave five away. How many cards did he have left?	23. Michelle collected eighteen seashells but gave nine away. How many seashells has she now?	24. There were nine children at John's party. If four had to leave early, how many children were left?	25. Mum made two dozen small cakes for the school fete. If Jim ate two of them, how many were left?

26. Jim had fifteen marbles and lost three. How many marbles has he left?	27. Jane had six extra tickets to take her friends to a concert. She lost three tickets. How many friends could she take to the concert?	28. Find the difference between 15 and 10.	29. What is the difference between 25 and 15?	30. Subtract 7 from 12.
31. Subtract 12 from 30.	32. Nancy has one dozen apples and takes away four apples to give to her grandparents. How many apples has Nancy now?	33. I have eight baby guinea pigs and I take away four baby guinea pigs to give to my friends. How many baby guinea pigs have I now?	34. What is 6 less than 10?	35. Find 13 less than 20.
36. There are sixteen cards in a set. If Mary has four sets, how many cards does she have altogether?	37. Daniel has six pairs of shoes. How many shoes does he have to polish, altogether?	38. Apple trees were planted in eight rows with three trees in each row. How many apples trees were planted?	39 During the game Sandra scored nine goals. Each goal is worth two points. How many points did Sandra score?	40. There are three lines of children. If there are eight children in each line, how many children are there altogether?
41. Three people each donated five books to the library. How many books were donated to the library?	42. Multiply five by six.	43. What is the product of eight and four?	44. Find the product of five and nine.	45. John has $6. How much would he have if his father multiplied it by three?
46. What are three times nine?	47. In the game Steve threw a "6" three times in a row. How many places did he move forward?	48. Mrs Wilson bought nine packets of soap. If there are five cakes of soap in each packet, how many cakes of soap did she buy?	49. Luci's father jogs five kilometres every day of the week. How far does he jog in a week?	50. Susan was given a set of ten cards, which she shared with her friend, Fay. How many cards will each girl receive?
51. Eighteen jellybeans are to be shared amongst three children. How many should each child receive?	52. If a class of ten students is divided into two groups, how many will be in each group.	53. If $28 is to be equally divided between seven girls, how which each girl receive?		

Answer Sheet for Word Problems– One-step.

(CLP3)

Question	Operation	Answer	Question	Operation	Answer	Question	Operation	Answer
1			19			37		
2			20			38		
3			21			39		
4			22			40		
5			23			41		
6			24			42		
7			25			43		
8			26			44		
9			27			45		
10			28			46		
11			29			47		
12			30			48		
13			31			49		
14			32			50		
15			33			51		
16			34			52		
17			35			53		
18			36					

Two-step Word Problems (CLP4)

1. There are six rows of pine trees. There are ten pine trees are in each row. If eight pine trees died, how many roses would be left?

2. Year 7 and 8 students were to go to a concert. There were 285 students of the 175 students in Year 7 and 160 students in Year 8 who paid their money to attend. How many students did not go to the concert?

3. Jenny asked Mary to count the money for the day's collection for the talent quest. There were 30 five-cent coins, 20 ten-cent coins and 50 twenty-cent coins. How much money did Mary have to count?

4. On Saturday night there were fifteen rows of eight people at the Springwood High School Theatre Company production. On Sunday matinee there were twelve rows of six people. How many people attended the production?

5. A horse owner sold 8 mares for $200 each. What is his profit if he originally paid a total of $1300 for these animals?

6. Chris and Greg went to swimming training. Chris swam 10 laps of the 50 metre pool and Greg swam 16 laps. How many more metres did Greg swim than Chris?

7. Mark' s step is 90cm and Patrick's step is 44cm. How much further will Mark go than Patrick if they each take 100 steps?

8. During the week Dad used 46 litres of petrol and Mum used 34 litres. How much did they spend on petrol altogether if petrol costs 83 cents a litre?

9. What is the total mass in my shopping bag if I have 5 tins of salmon each 75g and 2 packets of soap each 650g?

10. A transport vehicle weighs 5 tonnes by itself. It has 3 containers each weighing 2 tonnes. What is the total mass of the vehicle with its load?

