

Science and Mathematics Education Centre

**Scaffolding Collaborative Learning In Mathematics
Classrooms**

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of
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DECLARATION

This thesis contains no material which has been accepted for any other award in any tertiary institution.

To the best of my knowledge and belief, this thesis contains no material previously published or written by any other person, except where due acknowledgement has been made.

Signature:

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ABSTRACT

Motivated by the desire to present engaging and relevant lessons in my mathematics classroom where my students were active participants in their learning, I saw many benefits of collaborative group learning in the classroom. I found the theory from professional development workshops did not always transfer seamlessly to practice and discovered some students were reluctant to participate in group learning activities because of previous bad experiences. These observations suggested to me that group learning may need to be structured to ensure that all participants learning goals were met. I began analysing the way science practical experiments were conducted with the intention of transferring the same methods to the Mathematics classroom.

During the course work component of my Masters studies I saw a disconnection between the quantitative methods of research and what I wanted to achieve as a teacher-researcher. I found the large sampling processes and multiple graphs communicated little understanding of the life-world experiences of teachers and students. This realisation led me to define my pedagogical style as student-centred and constructivist. I began to read widely about the historical, political and economic forces that shaped this pedagogical style and its place in curriculum policies in the UK, Europe and the US.

Shaping my research questions and title broadly was quite easy because I knew that I wanted to improve the functioning of collaborative learning groups in a before/after type comparison, but every decision led to more questions and more research. Eventually I decided to use the interactions between the group members as indicators of group function. I found ethnographic methods of participant observation, informal interviewing and tape recorded group interactions to be consistent with my belief that research of a social situation should involve the voices of the participants of those immersed within the culture.

The principal of my participant school provided me with sound advice on how to structure my requests to conduct my research in the rural demographic in which the school was located and thus I gained the consent of the sample class and their parents and guardians. I had already developed ethically sound relationships with my sample class, and had taught most of them on and off for the three previous years. My students trusted me implicitly and for their investment, I felt humbly in their debt. The unconditional trust my students placed in me gave me a sense of the importance of the ethical protocols I was required to follow.

The three phases of research where I generated most of my data was an intensely busy time. I was immersed in my research as well as teaching other classes. I felt hyper-aware of the interactions in my classroom and the seating arrangements. I was responsive to what was unfolding before me and tried to adjust my interventions to make them appear like a natural progression of the needs of the collaborative groups. I recorded my thoughts and observations in my journal at odd moments of the day; between classes, in staff meetings at my desk at the end of the day and I developed code names for my students and their groups which became more real to me than their actual names.

I had generated the data in 5 weeks and I tried to analyse the quantitative data I collected in the group questionnaires. I found this data quite useless but was not quite ready to discard this last vestige of positivism from my research.

I was rewriting my literature review and beginning to transcribe the group interview and tapes when Associate Professor Bill Atweh informed me he was leaving Curtin University to offer opportunities of further study to graduates in other countries. He asked me if I had ever heard of Grounded Theory and suggested I research it because it might suit my analysis style.

I was half way through transcribing my tape recordings and had read articles from *The Grounded Theory Review Methodology Reader, Selected papers 2004-2011*, when I first met Associate Professor Peter Taylor. His enthusiasm for educational research and support gave me confidence to apply grounded theory methodology to analyse the data I had generated. Professor Peter Taylor shared my excitement of my emerging theories, cautioned me, and introduced me to quality standards to regulate my interpretive knowledge construction.

As soon as school commenced I began the process of member checking my interpretive commentary which generated more valuable data and confirmed and provided alternatives to my emergent theories. I had immersed myself in the life of my students for four years which gave credibility to my interpretations and thick descriptions. Initially I did not know what theories might emerge from my data and so I applied grounded theory analysis with the open mind of a novice.

My decision to embark on post graduate study has achieved much more than giving me an understanding of how to improve the effectiveness of collaborative learning groups. It has changed my view on the nature of data, feedback and awakened in me a desire to continue researching and learning. Paradoxically, the long anticipated completion of my thesis is probably the start of my journey.

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To my Year 10 Advanced Mathematics class, thank you for the generosity of spirit you have shown me and for assisting me in my research. Thank you for allowing me to introduce new ideas in our classes and for your attention, perseverance and for the fun we had discussing my analysis. I will never forget your contributions.

I would like to acknowledge the encouragement I have received from Dr Ian Lowe from the Mathematical Association of Victoria (MAV) and Douglas Williams (www.mathematicscentre.com) who also valued activities in mathematics.

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My last acknowledgement is of Karen Crowley who introduced me to Mathematics Learning and Teaching for Success (MLATS) and suggested we attend the first SMEC meeting at The Southport School TSS in July 2006. You were a most inspiring Head of Department and it was a pleasure to work with you.

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CHAPTER 1

INTRODUCTION

While teaching on the Gold Coast in Queensland, Australia, I was fortunate to work with a very inspirational Head of Department in Mathematics, Karen Crowley, who introduced me to MLATS (Mathematics Learning and Teaching for Success). MLATS is a P-12 approach of teaching Mathematics which encourages thinking skills in students through problem solving and group learning. It is based on establishing a foundation of conceptual understanding in the junior years, of learning through sharing ideas and being motivated by inquiry and a social approach to learning.

I signed up as a participant to a series of 10 workshops which required between session planning, application activities and journal writing. It was a large undertaking, but I became very involved in the program and enthusiastic about its implementation. It appealed to my background because I had worked in other fields besides Mathematics, including the creative arts and design. I liked to see students being physically engaged with their learning as much as being mentally engaged, and I believed that Mathematics could benefit from creative thinking as much as Art. I saw Mathematics as a multi-dimensional skill that could be integrated into other subject areas. I adapted many lessons using the techniques MLATS promoted; problem solving activities which gave students the opportunity to reflect on their learning and report back to the class. The intention was that students would develop generalisations which could be applied to more theoretical situations. I went on to train as a presenter for MLATS. Concurrently, I began to identify some of the problems that could be associated with group learning and was occasionally quite disappointed with how some activities went in the classroom. I became aware that there was an undercurrent to my work as a presenter with MLATS.

DEVELOPING AN AIM

I decided to undertake further study in mathematics education and enrolled in a postgraduate program at Curtin University. I saw this as an opportunity to conduct research into group learning in Mathematics because I was involved with running group sessions with professional teachers but found these did not always translate effectively to the classroom. At this time I was looking at my teaching and how I could improve my delivery of group problem solving lessons. The ultimate aim of my completing further study was to teach Mathematics more effectively to students in the classroom.

Defining Constructivism

I began attending meetings at a nearby school with other interested teachers from a variety of backgrounds. We were encouraged to undertake research in the classroom and I started reading widely about teaching strategies. I found that I was using a social constructivist approach to students' learning in my classes. Vygotsky (1962) defined learning as being a constructive, situated and social activity, which awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in co-operation with his peers.

Harlow, Cummings and Aberasturi, (2006), defined constructivism by examining the learning theories of Jean Piaget and Karl Popper. Their thesis was that the construction of new knowledge developed from a state of disequilibrium. The learner was confronted with an object which could not be assimilated into prior knowledge and thus reconstruction occurred. Constructivism is a philosophy of knowledge and teachers who understand the underlying assumptions of this philosophy know that the teacher's role in orchestrating intellectual opportunities will maximize new conceptual learning (Brooks, 1990).

..the constructivist teacher may present new information in the context of a problem that introduces disequilibrium but that the student finds interesting and is capable of solving with some effort and support. In other words the teacher thinks about how to encourage the process of assimilation. (Harlow, Cummings, & Aberasturi, 2006, p. 46)

Constructivist Teaching

I began to develop an awareness of the range of constructivist approaches to teaching, such as 'discovery learning' which was described by Wesley Null (2004) as an idealized approach to learning. Rousseau an 18th century philosopher, described the education of his fictitious son, Emile, as he was given as much freedom as he desired to explore his natural surroundings without restraint.

Inquiry-based learning is achieved when a community of problem posing is established in a classroom. English (1997) described this environment in a mathematics classroom as empowering students to pursue lines of inquiry which are personally satisfying, where the connected dialogue between students and the teacher becomes a primary tool for promoting students thinking and learning skills. Inquiry-based learning involves a shift in the role of the teacher from 'telling' students what to do, to 'questioning and listening' and requires a commitment to creating an environment where problem posing is a natural process of mathematical learning. Fundamentally new problems are generated through questions which could be explored were used to engage students in investigating, formulating, representing and reasoning.

Experiential learning, as described by Kolb (1984), emphasises the central role of experience in the learning process and proceeds from the assumption that ideas are not fixed immutable elements but formed and reformed through experience. Kolb adapted Lewin's four stage model, where learning, change and growth are achieved through an integrated process of concrete experience followed by observation and reflection and new implications for action are deduced (see Chapter 2).

Exploring Group Learning

Prior to this research in my Mathematics classroom I had been using the technique of presenting concepts to students working in small groups, allowing students to construct their own understandings, but also providing opportunities for students to apply the concepts in a supportive collaborative environment. I used a blend of group work and class conferencing which aimed at promoting a stimulating learning environment in the classroom. I particularly wanted to scaffold the students learning in collaborative group work and believed that for things to change in the classroom, I needed to develop more effective teaching strategies. At this stage I started to investigate what research had been conducted in the area of group work. I started my literature review looking at the subject area of Science because group work was well used in this subject. I discovered that reasons that group work is used in science lessons underpins the reasons that I might use group work in my mathematics classroom. I began to research Johnson and Johnson (1991; 1994) and the group work they researched in the USA, and by looking at their references I found huge amounts of relevant research that had been conducted in Israel, UK and the Netherlands in the 1990s. I obtained information about why group work was being promoted by education departments as a teaching strategy in the classroom. The use of student groups in the UK and US were often encouraged to meet organisational and physical benchmarks rather than to promote learning (Kutnick & Rogers, 1994). The Plowden Report published in the UK in 1967 recommended that student groups would improve teacher efficiency, allowing students to teach each other and teachers would be free to help individual students (Kutnick & Rogers, 1994). However, simply by seating students around a table does not ensure that they are able to work collaboratively and the implementation of groups in a classroom is affected by a teacher's own education, ideology and preferences (Galton & Williamson, 1992; Alexander, 1984). Potentially, group work challenges the traditional role of the teacher who is in control of knowledge and organisation in the classroom and research shows that teachers are unsure of the merits and effectiveness of group learning (Cowie & Rudduck, 1988).

Students' perceptions of group work are often affected by their teacher's attitude and limited by their previous experiences, for example: lack of direction or non supportive group members (Galton & Williamson, 1992). I found a wealth of literature on the benefits of collaborative learning but fewer investigations had focussed on the preparation of students for working collaboratively (Prichard, Bizo & Stratford, 2006).

Teamwork Training

I began refining my research and narrowing my focus to the skills that are needed by students in order to work effectively in groups. I found extensive research and structured programs on teamwork training where every aspect of group work had been identified and researched. These studies were product focussed and were intended to have a commercial appeal to the Human Resources Departments of companies. Teamwork training courses were being marketed as products that were to be placed into businesses to improve the functioning and productivity of a team. I perceived that the benefit of teamwork training is the transferability of skills to collaborative learning groups in the classroom, but I wanted to find a way to promote these skills without conducting an entire separate subject called 'Group Work Skills.' In the Mathematics classroom, time is already short and the curriculum so crowded that there is insufficient time to teach the psychology and sociology of group work. I summarised the themes with the intention of finding simple techniques to scaffold student performance in group learning situations to make them more effective communicators and contributors.

Structuring Group Learning

Prichard, Bizo and Stratford (2006) suggested that there is no reason to assume that students will possess the skills necessary to function effectively as a group, or that they will develop naturally by merely being placed in a group. Indeed, they found that bad experiences of the past may deter students from future group learning (this is discussed further in Chapter 2). Prichard, Bizo and Stratford (2006) found that a comparative review of teamwork training and collaborative learning revealed common underpinnings: the existence of a group goal, member interdependency, co-ordination of members' activities, structuring of group roles and the focus on interactive processes. They found that there was little attempt to bring the two literatures together.

At the outset of this research, I believed that it was important for students to develop some simple rules (ie, social norms) to provide explicit guidelines for how they function in a group. It seemed important that the rules were simple, clearly understood and that students saw them as helpful rather than imposed. While it may have been preferable that social norms were developed by the group, there was not adequate time to do this in Mathematics classes. I could see the benefit of introducing simple roles and giving students specific responsibilities. I wanted to make the roles as simple and as clear as possible so that everyone understood the job descriptions of each of the roles.

I wanted to introduce a framework students could use for problem solving. I saw problem solving as the primary task of the group because the practical problem was the context from which the learning would emerge. In guiding and scaffolding students through the problem my intention was that they would be able to discuss and share their ideas with the group, develop an understanding of the foundation concepts of a topic and feel a level of success. The benefits of sharing ideas were that students could explain concepts in their own language and by hearing different explanations the concepts might just "click"

for students who were unsure. The second benefit of these discussions was that students become more confident with the language specific to the subject area. So, for example, the terms of cubing, finding cube roots, squaring and finding square roots might become more familiar to students and that they are able to articulate descriptors like; 'linear model', 'quadratic model' or 'power function', themselves rather than just hearing a teacher say them at the front of a classroom. So these descriptions might become part of their language about which they have some understanding, rather than a foreign language which ultimately becomes a barrier to their progress in Mathematics. Explanations benefit both the giver and the receiver. Receiving information is helpful when it is framed to enhance the receiver's understanding. Studies confirm that giving information is positively related to achievement, because the giver must clarify and organise the information conceptually (Bennett, 1994). I saw that the scaffolding provided by students to each other through explanations in a group was very valuable. If everybody understood in a group, then students would have a lot more questions answered than I, as one individual, could possibly answer. There would be less waiting and the situation would be avoided where the teacher sits at the front desk and 10 to 15 students wait in a line to ask a question. I had come through that kind of education system and absolutely disliked it. I did not want to perpetuate that kind of system in my own classroom. Bennett, Desforges, Cockburn, and Wilkinson (1984) found that curriculum practice based on individual cognitive tasks actually hindered the development of effective learning because the students had to rely on the teacher when they encountered a problem. Over reliance on the teacher to solve all student problems potentially leads to class management issues because many students are competing for the teacher's attention at the same time. While teachers often site off-task socialising as a problem behaviour prevalent in group work (Brown, 2000), it is equally a feature of individual cognitive tasks. Both instances can be managed by addressing the possible reasons for the socialising (see Chapter 5).

Teachers can manage socialising by subtly intervening and reducing any task confusion, thus allowing the development of beneficial social and emotional skills (Biott, 1987).

Kagan (1988) argued that language is essential for students to make sense of new knowledge. The ability to articulate a point of view, to engage in discussion and to question are skills that need to be promoted through organising classroom environments which offer opportunities for students to be involved in cognitive and social activities (Kagan, 1988; Bennett, 1994).

Learning Styles

The next consideration was how I was going to form these groups; it became clear that there was a lot of research on different learning styles. I was not interested in whether a student was a visual, auditory or kinaesthetic learner, because opportunities to learn in any of these ways were inherent to group problem solving tasks. I was looking at how people solve problems, whether they are divergent thinkers, assimilators, convergent or accommodators, and whether it was better to group like-minded problem solvers together or whether a combination of styles was preferred. I read widely about how groups could be formed and thought that self-awareness on how problems could be solved differently

could develop tolerance in group learning situations. I wanted to introduce knowledge in this area without launching into a highly theoretical exhortation and decided to use a learning-profile grid system where we categorised ourselves and discussed where we fitted in the grid. My class and myself analysed each other and found that everybody fitted into two neighbouring categories in the grid. No person was placed in a single category and the overlapping cycle allowed us insights into the thinking skills of others. My intention was that students would come to the realisation that although we think slightly differently, we bring useful insights to the group. Diversity in problem solving styles brings more options and more creative solutions to problems. If all group members have exactly the same problem solving style then conflict may be reduced but the group learning experience will not necessarily be as rich because fewer alternative options are likely to be explored. Intellectual disagreements amongst students instigate invention. Controversy exists when one student's ideas differ from another and when they are resolved through deliberate discourse where students structure their position and listen to the perspectives of others, they teach their knowledge to their peers (Johnson & Johnson, 1994c).

DEVELOPING MY RESEARCH QUESTIONS

What I hoped to gain from my research was to understand how groups functioned in my Mathematics classroom when I use collaborative learning groups.

Conversational Space

A useful outcome of my literature research was the idea of giving students conversational space, allocating time for them to discuss how they thought their group was functioning and how effectively they were learning in the group setting. I describe this as promoting meta-learning, where students analyse how effectively they have learned and plan to make changes to promote more effective learning in subsequent group learning experiences. I have found meta-learning to be empowering for students because it takes them out of the passive role where someone else is going to solve their problems to a position where they plan and enact changes themselves. Meta-learning gives students permission to be stakeholders in their own learning. Year 10 is a good time to introduce the concept of meta-learning because the students at this level are ready to take some responsibility for their own learning. Vygotsky's notion of the zone of proximal development identifies the differential between what a learner can do unaided and what can be achieved collaboratively.

What a child can do today in co-operation, tomorrow he will be able to do on his own. (Vygotsky, 1962)

Grounded Theory Analysis

My discovery of ‘grounded theory’ as an analysis technique altered the way I view research in social educational contexts. I now view all student comments made to me, as their teacher, as part of a cycle of feedback, reflection and modification of the methods I use in teaching. In the words of Carol Roderick (2009):

Actually participating in research, however, goes beyond coursework learning, it engages learners, scaffolds their learning, helps them to build connections with other scholars, and provides them with experience to mitigate research anxiety (Roderick, 2009, p. 318)

In the context of this research project, grounded theory allowed me to conduct my research in synchronicity with my teaching methods and allowed my path as a researcher to run parallel to the journey of my students who were my co-participants in this research. I hope the significance of this observation will become clear as you follow the journey I have taken through this research in the following chapters.

OUTLINE OF THESIS

In Chapter 2 I have presented the theoretical framework that underpins my research. The chapter begins with looking at the types of groups utilised in classrooms and then theoretical foundations are laid for why collaborative learning groups are useful in mathematics classrooms. Literature describing where collaborative learning sits in education theory is discussed and specific research projects about collaborative learning are reviewed. The results of my research into team training have been presented and models of problem solving. I was particularly interested on where previous research in collaborative learning stopped and the future directions suggested. I aimed to define all educational terms I used in my research and discussed why I selected my method of research.

Chapter 3 details my research methodology, explaining my research intentions and describing the co-participants of my research. Each phase of the research is detailed and the tasks presented to the students are explained (All class presentations and tasks have been included in Appendix 1 and 2). I have explained how the data was collected, organised and processed (The transcripts and analysis of the data is provided in Appendix 3). The ethical considerations and protocols of my research have been discussed.

Chapter 4 includes the analysis of Phase 1 of my research. Excerpts of the transcripts are provided to justify the themes I found in this phase of the research. I included member checking and my journal comments to explain the context and multiple perspectives of the participants in the research. The results are summarised at the end of the chapter.

Chapter 5 describes how I structured Phase 2 of the research and provides the analysis for this phase. Detailed transcripts are used to justify why themes I have chosen to describe the climate in the collaborative learning groups. I have organised the themes found in Phase 2 and presented this in the summary at the end of the chapter.

Chapter 6 includes the way I have structured the final phase of the research including descriptions of the learning materials. I have detailed the evidence that has led me towards finding the themes in the data and given examples from the transcripts, the group interview and member checks.

Chapter 7 provides the conclusion of my research. I discuss what I learned in each phase of the research and what aspects I was happy with and those that I would have changed given the opportunity. I discuss how I have analysed the data and importantly how this research has informed my classroom teaching of mathematics.

CHAPTER 2

LITERATURE REVIEW

INTRODUCTION

Learning has been defined as a constructive, situated and social activity, it ‘awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in co-operation with his peers’, (Vygotsky, 1962)

The implications of this statement are that teachers should consider grouping techniques when they plan lessons and that groups should influence the lessons resources and content. The structure and dynamics of how groups function in Mathematics classrooms is the subject of this research, but before structuring any research in this area a number of questions need to be answered. The literature review which follows provides an examination of the philosophy that underpins this research and defines the terminology that is used. The structure of this chapter is from general and broad questions initially which then lead to specific questions which have informed the design of the research project.