11. In 2000 Mr. O'Neill bought a home unit for $250000. If he spent $32000 on repairs before selling it for $300000, what amount of profit did he make?

12. John intends to go on a trip to Europe. The trip cost $3500 and he decides to take $1500 spending money. If his parents give him $1000 towards the trip, how much does John have to earn to pay for the trip?

13. Simon drove from Sydney to Canberra at an average speed of 80km/h. The trip took 5 hours. He stopped for an hour at Goulburn. How far is it from Sydney to Canberra.
14. If Uncle Sam's car can travel 286 kilometres on 26 litres of petrol, how far can he travel on 2 litres?

15. A motorist received $28.72 change from $50 note when he purchased 38 litres of petrol. How much a litre was the petrol?

Answer Sheet for Word Problems – Two-step. (CLP4)

Question	Operation 1	Operation 2	Answer
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Appendix D – Results Summary

Results of the Questionnaire

Results of Questionnaire - Cognitive

	Beginning				End			
	Very Skilled	**Skilled**	**Unskilled**	**Very Unskilled**	**Very Skilled**	**Skilled**	**Unskilled**	**Very Unskilled**
1. Your feeling about your Mathematical Ability.	Je Jo M	B K	N	E	K Je M	A B Jo		E N
2. How well you think you solve word problems.	B K Je M	A N	Jo	E	Je Jo M	B K	A E	N
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
5. I think I could handle more difficult mathematics.	Je	M	B Jo	A E K N	Je	M	A B Jo N	E K
14. I like adding numbers in my head.	K Je M	A B Jo	N	E	Je M	A B Jo	E K N	
18. I have trouble working out word problems in mathematics.	E K N	Je	A B Jo	M	E K N	A	B Jo M	Je
22. I think I could do more complicated mathematics.	N	A Jo	A B E Jo	K	Je	Jo M	B N	A E K

Results of Questionnaire - Affective

	Beginning				End			
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
4. I feel good about mathematics.		K Je Jo M	A E N	B	K Je	A Jo M N	B	E
6. Even though I try hard in mathematics, I find it hard.	E K	Jo N	M	A Je	E N	A K Jo	M	Je
7. I would be happy to do well in mathematics.	Je	B E K Jo M N	A		Je Jo	A B E K M N		
11. Mathematics does not scare me at all.	K Je M	B Jo N	A E		K Je	B E Jo M	A N	
12. Mathematics test scare me.	N	A E	B Je Jo	K M		E K N	A B Jo	Je M
13. Mathematics makes me feel uneasy and confused.	E K Je	A B N	Jo M		N	A E K	B Je Jo M	
15. I am frightened to raise my hand in a mathematics class to ask a question.	E K	N	A B Je Jo	M	K	E N	A B Je Jo M	
19. I feel anxious thinking about a mathematics test one day before the test.	Je N	A E	B Jo	K M	E	A N	B Jo M	K Je
21. I like getting mathematics tests back.	A Je Jo M	E K N			A B E Je Jo M	K N		
23. I enjoy my mathematics homework.	Je	A Jo	E N	B K M	Je	A Jo N	E M	B K

Results of Questionnaire - Social

	Beginning				End			
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
8. I don't like people to think I'm smart in mathematics.		Jo M N	A B E K	Je	N	K Jo M	A B E	Je
9. Mathematics is a worthwhile and necessary subject.		E Je Jo M N	A	B K		A E Je Jo M	K N	B
10. I expect to have little use for mathematics when I leave school.	K Je M	B E Jo N	A			A B K N	E Jo	M
16. I like helping my friend work out mathematics problems.	E Je	A K Jo	B N	M	E K Je	A Jo	B M N	
17. I enjoy walking into a mathematics class.	E Je	Jo N	A	B K M	A Je	Jo N		B E K M
20. It bothers me when I do not understand the explanation of a student in my mathematics class who does understand.	E M	A B K Je N	Jo		E K N	A M	B Je Jo	