What are The Types of Groups that can be used in The Classroom?

Galton and Williamson’s (1992), review of studies concerning classroom groups in the UK and US classified the range of small groups, the tasks assigned and the intended outcome, see Table 1. A clear distinction is made between co-operative and collaborative group work. Co-operative work is where students have individual sections of an assignment which is compiled into a joint outcome, where-as collaborative work is usually problem-solving or debating a social issue and the end point is an agreed solution.

Type	Task Demand	Intended Outcome
1. Seating Groups	Each student has a separate task	Different Outcomes: Each student completes a different assignment
2. Working Groups	Each student has the same task	Same Outcome: Each student completes the same assignment independently
3. Co-operative Group	Each student has a separate but related task	Joint Outcome: Each student has a different assignment

4. Collaborative Group	Each student has the same task	Joint Outcome: All students share the same assignment
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In this research project the definition of Collaborative Learning (CL) groups presented by Galton and Williamson (1992), will be used. Members are peers working together to acquire knowledge and skills and each member is expected to contribute to the outcome.

Johnson and Johnson (1994), classify learning groups as one of three types:

Problem Solving Groups: where a hypothetical problem is given to a group who develop solutions

Special Purpose Groups: which have a fixed duration of time for the introduction of something new for example learning some new technology

Self Management Groups: which oversees an entire project from beginning to end

The three purposes described by Johnson and Johnson (1994), have been included in this research project. The learning groups in the mathematics class used in this research project have been given hypothetical problems to solve through the course of the study. The Special Purpose type of group task was employed when each group was given mathematical puzzles to solve to reinforce the use of CAS Inspire calculators and methods which benefit from teamwork and scaffolding to ensure each other understands use of the technology. The final Self Management type of group was utilised when the groups of students were given research assignments and equipment and were required to organise themselves to complete the tasks and submit a group report.

Why Should We Use CL Groups in Mathematics?

The traditional model of teaching Mathematics is challenged because of the declining levels of numeracy demonstrated by students. Reports of students who learn successfully as a result of the traditional model of instruction is probably the result of students having similar learning styles to that of their teacher, but for the majority of students the delivery system has failed and presenting alternative pedagogies is justified (Sewell, 2002). Learning in Mathematics is more than the transmission of knowledge where the teacher delivers the content and the students are passive recipients of new information somewhat like a sponge. Sewell (2002), states that traditional assessment testifies that students are able to cram for and pass tests while in reality no real learning has occurred. If a few questions are posed to students to discover the depth of their conceptual understanding teachers will be disappointed. An alternative view is that learning is an active process where students construct knowledge through problem solving, reasoning and critical thinking which are intrinsic processes in the application of Mathematics.

A theoretical justification for the use of CL groups in the Mathematics classroom can be derived from both cognitive and motivational perspectives. From a cognitive perspective,

interpersonal interactions are important for facilitating learning in CL groups. These interactions include opportunities to consider multiple methods and alternative modes of representation also through social negotiation in which students are exposed to cognitive conflicts and conflict resolution (Prichard, Bizo & Stratford, 2006). The intention of exposing students to cognitive conflicts and resolution is the potential resulting improvements which occur in the area of mathematical literacy. This can be defined as the fluency they have when discussing mathematical methods and concepts which in turn leads to the facility students have in interpreting problems and in their production of spoken and written text.

Learners benefit cognitively from active participation in the learning process where they are given the opportunity to work together to achieve a joint construction of shared knowledge. They are able to scaffold each other's learning to develop a Mathematical literacy through explaining their thinking to each other and through verbal elaboration of the material (Palinscar & David, 1993). This benefit from CL groups is illustrated of the famous quote of Albert Einstein (1879-1955) where he states that if you cannot explain a concept to your grandmother then you have not understood it.

Motivational theory proposes that learning occurs in relevant environments where students are motivated to reflect on and use their prior knowledge to construct new generalisations. They become invested in their project and become a classroom community engaged in the activity of the active and reflective use of knowledge.

The scaffolding of learning within groups should improve the learning outcomes for a greater number of students in a classroom. Students in CL groups are motivated to help fellow students to learn because they come to care about each other and realise that personal goals are met when a CL group is effective (Prichard, Bizo & Stratford, 2006).

As a CL group becomes experienced in Reflective–Action it is able to assess its own performance and rearrange its internal relations for decision making, it is able to learn how to learn through acting and assessing the consequences of action (Kayes, Kayes & Kolb, 2005). Students are given the opportunity to learn how 'to learn' through a positive interdependence. Students are better prepared to function in higher education by developing competencies for self directed learning (De Kock, Slegers & Voeten, 2004). Self directed learning is enabled by metacognition which is as an important learning goal and defined as the awareness and knowledge of one's own cognition (Elshout-Mohr, Van Hout-Walters, & Broekamp, 1999; Anderson & Krathwohl, 2001).

Mathematics forms part of the education of the whole person and the skills intrinsic to the process of learning of Mathematics in CL groups are transferrable to the scope of abilities a student is able to take with them to into their future work and life skills environment. Within workplace environments there is a developing culture of team skills training intended to enhance group member's skills in goal setting, problem solving, role clarification and interpersonal relations (Prichard, Bizo & Stratford, 2006). Life skills encompass the ability to make considered financial decisions with short and long term consequences. Whether a student can weigh up all the costs associated with buying their

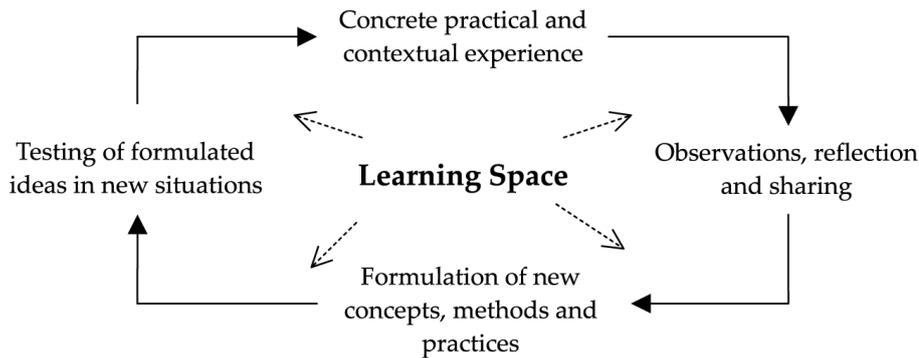
first car or considering a longer term decision of developing or purchasing for a business or buying an investment property, mathematics fluency is involved.

Where Does Group Work Fit into Educational Theory?

Using CL Groups as a classroom organisational technique promotes a constructivist view of learning. In essence constructivism is a theory of how people learn, which has implications for how teachers should teach. Constructively speaking, teaching is not about delivering content but an act of designing experiences that encourage and enable learning (Lattuca, 2006). The argument being that teachers should consider student's prior knowledge when planning lessons and should pose questions which are relevant to students' lives. Constructivists advocate teaching practices that are interactive rather than domineering and alternative modes of assessment which are incorporated into the process of learning rather than based on competition (Null, 2004; De Kock, Slegers & Voeten, 2004). Traditionalist theorists give primary emphasis to the acquisition of abstract symbols and behavioural learning theorists deny any role of consciousness and subjective experience in the learning process (Kolb, 1984).

Constructivists believe that knowledge is the result of individual constructions of reality and learning occurs through the continual creation of generalisations and hypotheses to explain what is observed. The need to create new formulae and hypotheses occurs when the student's present conceptions of reality are thrown out of balance by disparities between previous conceptions and new observations (Kolb, 1884; Brooks, 1990; Sewell, 2002).

Brooks' (1990), description is underpinned by the same theories as Kolb (1984), in his experiential learning theory. Experiential learning has its intellectual origins from the work of Dewey, Lewin and Piaget and is so named because of the central role that experience plays in the learning process. Kolb (1984), developed a four stage learning model or cycle (ELT), which is the process where knowledge is created through the transformation of experience. Concrete experience is the basis for observation and reflection. The observations are assimilated into a hypothesis or rule which is tested and has new implications for action and creating new experiences. The goal is to learn from experience as a group, by sharing experiences together and reflecting on the meaning of the experiences to create a collective understanding that will guide the group in action. Kolb (1984), provides the structure for Group Learning which is both clearly explained and transferable to a CL group in the mathematics classroom.



Source: Based on Kolb (1984)

Reflective- Action learning has become acknowledged as an integral part of development and growth of team or group work environments. The Reflective-Action Learning Group (RALG) is predicated in Kolb's ELT. The objective of RALG is to provide opportunities for groups to internalise experiences of trials and errors based on concrete experience. Of importance in this process is the ability to embrace change and actionable outcomes. True learning can only take place as the learner questions his/her insights and actions to create new knowledge. The role of reflection based on concrete experience is critical if something meaningful is to be learned. Teams in learning institutions and industry are finding Reflective-Action Learning relevant to their performance (Yeo, 2006).

THEORETICAL CONCERNS ABOUT GROUP WORK IN THE CLASSROOM.

With such a rich history, we might ask why constructivist-like ideas have had such difficulty in impacting the classroom. Null (2004), suggests that educators often look for simplistic answers to often complex problems, and the translation of constructivist-like ideas to the classroom appears anything but easy. Brown (2000), responded to the increased emphasis on teamwork in many industry settings with extensive research into the area of "working in groups"; she found that instructors who wanted to use group work would encounter considerable resistance from their participants in addition to their own lack of experience. She recommended that teachers who wished to use groups in their classroom read her entire book of research before attempting the venture. Researchers such as Vogel et al. (1987), alluded to this issue much earlier, observing that while group skills are recognised as important, little systematic attention has been given to group facilitator training. Also Prichard, Bizo and Stratford (2006), noted there has been little specific research investigating the role of training students in the skills necessary to interact effectively in a group and on the influence this may have on learning outcomes (Prichard, Bizo & Stratford, 2006).

Brown (2000), found that many students reported that they hated working in groups because they found it frustrating and time consuming trying to work with others and preferred to work independently. Many students reported this even though they had no experience working in a group.

Kayes, Kayes & Kolb (2005), found many who work in collaborative teams are not happy about it. They complain about wasting time in meetings that did not result in any action. Students complain about team members who do not pull their weight but a group's grade is dependent on their group's performance. Some specific problems experienced are: an overdependence on a dominant leader, a tendency to conform to group think, an over commitment to goals, a failure to express true feelings and social loafing.

De Kock, Slegers & Voeten (2004), highlighted pitfalls to be avoided in team work and CL groups as: the Free Rider Effect where a more talented or motivated student does all the work, the Sucker Effect where a group member who gets stuck with doing all the work decreases his activity, the Status Differential Effect, where higher status members dominate the group and therefore have more learning opportunities than other members.

If students are to work together successfully then they must be equipped with skills that they need to achieve this. These skills will not develop as a result of being placed in a CL environment. Researchers have argued that the consequential bad experiences may deter students from future group learning experiences (Prichard, Bizo & Stratford, 2006).

The Need for Facilitator and Participant Training

For students to be motivated to help each other to learn, group cohesion is critical. The use of team building exercises to induce cohesiveness has been suggested as crucial to promote successful learning in CL groups (Prichard, Bizo and Stratford, 2006). The need to develop interpersonal and processing skills in small groups was identified by Yagar, Johnson, Johnson and Snider (1986). Prior training of groups was identified as an important variable by Druckman and Bjork (1994). In conjunction with the need for more research on how to prepare students for working collaboratively in educational settings have been government initiatives to ensure graduates are equipped with the skills necessary to work effectively in teams in the workplace. The standard response has been to provide students with the opportunity to work on group products with the expectation that they will learn through experience. This has been challenged by researchers who argue that team-skill ability needs to be facilitated (Druskat & Kayes, 2000; Prichard, Bizo and Stratford, 2006)

While group skills are recognised as important in the classroom little systematic attention has been given to instructor training (Vogel et al., 1987; Yeo 2006). In conjunction to this the features of co-operation are seen as central to our existence in society, schools seem the least characterised by co-operative research (De Kock, Slegers & Voeten, 2004).

Research on the use of groups in the classroom in the UK and US provided a useful summary of the features essential for the effective use of CL groups (Galton and Williamson, 1992).

- Students are likely to achieve more in small groups if they are working towards a shared outcome

- Groups function best when they are of mixed ability
- Problem-solving tasks with a clear outcome generate a greater degree of collaboration than open-ended tasks
- Students need to be taught how to collaborate so they have a clear idea what is expected of them

Further characteristics were added by Johnson and Johnson (1991a; 1994b), group members should:

- share the responsibilities and have expectations of individual responsibility and accountability
- demonstrate the use of consensus for decision making
- be open to conflict and controversy
- be cohesive and show acceptance and support among members
- have strong interpersonal skills

De Kock, Slegers & Voeten (2004), provide a useful framework for effective constructivist teaching practice by describing the instructional strategies for CL groups. These strategies suggest the emergent nature of the skills required for effective group work rather than expecting the participants to already possess the skills.

- (a) Structure positive interdependence between students
- (b) Structure individual accountability within groups
- (c) Stimulate direct interaction between members
- (d) Develop communication skills
- (e) Evaluation of group product

DEVELOPING A MODEL FOR PREPARING STUDENTS FOR CL GROUPS

Brown (2000), provides a detailed account of the preparation an instructor must undertake prior to introducing CL in the classroom. Firstly the instructor needs to develop clear goals of what is to be accomplished. When groups are new, it is useful to set cognitive goals and group goals for example:

The cognitive goal might be to gather results, describe the pattern and state a general rule and the group goal might be to learn the value co-operation to enhance productivity. Both goals should be measureable so that students know how they function as a group is important and will be assessed.

It is important that CL work is embedded in a timetabled unit of work with critical points specified so the groups have clear direction.

It is not sufficient to have students read about group work, the instructor will need to explain the subject which may need some “selling”. Brown (2000), suggests that instructors may need to be patient with general classes where there may be resistance, intolerance and fear of appearing ignorant. These students will need reassurance, specific instructions and frequent feedback. Students who have taken the subject as a major have more confidence in their ability and tend to trust the instructor’s expertise. When structuring the explanation of the group work we need to take into account that some students learn best when they understand the global context and then learn the specifics where as other students like to learn the specifics and then put them in a global context. Brown (2000) suggests addressing both perspectives when group work is unfamiliar.

Selecting Student Groups and Team Work Research

Knowing the general interests, abilities and personalities can aid the instructor when planning the groups. Research using The Learning Style Inventory developed by Kolb (1984; 1999), has identified four prevalent learning styles which are summarised below (Kayes, Kayes & Kolb, 2005).

<p>Diverging</p> <ul style="list-style-type: none"> - Learn from concrete experience and reflective observation -Like to gather information -generate ideas by brainstorming -Interested in people -Tend to be imaginative and emotional -Have broad cultural interests -Often specialise in the Arts -Like working in groups -Listen with an open mind -Enjoy receiving personal feedback 	<p>Assimilating</p> <ul style="list-style-type: none"> -Learn from abstract conceptualisation and reflective observation -Put information into a concise logical form -less focussed on people and more interested in ideas -more interested in logical soundness than practical value -Tend to go into Science and IT areas -Prefer reading and lectures -Like to have time to think things through
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<p>Converging</p> <ul style="list-style-type: none"> -Learn from active experimentation and abstract conceptualisation -Find practical uses for ideas and theories -Prefer technical problems rather than interpersonal issues -Find careers in specialist technology areas -Like to experiment with new ideas, simulations, assignments and practical applications 	<p>Accommodating</p> <ul style="list-style-type: none"> -Learn from concrete experience and active experimentation -Learn from “Hands On” Experience -Enjoy carrying out plans and involving themselves in new challenging experiences -Use “Gut Feelings” rather than logical analysis -Rely on people for information -Choose action oriented careers such as marketing or sales -Prefer to work with others to get assignments done -Set goals, do field work and test different approaches.
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Research has found that teams comprised from members with the same learning style, had similar performance results, however teams from diverse learning styles performed significantly better (Wolfe 1977). Similarly Kayes (2001), found teams made from members whose learning styles were balanced among the four modes performed at a higher level in critical thinking. Further research found that student teams formed randomly to include all learning styles performed better than self-selected teams. Students in the classroom can improve their teamwork skills through respecting all learning styles in mixed groups capitalising on their strengths and discussing style differences to resolve conflicts (Sharp, 2001).

Randomly selected teams where students are removed from their friendship groups can result in reducing the psychological safety of the members. Psychological safety is the feeling that team members can feel safe to make mistakes, have their contributions valued and be able to express views that differ from the majority opinion (Kayes, Kayes & Kolb, 2005). Research has found that teams with low psychological safety tended to have early conflicts which limited the conversation and tended to be more turbulent (Wyss-Flamm, 2002). The better students perform in the group the more satisfied they become and the more psychologically safe they feel to take risks with the team (Lingham, 2004). With psychological safety in mind, the groups selected in this research study were chosen by the researcher but contained members who the researcher perceived to be comfortable with each other.

Team Work Training

As organisations increasingly rely on teams to get work done the ability of individual team members to learn team work skills has become relevant in education. Team Skills

training is experiential in nature, designed around Kolb's Learning Cycle (1984). Students work in groups on a variety of tasks that require them to work together. A subsequent review activity is then introduced which requires them to focus on what happened during the task with other group members, sharing their observations and reactions. From this process students are able to integrate their experience with other information they have acquired to develop a greater understanding of what has occurred and to develop key focus points for future investigations. Kolb's Learning Cycle (ELT), provides a useful model which illustrates the problem solving process in CL groups. Team work training is the analysis of how teams function effectively and how to structure activities which enhance the development of team skills. The six areas of team functioning are; purpose, membership, roles, context, process and action taking (Kayes, Kayes & Kolb, 2005). This research project has drawn on the discussion of the six areas of team functioning to develop a model for CL groups in the Mathematics classroom. Previous research on the use of the ELT in student learning teams found the model enhanced the transfer of learning between theory and practice and between the classroom and the workplace (Gardner & Korth, 1997).

Social Norms and Participation Requirements

Students not only have rights but they also have responsibilities, this means that there are expectations for performance and demeanour in class (Brown, 2000). If groups are to function effectively all group members will need to participate. Social learning skills are critical to the functioning of a CL group, for example active listening and explaining thing to others will assist groups in meeting both their cognitive and group goals. The development of these skills will promote feelings of group cohesiveness because members will feel valued and supported.

Specifying what participation means reduces ambiguity and promotes security in students because they know they are meeting the instructor's expectations (Brown, 2000).

Social norms are the participation requirements of working in a CL group. Palincsar, Anderson and David (1993), solicited students help in developing the social norms used in their CL groups with the aim that students practice the language and methods in a supportive environment. The four social norms are:

1. Contribute to the group's efforts and help other's contribute
2. Support one's ideas by giving reasons
3. Work to understand others ideas
4. Build on one another's ideas

To ensure the group learning goals were met in the Mathematics classroom in this research a fifth social norm was added.

5. Ensure all group member's understand concepts

In this research project the social norms listed above were used because the wording was simple and intended to show a respect for differing values of students. This is important because classes have considerable diversity in racial, ethnic, gender, religious and social class areas (Brown, 2000). At the commencement of each session the social norms were reinforced and were on a poster in the classroom. The researcher acknowledges that if social norms were developed by a class it is likely that there would be increased ownership of the rules.

Student Roles Within CL Groups

The use of the organisation technique of having group members lead their group in different activities has further benefits in giving all members an equal opportunity to feel valued and in a sharing of the responsibility in the completion of the project. Thus members assume a specialised role which needs to be defined with a clear job description. What determines the nature of the roles a group uses has been the subject of extensive research. Roles can match the stages of a learning cycle that the group works through. Park and Bang (2002), used 9 roles covering 9 sub-stages of the ELT and found their results validated the use of these roles over 52 research learning groups. Some roles are chosen on the basis of task accomplishment for example: Initiator-Contributor, Information Seeker, Co-ordinator and Evaluator-Critic. Other groups focussed on maintenance such as; Encourager, Compromiser, Standard Setter and Group Observer (Kayes, Kayes & Kolb, 2005). McMurray (1998), organised roles based on the group member's strongest learning mode and used the roles of: Leader, Artist, Writer and Speaker. Gardner and Korth (1998), used the the ELT and matched the roles to the learning styles of Converger, Diverger, Assimilator and Accommodator, with the intention of developing an appreciation of all the different learning styles present in a group. While these roles have appeal and strong theoretical justification they are difficult to define and in a Mathematics classroom their complexity is likely to be ambiguous. Given the definition that CL groups using the ELT are constantly assessing the consequences of action and learning how to learn all team members can take an executive role in a group. When considering the match between the learning styles of individual members and team roles it is important to remember that team learning is based on adaption. Roles are not static and individual team members will benefit from adapting to the changing context of learning new roles, taking on new responsibilities and assisting others with these transitions (Kayes, Kayes & Kolb, 2005). In contrast to the belief that a role like leadership is a characteristic of a person and that a group should have a single leader. The researcher believes that rotating roles are better for students because this allows all students the opportunity to develop the requisite skills. Keeping the roles simple and clear was seen as important so only two roles were used in this research; Leader-Contributor and Presenter-Contributor. The Leaders task was to ensure the social norms were followed and guarantees all group members take part. The Presenter records

the major decisions of the group and reports on these at the lesson conclusion. At the beginning of each CL session, students assembled their groups and the roles were established for the session.

What is Leadership?

Leaders have the capacity to make considerable impact on the functioning of the group and the satisfaction of group members. Effective leadership is the key to avoiding dysfunctional inefficiencies of teamwork and potentially maximises the skills of the team members (Kayes, Kayes & Kolb, 2005). While Brown (2000), describes a process of selecting, guiding and evaluating group leaders which is not consistent with the experiential learning model adopted by the researcher, however, she describes the characteristics of leadership which could be used as group goals in a CL group. Effective group leaders have faith in the group process, awareness of the undercurrents of the group, tolerance of diversity and need to value and respect every group member. A summary of some of the significant skills that will develop through leadership are;

- Organising what needs to be done and in what order so all tasks are accomplished
- Communicating honestly, directly and accurately
- Assisting in relationship building by responding directly to others, clarifying what is heard, encouraging, considering other perspectives, expressing important feelings of the group.

Developing these characteristics and skills is an on-going process that continues with each CL group experience (Brown, 2000).

QUALITY INTERACTIONS DEFINED

Leikin and Zaslavsky (1997) developed a checklist of the types of interactions that occur between students in group work with the main intention of measuring how much help they receive in CL groups. Interactions were categorised as on-task or off-task between students (S-S), student and teacher (S-T), Student and Learning Material (S-LM). Clearly on-task interactions were considered preferable but the researcher considered these hard to quantify in terms of duration, hard to qualify in terms of quality and likely to be ambiguous. Therefore while the categories are useful to differentiate the types of interaction, they have not been used as a quantitative instrument in the current research project.

One of the paramount goals of the group research conducted by Palincsar, Anderson and David (1993), was to increase the discourse between students communicating their ideas and discussing the relationships between concepts. The types of interactions between

students involved; making sense of the data gathered, explaining their observations and building on their prior knowledge through reflection. In problem solving tasks in Mathematics discussions would include:

1. Identifying the variables involved in a problem
2. Describing what is happening to the variables using observation and data
3. Defining what is happening to the variables by applying a model they have previously seen, for example, linear, quadratic, exponential, etc

The emphasis Palincsar, Anderson and David (1993) gave to communication in their research is seen as very consistent with the goals of ELT by the current researcher. They considered social norms as conducive to successful collaboration and fluent in the specialised language of a subject area. They recognised the tension between academic and colloquial discourse. The social norms they developed addressed this tension and provided a positive framework for communication in a CL group.

Like the presence of amphibians are indicators of the health of an ecosystem, so are the type of interactions an indicator of the effectiveness of a CL group. It is through the quality and quantity of their interactions that group members judge the degree of their inclusion with the group (Brown, 2000). In a CL group, peers are required to work co-operatively to accomplish a task so interactions which show evidence that consensus has been used for decision making provide evidence that this is occurring. Data obtained from a group which indicates that all group members are contributing would indicate that there are effective communication patterns occurring in the group. Evidence of active listening and responding within a group where members build on one another's ideas are interactions that will lead a shared understanding of where the group is heading. Interactions which provide evidence of peer scaffolding through clarification and explaining are likely to make CL group work both productive and a positive experience. Tolerance of diversity and the valuing of all members' skills and expertise is demonstrated when interactions show there is a sharing of multiple methods and perspectives.

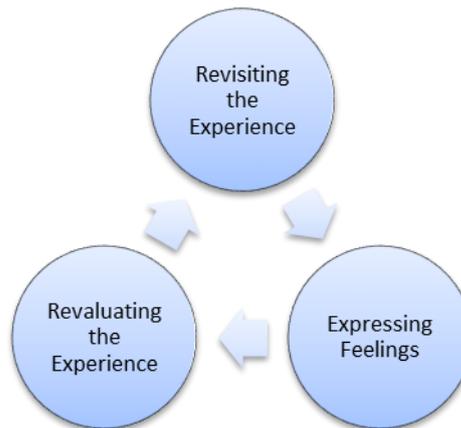
Communications of encouragement and support can be helpful from a group leader in the early stages of group development because group members are often anxious and floundering at this stage. Interactions that coach a group into trying new activities or encourage participants to see new ways of seeing a problem can help a group make progress towards finding a solution. Interactions which can be helpful are those that focus on the positive developments of a group, show faith in their abilities and competencies of the members, block negative statements and take pleasure in the groups progress.

REFLECTIVE ACTION

Reflection is the response of a learner to experience, it is a processing phase where the experience is evaluated and therefore leads to action (Yoong, 1999). Reflection is critical

to progressing through the stages of Kolb's ELT. The cycle begins at contextual experience and through reflection new concepts are developed, these concepts are evaluated and modified through reflection which leads to the formation of new ideas. The Action phase is important because as the learner gains new insights, actionable outcomes are formulated. True learning only takes place when the learner questions their insights to create new understandings which result in further action (Yeo, 2006). For a diagram of the Reflective-Action Learning Cycle, refer to page 12.

Reflective-Action Learning includes what Yoong (1999), describes as a reflective space for thinking through issues relating to practice and a conversational space which is an exchange of views through dialogue and feedback. A diagram of Reflective-Action Learning illustrates the stages described by Yoong (1999).



Brown (2000), highlights the need for the instructor using CL groups to provide time for students to talk or think about a problem before beginning to work, time for reflection before requiring a decision or action and time for reconsidering decisions. Yagar, Johnson, Johnson and Snider (1986), provided CL groups with a series of verbal instructions to guide them through a discussion on how well they were performing on a task and how they could improve their effectiveness. Results showed that the CL groups that used group processing or reflective-action significantly outperformed those who did not. For this reason the researcher used a structured conversational space where the students were encouraged to process the functioning of their group.

CHAPTER 3

RESEARCH METHODOLOGY

INTRODUCTION

The purpose of study is to improve the way I use group work in the classroom. This is intended to be achieved through developing a rich understanding of how the functioning of collaborative groups in Mathematics can be scaffolded to make them more effective instruments in learning constructively.

The design of this research is an interpretive inquiry where my role as the teacher can be described as a reflective practitioner or a participant in the action. The methodology used is appropriate for researching collaborative learning groups which assumes a constructivist approach to learning and teaching. Constructivist theory is both the focus and the method of this research which allows it to be classified as “interpretive” in the style described by Peter Taylor (2014), as radical/social constructivist when deployed in research in the areas of Mathematics and Science. The nature of this qualitative research focuses on the value of human interactions, acknowledging that research with human participants is different to animals or inanimate objects because human participants are able to make and share meaning (Gallagher, 1991). As a result the research methods chosen record interactions and observe them occurring within the social context. This research is underpinned explicitly by social constructivist epistemology, used by anthropologists seeking to understand the significance of behaviour in its cultural context. It aims to construct authentic accounts of the participants through ethnographic methods including participant observation, non-clinical interviewing, emergent analysis via grounded theorising and the inclusion of thick descriptions. I chose these data collection methods with the quality standards of interpretive research in mind and my understandings that emerge from prolonged immersion in the participants social world. This research combines the methods of group and individual interviews, journaling, tape recorded lessons and reflection sheets. The quality standards used were designed by naturalistic researchers Egon Guba and Yvonna Lincoln (1989).

The school used in this research is a co-educational private school in a rural town in Western Victoria, Australia, which sources a representative cross section of the community. The school community mixes a wide variety of different socio-economic and cultural groups including; professional, agricultural, local businesses including tourism, long term infrastructure employees involved in the establishment of a number of large correctional centres which are expanding in the district and also families that support and are supported in the correctional centres. The school provides multiple pathways for students including the opportunity to elect to participate in a more challenging Mathematics in Year 10 to prepare them for Advanced Mathematics in the final two years

of secondary education. The sampled class is an Advanced Year 10 class containing 16 students.

RESEARCH INTENTIONS

Specifically the study will investigate:

1. What is the quality of the group's interactions in CL settings in a mathematics classroom when roles, social norms and reflective-action learning cycle have not been introduced?
2. How does the quality of the group's interactions change in CL groups in a mathematics classroom after roles, social norms and reflective-action learning cycle have been introduced?

THE NATURE OF THE RELATIONSHIP BETWEEN THE RESEARCHER, THE CONTEXT AND THE PARTICIPANTS

My research was discussed and sanctioned by the Principal who suggested that the College letterhead be used on all consent and information material in conjunction with that of Curtin University. I selected my Year 10 class to be the co-participants in the research. I had been their teacher of Advanced Year 10 Mathematics for one half of the academic year before my research commenced. Four of the students had been students in my Mathematics class in Year 8, two years previously. However, I was a well known and trusted teacher in the school and this reputation facilitated 100% consent from the participating class. At this stage of the year a good rapport had developed between me and the students involving mutual respect and trust. I felt I had permission to openly discuss the nature of my research with my class and their response was simply that "they trusted me". Their trust brought with it a personal and ethical obligation to cause no intellectual, social or psychological harm to any member of the class. I sought to provide an educatively authentic experience for the participants where they would have the opportunity to improve their problem solving skills and develop an awareness of their learning styles actively contributing to the participant's self-understandings as well as their understandings of other stakeholders in their collaborative group. While the research fieldwork was conducted in the middle of the year, the transcriptions and analyses were not completed until after the academic year had concluded. Therefore none of the conclusions drawn had any bearing or effect on the assessment of any of the participants.

When I commenced this study I was not sure whether the interventions would be successful, therefore research was not deterministic. There was no single hypothesis being tested using a scientific method, instead my conclusions emerged from the data. As I conducted my research as a reflective practitioner I found the input I received quite

overwhelming in volume. My perceptions were that I was dealing with a multitude of student concerns from different groups, I was not able to understand what was happening in any depth in a single collaborative group. There was a great deal of noise and excitement in evidence and I thought the whole exercise was going to be a monumental failure. Rather than adopting an attitude of discovering a self-determined prophecy for the success of the interventions I had extensively researched, designed and introduced, I actually started to doubt that anything remotely useful was going to emerge from my research. My early predictions were that my research was going to show that student empowerment in the classroom was going to lead to chaos. The possible dilemma of seeing only the data that supported my research was therefore avoided by entering the context of the research with an open mind and a growing sceptical trust in my interventions. I approached the introduction of grounded theory analysis methods with a completely open mind.

Timing was an important design consideration in this research project. If students spent too long in phase one before phase two was introduced, it may have been hard to distinguish changes which resulted from the interventions and those occurring due to natural proclivity. The Year 10 calendar controlled the pace of all phases of this research: Phase One and Two needed to be completed before the students went on camp. Phase Three followed the camp and then a group interview needed to be conducted before the midyear examinations and two weeks of work experience. This research project was carefully planned to fit in between the different events that occurred in a school term and not disadvantage the participants in any way. I did not have room to manoeuvre when students were absent, I simply had to make the best of changing circumstances and try to provide a seamless educational experience for all class members and attempt to preserve the distinct changes in the phases of my research.

Juggling the Mathematics Curriculum, the Year 10 Program, the phases of my research and the integrity of the learning experiences I was providing for my students was challenging.

DISCUSSION OF RESEARCH INTENTIONS

There is a large body of evidence (discussed in the Literature Review in Chapter 2) supporting the use of collaborative learning which provided initial impetus for my study. It is acknowledged that learners benefit cognitively and motivationally from active participation in the learning process. The use of collaborative learning groups in the classroom provides an opportunity for students to work together to achieve a joint construction of shared knowledge, however, it is a teaching practice which requires more shaping. Just because students are placed in collaborative learning groups you cannot assume they will necessarily learn effectively in them. It became apparent to me that a large amount of research had been conducted in team work training for the workplace which could possibly be adapted to the classroom. Rather than reinvent the wheel, I

thought there may be some merit in researching what team work training had already discovered and adapting the features that could be beneficial to my specific purposes of improving collaborative learning in the Mathematics classroom. My primary intention was to improve my own teaching so I was able to provide better structured and well considered lessons to my class. In doing so, I intended to improve their mathematical understandings and many other beneficial skills useful in their general education and in their post school life. I was also intending that my research might be a useful resource to other teachers who may be interested in improving their skills in delivering collaborative group learning experiences to their classes in mathematics specifically but also in other related areas.

TEACHING METHODOLOGY

Phase 1

The three lessons sampled in Phase 1 of the research (the before stage) included a problem solving session, an assignment session and a session focussing on answering routine worded problems in collaborative groups. I intended the progress through this phase to be seamless to avoid the possibility of any natural proclivity developing due to cues evident in the group discussions. It was also a consideration that mathematics classes are important and students needed to grasp the required concepts within an allocated time frame or their progress through the course may be affected. The 3 lessons were tape recorded and in the group discussions, students were asked to reflect on their experiences and rate them in a group conversation at the end of each session. The topic being studied was Trigonometry, the basics of the sine, cosine and tangent ratios had already been covered in the previous year so the first group curriculum activity was to work through a sheet of worded problems which required students to draw diagrams and determine which trig ratio could be applied to the question in order to find the solution. Worded problems provide an extra challenge to students and I considered that group collaboration would be beneficial in this skill review process. The extra challenge to this task which separated it from the previous year was the inclusion of the use of the TI-Nspire calculator which was quite different in its operation than the junior mathematics calculator. Most mathematics text books provide a set of worded problems and this task was accessed from the Year 10 text book. The group assignment was an application task requiring students to find a distance on the Earth's surface using the cosine ratio. This assignment has been included in Appendix 1. The distance on a great circle or a meridian which has the radius of 6375 km is found using the formula for finding an arc length, that is:

$$\text{Distance between 2 pts on a great circle} = \frac{\text{Angular distance between pts}}{360} \times 2\pi \times 6375$$

For example if you wanted to calculate the distance between the two points: C(85°S, 89°E) and D(46°S, 89°E) which are on the same meridian of Longitude.

1. *The angular distance = 85 – 46 = 39.*
2. *Distance b/w 2 points on a great circle = $\frac{39}{360} \times 2\pi \times 6375 = 4339.32$ km*

If you are required to calculate the distance between two points on a small circle (a parallel of latitude) it will be necessary to calculate the radius of the small circle using the cosine ratio.

The formula is as follows:

The distance b/w 2 pts on a small circle =

$$\frac{\text{Angular distance b/w pts}}{360} \times 2\pi \times 6375 \times \cos(\text{Latitude})$$

For example the distances between Beijing and Rome which are on the same small circle, Beijing is (40°N, 120°E) and Rome is (40°N, 15°E).

1. Angular distance= 120 -15 =105° with a latitude of 40°
2. Thus $\frac{105}{360} \times 2\pi \times 6375 \times \cos(\text{latitude}) = 8949.54 \text{ km}$

The problem solving task in Phase 1 was not related to the curriculum material. Groups were required to find the sum of the numbers 1 to 100. Students were given the opportunity to think about this problem individually first. They were prompted with questions like: ‘What techniques can you use?’ and ‘Can you list the ways your group can solve this problem so everyone understands each method?’ or ‘How can you easily find the sum of the numbers 1 to 10, 1 to 1000, and 1 to 10,000?’ At the conclusion of the session one student was required to report to the whole class on the solution/findings of the group. This problem was chosen as the initial problem solving task because it is very accessible to students and there are many different ways it can be solved. There are diagrammatic and abstract methods, for example, the numbers 1 to 10 can be arranged so each pair adds up to 10 (as shown below), and this is illustrated in the grid below:

0	1	2	3	4	5
10	9	8	7	6	
=10	=10	=10	=10	=10	unmatched

This method may be extended by simply laying the numbers from 1 to 49 out in a line and match them with the numbers 51 to 99. That makes 49 x 100 + 100 and 50 which are left unmatched. This yields the answer of 5050 which is correct.

Another method utilises the Sum of a Sequence formula:

$$S_n = \frac{n}{2}(a + l),$$

where n is the number of terms being added,

a is the first term

and l is the last term

This is solved by letting $n=100$, $a=1$ and $l=100$

$$\text{Thus: } S_{100} = \frac{100}{2} \times (1 + 100) = 5050$$

These are two types of solutions but students find many more ways to solve this problem which are equally valid.

Phase 2

In Phase 2 of the research students participated in a class conference about collaborative learning in groups, the positive and negative factors of group learning from the students position were discussed and summarised. Solutions were suggested to the problems by: introducing an understanding of the different learning styles of the participants, adopting simple roles within the groups, introducing social norms as a guide to productive group behaviour and a cycle which modelled problem solving in a group were introduced. The slides and description of the content has been provided in Appendix 2.

The three lessons in Phase 2 of the research included; a problem solving activity, a curriculum exercise and a group assignment. The lessons were tape recorded and a conversation space was provided at the end of the group session for reflection.

In the assignment, students use a drawing they have made of a unit circle and also a manufactured model of the unit circle called a 'Trigmaster' to complete a given table of values from 0° to 360° for $\sin \theta$, $\cos \theta$ and then $\tan \theta$. From these students construct the circular functions of $y = \sin \theta$, $y = \cos \theta$ and $y = \tan \theta$. This lesson is included in Appendix 1.

The curriculum topic being studied by the class was Trigonometry. In Phase 2 the topic included using the Sine Rule, finding the exact values of sine, cosine and tangent for the angles of 0° , 30° , 45° , 60° and 90° . The material presented was from the text book.

The problem solving task was not related to the curriculum material. The problem is known as 'Jumping Kangaroos' There are 3 female kangaroos travelling one way along a narrow mountain path and three male kangaroos going the other way. They stop with 1 space between them. Kangaroos can jump so they can pass each other following two rules:

1. Jump but only forwards, over one going the other way and into a vacant space

- Slide into a vacant space directly in front of where you are standing

Students act out this problem using 7 chairs in front of the room. The number of jumps, slides and total moves are counted. Then in groups the problem is modelled with different coloured disks. Students then alter the number of kangaroos involved and record the moves on a given table. They are asked to look for a pattern and to find a rule and express it using algebra.

Number of kangaroos at both ends	1	2	3	4	5
Number of moves					
Number of Jumps					
Number of slides					

At the conclusion of the session one student from each group reported on the solution/findings of his/her group.

The expected solutions to this problem are as follows:

# of kangaroos at both ends	1	2	3	4	5	n
# of moves	3	8	15	24	35	n^2+2n
# of Jumps	1	4	9	16	25	n^2
# of slides	2	4	6	8	10	$2n$

Some of the prompts that can be helpful for coaching students in this game are:

- You can only jump or slide in the direction you are heading, that is: no backwards moves
- At no point in time should two counters of the same colour be directly next to each other unless they are in their destination position. They can be separated by a space however.

Phase 3

Phase 3 occurred after a week had elapsed. This provided the opportunity for me to develop another feature of group learning that correlated positively with high performance; this feature is the development of shared goals within a group. I emphasised tolerance and inclusivity because I saw these as essential features of a group for all members to feel that their opinions and goals were valued. After a presentation and discussion about shared goals the groups were reformed and a problem solving activity was introduced (Presentation 2 is included in Appendix 2). Three groups were tape recorded at different stages during this problem solving session and students were given the opportunity to reflect on their performance in a group discussion at the end of the session.

A simple problem was presented to the collaborative learning groups: ‘How many squares can be found on an 8 X 8 chess board?’ A suggested table of results was explained to students. They were asked to find a pattern.

size	1 x 1	2 x 2	3 x 3	4 x 4	5 x 5	6 x 6	7 x 7	8 x 8	total

While this problem appears overwhelming initially, it can be broken into parts and drawn together. The pattern is so clear that students gain a great deal of satisfaction from the certainty of their solution.

Some coaching questions that can help students progress through this problem are:

1. Do you think the squares can overlap?
2. Do you think there will be the same number of squares in the length as the width of the chess board?
3. Which is the easiest place to start?

The solution to this problem is:

size	1 x 1	2 x 2	3 x 3	4 x 4	5 x 5	6 x 6	7 x 7	8 x 8	total
	64	49	36	25	16	9	4	1	204

Following this session the class met as a large group for a social gathering where they addressed specific questions that compared the different phases of the research. I asked one question initially; ‘What differences did you notice to how your group worked before and after I introduced group learning skills?’ The discussion flowed naturally where I responded to comments asking for reasons and ensured all students were able to contribute. This session was tape recorded and I transcribed the results into a short play with spaces for additional comments. The following lesson I conducted a play reading of the group discussion and I gave the students time to add extra comments and clarify what they said. This was a very successful activity and the students enjoyed acting out the group interview. I have always enjoyed including drama activities in other subject areas because it provides a mask that student are able to hide behind but still reveal their opinions. This was actually a form of member checking. I knew approximately a third of my class members were drama students and where familiar with the genre of play reading, and I knew I had the trust of my students so I used these factors to obtain further insights into their opinions. The transcript and member checks from the Group Discussion are found in Appendix 4.

SAMPLING

I selected my Year 10 Advanced Mathematics class as the research group for a number of reasons. Firstly they were confident in Mathematics and less likely to be psychologically vulnerable to effects of research, particularly to problem solving activities which were to be completed in a time frame compared with students in the general stream. Secondly they were already ahead of the general cohort with regards to completion of the curriculum and their progress would not be negatively affected by participating in research. In fact this group of students would benefit from completing extension material that would transition them into their higher studies in Mathematics. There was an established trust between the class and myself and openness for discussion. Finally at the Year 10 level, the students had not yet embarked on the 4 units required to gain the Victorian Certificate of Education.

METHODS OF GENERATING DATA

Classroom Activity

I elected to use tape recording to collect data because it was less obtrusive than using video but recorded more information than checklists and journal notes. Tape recording enabled me to record naturally occurring interactions in the collaborative groups. The tapes served as a detailed record of what the participant and observer were actually involved in, therefore enabling me to recall and add details of the classroom and explain them in the historical context. The tape recorded data allowed detailed scrutiny of the interactions in terms of content, inflection and responses which were available for discussion either with research colleagues or with the students. Relevant interactions were transcribed and background or irrelevant details were omitted from my transcriptions. Unlike other forms of qualitative data, tape recorded data forms a useful archive for future collaboration and enables us to present the findings of our research in interesting and engaging ways (Heath, Hindmarsh & Luff, 2010). The class was taped and observed for six 70 minute lessons over the duration of the study. An iPad with a tape recorder app was placed on the table of different groups. The tape recorder was a distraction to some students initially but most groups forgot about it after a while because they were engaged by the work.

Interviewing

Interviewing was used in two ways. Firstly the group interview was conducted in the scheduled lesson immediately following the lunch break. This time was chosen because it was convenient for students, many of whom travel by bus to school, some have after

school sporting and work commitments. During the group interview, afternoon tea was provided to thank the students for their participation in my research. As the interviewer, I was attempting to facilitate a natural discussion where students felt they could express their opinions about whether or not they thought that group learning was enhanced by the interventions I had introduced. I managed the group to ensure all students were able to express their opinions but with consideration of the varying dynamics within the group. It is beneficial to note that interviews are intentional interactional encounters and the nature of the social dynamic of the interview can shape the nature of the knowledge generated (Fontana & Prokos, 2007).

The questions used in the group interview were as follows:

These questions give you an opportunity to comment on your experience in your group.

- What is your opinion of working in a group in Mathematics?
- Did you notice any difference before and after group dynamics were explained to you?
- In what ways did you find the group work relevant to your learning?
- Would you like to see me incorporating group work into the lessons I do with you in the future?

The second form of interviewing was the individual member checks. Students were given the opportunity to read and comment on the transcript of the group interview and add further remarks, and all students, where possible, who were sampled in the interpretive commentary were shown the transcripts and my interpretation, and their responses were dated and recorded. These interviews were conducted individually in the school yard with other students present and interested in the proceedings. I found this to be an invaluable resource. It provided triangulation, verification and a closure for the participants. The contributions they made in the form of member checks have allowed me to add further insights into the group interactions. The fact that other students were able to hear their contributions enriched all students' awareness of learning and meta-learning and the role of further study. I think the inclusive nature of the member checking process has been very valuable for all stakeholders.

DATA PROCESSING

The data from each phase was generated and transcribed into a two column table with an interpretive commentary in the second column. The interpretive commentary included quotes from my observation journal, the group interview and member checks. Recurring themes were identified that were evident in the interactions in each phase of the research. These themes established the basis for a coding process. Coding the data from each phase of the study ensured that the information extracted was new and not predetermined. Coding helped define and categorise the data whilst gaining a new perspective on the

information (Denzin & Lincoln, 2005). The information collected and categorised using codes outlined the emerging themes in each phase of the data. Once the themes were established, answers to the research questions clearly emerged. This was achieved by searching for consistent patterns of behaviour in each phase of the research data. The resultant themes clearly comment on the success of the interventions. The researcher is an *in situ* ethnographer in this approach to data analysis. As the ethnographer, I provided my own interpretation of what the participants were doing. According to Bevir and Rhodes (2003), ethnographic research has four main characteristics: it interprets the flow of social discourse, the discourse is inscribed and it is microscopic, it assesses the interpretations and draws explanatory conclusions. So my task was to set down the particular meaning of different interactions and then extrapolate what these ‘thick descriptors’ might have to say about the society in which they have been found.

DATA ORGANISATION

My research data was generated from three different treatment phases. The information given to the participants in each phase changed with the transition to a new phase of the research. The changes introduced were; firstly the structured scaffolding and secondly were responsive to situations which arose from the group dynamics. The students interactions in the collaborative learning groups were recorded. The results were then analysed with the intent to find an emerging pattern which could be explained in terms of changes in the intervention. The data was collected using different methods, but the majority was collected through tape recording the interactions. The tapes recordings were collected on an iPad and were converted to sound files on my lap top. The six taped sessions were transcribed by me because there was considerable back ground noise which was mostly irrelevant, interactions between groups which was sometimes relevant and I needed to be selective about the data transcribed. It was also important to bear in mind that I was seeking to answer explicit research questions which directed the data transcribed. Running parallel to the transcription, I included a column containing data from my journal observations of the class, an interpretive commentary and relevant excerpts from the group interview and the member checking process. The transcriptions and interpretive commentary were stored on my laptop and are included in Appendix 3. The journal notes I made were hand written in a diary. This was followed by a group interview which was recorded on my iPad and transcribed and is included in Appendix 4. The transcribed group interview was distributed to the participants and I conducted a role play which the students found interesting and served to reduce any tension that may have arisen from the situation. The students were given the opportunity to elaborate on or make changes to their comments. I collated these responses and asked for further elaboration and verification in the member checking process. The member checks were mostly conducted on an individual basis and written directly onto a copy of the transcriptions and interpretive commentary. These were dated and included in my data analyses found in Chapters 4, 5 and 6 and in Appendix 3.

DATA ANALYSIS

Phase 1 of the research contained the data generated before any intervention and scaffolding was introduced. Themes were identified in the data by using the method of Grounded Theory Analysis, whereby memos or adjectives which describe what might be underpinning the types of interactions were collected in the margin of the transcriptions. As the memos accumulated they were grouped into categories. A category describes similar memos and gradually develops into a specific description or theory of what is occurring in the social situation. As one or more categories are found to emerge with a higher frequency they are connected to other categories also emerging and a core category is identified. The theories found emerge from the data and therefore fit the situation. They describe what is going on and attempt to make sense of the interactions in the context of the situation. I tried to develop the memos in Phase 1 with an open mind and while I was tentative initially, clear categories emerged. I prepared excerpts and examples which supported the emerging categories and began to list core categories. After consulting my supervisor, I felt confident that the core category I chose was supported with sufficient evidence and began to follow the same process with Phase 2.

Phase 2 of the research contained the data generated after group work skills had been introduced. This session began with a presentation on the benefits of collaborative group work and was followed with discussion about any concerns or problems the groups were discovering. These problems were summarised and the solutions tendered were following social norms, introducing roles and utilising the Reflective –Action Learning Cycle. Students were also introduced to learning style theory with the intention of developing tolerance of others and confidence in their own contributions. Posters summarising this content were displayed on the classroom wall for reference during all group sessions. The taped recorded sessions were transcribed and analysed in the same manner as in Phase 1. The memos contrasted dramatically to those found in Phase 1 and I worked hard to distance myself psychologically from the data to avoid developing a self-fulfilling prophesy. I prepared excerpts and examples to support the emerging core categories.

Phase 3 of the research contained the data generated after a week where the students had been absent from school. I commenced the session with a discussion about group goals which was intended to refocus the students on the group skills they had learned. The final tape recorded session was transcribed and a number of core categories emerged. The overall pattern that emerged from the three phases of data was identified using the research questions as a reference for relevance. These are discussed in detail in Chapter 7.

The process of member checking was vital to the process of data analysis. It allowed me the opportunity to verify the emergent themes and gather further data that might support the themes through triangulation. The input of the participants provided further explanation and insight into how the interactions might be interpreted. After all, what occurs in the mind of another person is only accessible through communication (Taylor &

Medina, 2011). The additional information made available to me provided valuable content for ethical discussion. The member checking process occurred after some time had elapsed and with the wisdom of hindsight, the participants were often able to summarise what they were experiencing at the time.

LIMITATIONS

The limitations of my research are that I did not have access to all groups' interactions for the entire lesson during this research and I also could not give each group my entire attention during the 6 lessons. This may have created some gaps in the findings and made it harder to monitor individual student progress. However, I could make general observations about the climate in the classroom and I positioned the tape recorder with group of students who were situated near previous groups to allow some progress of individuals to be monitored throughout the research period.

Another limitation was that the course of the school term determined the pace of my research. The Year 10 Camp provided a break before Phase 3 was conducted and gave me a window of opportunity to complete my research before the examination block commenced. After the examinations the Year 10 students began their work experience program therefore there was no opportunity for further research. To a certain degree, the Year 10 program shaped the pace and length of research, as a result the collection of data and group interview had to fit into a crowded schedule and there was undoubtedly pressure on the participants as well as the researcher.

ETHICAL CONSIDERATIONS

The protocols for research were followed in preparation for this study. After I obtained Candidacy and Ethics Approval from Curtin University My research was sanctioned by the Principal, Head of Curriculum and Head of Department and I was able to explain the structure of my research to the class. This gave the students the opportunity to questions about the study and voice any concerns. Plain language statements outlining the purpose of the study were given to all participants and a second letter was distributed to their parents/guardians which provided them with an outline of what would be required of the students in the course of the research. The consent forms were approved by the Ethics Approval Board of Curtin University and provided me with documentation that the students understood the purpose of the research and that they were willing to participate. Student participation needed to be seen as an agreement between the students, parents and me. I did not want the students to feel coerced to participate in any way. If a student objected to being tape recorded then they would be placed in a group that I would not sample for this research. However, all students agreed to fully participate in the research.

With the knowledge that informed consent was granted I assured students of the confidentiality of the data obtained in the research. Assurance was given that the findings would have no impact on student reporting and academic performance. All findings were sorted in a private place and are stored securely in a locked filing cabinet and on a password protected personal laptop computer. Student identity is protected by falsification of names. As the researcher, I am bound by the requirements and constraints on the use of the data. Regular contact was maintained with the responsible researcher; my supervisor, who ensured all protocols outlined in the research proposal were complied with.

CHAPTER 4

PHASE 1

INTRODUCTION

This chapter has three major sections:

1. Learning Materials
2. Analysis
3. Summary

This research project investigated the extent to which student interactions improved with the introduction of roles, social norms and the reflective-action learning cycle to collaborative learning groups in a mathematics classroom.

The overall research question was:

Can the quality of student interactions be improved in collaborative learning groups in a mathematics classroom by introducing roles, social norms and a reflective-action learning cycle?

Specifically the phases of the study were designed to address the two research questions:

1. What is the quality of group interactions in collaborative learning settings in a mathematics classroom before roles, social norms and reflective-action learning cycle have been introduced?
2. How does the quality of interactions change in collaborative learning groups in a mathematics classroom after roles, social norms and reflective-action learning cycle have been introduced?

LEARNING MATERIALS

Three types of learning materials were presented to the collaborative learning groups during the 'Before' stage of this research.

1. Working through routine problems, worded application problems and completing group puzzle sheets

2. A group assignment which is in context of the curriculum topic being covered
3. A problem solving activity

The curriculum topic being studied by the class was Trigonometry. In Phase 1 the topic included the application of the three trigonometric ratios: sine, cosine and tangent, to solving right angled triangles and the use of the TI-Nspire CX CAS calculator to solve these problems. Calculations involved DMS and degrees in decimal form. The material presented was from the text book, from a distributed sheet which contained a puzzle intended to provide routine practice of calculator skills.

The assignment was an application of the topic of Trigonometry to Earth Geometry where students are required to find the distance between two points on the Earth's surface. This involves finding the angular distance between two points and therefore calculating the arc length on a great circle which are meridians of longitude and on small circles which are parallels of latitude. The assignment culminated in students being required to find the distance between two points which are on a diagonal. The approximate solution of this can be found using the Pythagorean Theorem.

The problem solving task was not related to the curriculum material.

Find the sum of the numbers 1 to 100. Think about this problem individually first.

What techniques can you use? List the ways your group can solve this problem so everyone understands each method. How can you easily find the sum of the numbers 1 to 10, 1 to 1000, and 1 to 10,000? At the conclusion of the session one student will report on the solution/findings of the group.

ANALYSIS

During Phase 1 a tape recorder was placed on the tables of collaborative learning groups on a rotational basis to sample the types of interactions taking place. The intention was to gauge the quality of interactions before roles, social norms and the reflective-action learning cycle had been introduced.

DOMINANT THEME: ANXIETY

Anxiety Example 1

Anxiety was a frequently occurring issue in all Phase 1 data. Anxiety developed into a theme because many other interactions which were initially described differently seemed to be underpinned by student anxiety. An example of anxiety occurred in the interactions of Group X which had four members, Amy, Rick, Dan and Ed. This interchange occurred immediately after the problem of finding the sum of the numbers from 1 to 100 was introduced. This problem is described in detail in the Learning Materials section. The students had previously worked together as a group on three occasions.

Transcript 1 Group X Problem Solving (23/4/2012)

Amy: "I am not liking this," (1:38)

Amy begins to put her head phones into her IPod.

Rick: "No, you can't go away! Take that out [Amy], you are not going away"

Rick is referring to Amy using earphones to listen to music.

Amy: "No, I'm not going away...I think better when.."

Rick: "No, take it out!" (1:50)

Rick is very firm here but not impolite. He is trying to get the group to start work as a team.

Ed begins playing with his pencil case zipper to see the effect on the tape recording needle.

Rick seems to be annoyed now and raises his voice. The tension in his voice is audible because he was almost shouting.

Rick:"Shh! This is not a good day to be recording!"

Amy: "Ok guys, be normal please!"

Amy has removed her headphones and is prepared to participate. She seems to be trying to encourage some participation by physically moving towards the group and trying to diffuse the situation using humour.

Rick:"Ok, now we have to like, find the sum of the numbers from 1 to 10 and figure out the formula," (2:27)

Member Check (15/02/2013)

Rick: "I wasn't angry here; I was not in the mood for work and dealing with this stuff,"

Dan: "I was so used to Amy and Rick. That is just the way they are,"

Amy initially seemed to be withdrawing herself from the group. As her teacher, I had found that Amy often required encouragement to transition into a lesson. While Amy required some nurturing she had shown creativity in her problem solving and resilience when asked to make changes. I had adopted the strategy of giving her permission to have her own feelings, but required her to "just get on with it anyway". She stated that she was uncomfortable. This is not unusual and is likely to be an example of early anxiety, which occurs when the group is trying to sort through what they have been asked to achieve in a time frame (Brown, 2000). There appeared to be a level of confusion before the task was unpacked and also uncertainty that the group had the requisite skills to get the job done. When a student withdraws it is usually accompanied with an excuse, and Amy explained that she is able to concentrate when she listened to music. However, from my perspective, as the teacher, listening to music is not going to promote a discussion about the problem given to the group which was my intention in having students work in collaborative learning groups. To me, listening to music would likely introduce a distraction into the group.

Although group roles had not been introduced in Phase 1 of the research, Rick appeared to have adopted the role of leader. I had been Rick's Mathematics teacher prior to this year and he had displayed his competence in Mathematics, although I was aware that his passion was in the Dramatic Arts. He had developed effective strategies for problem solving and probably found his group's lack of application to be very frustrating. The fact that he adopted the role of leader is evidenced by three types of interactions he made; firstly, that he was giving orders, secondly, when he seemingly became angry in response to the lack of focus of the group and, finally, when he was able to simplify the task to finding the sum of the numbers from 1 to 10. Early anxiety in a group can be alleviated by a group leader acknowledging how everyone is feeling and encouraging the group, but at this stage the roles had not been organised. An inexperienced group leader may resort to giving orders, chastising or becoming angry. All of these responses seem to have been demonstrated by Rick but none resolved the issue of early group anxiety. Rick was likely to be feeling frustration with his group and anxious to reach a satisfactory solution within the allocated time.

Member Check (15/02/2013)

Rick laughed when we read through this paragraph and I asked him what he thought.

Rick: "This is great! I messed up a bit, I did everything wrong,"

I said that I thought he did a good job because the role of leader had not been explained to him at this stage.

I said, “It was not really fair ‘to throw you all in at the deep end’ you were flying without any instructions. That is why I had to get permission to do this study,”

Rick: “And you got permission, so that is fair enough. You know a lot about this stuff. You must have, you know, really studied it, I want to listen to the whole lot again, it is really interesting. It is like psychology, sort of learning to improve your teaching,”

I said, “Yes, teaching is like sociology because we are teaching people. There is definitely psychology involved,”

Lots of Year 11 students were crowding around us now and Rick was explaining the study to them. I felt that it was a privilege to be able share my Masters research with them and that they felt their experience might inform teaching in the future.

Rick said to me: “I hope you are still using this in your classes.”

I said that I actually did the ‘chess board problem’ with my Year 10 CAS class this morning, and used all the resources I learned from my Masters research.

I said: “It worked really well and the students responded very well. Not all of the groups solved the problem, but they all seemed to understand it at the end, and a student explained the solution to the class,”

Another example of student anxiety was Ed’s seemingly distracted behaviour of playing with the zipper of his pencil case. Ed had not applied himself well in Mathematics this year. He was usually a very courteous student who willingly set up projectors but seemed content to achieve very little in class. He became most animated when he talked about music and enjoys engaging me in conversations about bands of previous decades which would be less familiar to his peers. His early distracted behaviour could be a sign of anxiety (Brown, 2000). Ed would probably be out of his comfort zone in a problem solving exercise such as this one.

Member Check (15/02/2013)

Ed: “Yes, I agree. Not my thing....but I can solve some problems. Working in a group is my preferred way of problem solving... I definitely prefer working in groups,”

I said, “Well, you and Rick worked pretty well together, and Rick told me he learned a lot by explaining things to other people.”

Ed nodded and seemed to be very happy to be involved.

Dan had not contributed to the conversation of the group at this stage. He was physically situated in the group between the 'warring' parties of Amy and Rick. Dan's body language seemed to communicate that he was a very relaxed, non-confrontationist person and was satisfied to listen to the interchange between Rick and Amy. He communicated non-verbally with facial expressions of mock horror to express sympathy to Amy. I am not sure whether Dan was displaying any signs of anxiety. As Dan's teacher, I would say that not a great deal bothered him.

Member Check (15/02/2013)

I asked Dan, "So, what were you thinking during the problem solving task?"

Dan, "Well, er...uh..." He was thinking.

I said, "Were you pretty chill, or were you a bit anxious?"

Dan, "I was unsure of what was going on. I didn't really know what to do. It was definitely easier working in groups. It is better in friendship groups. It is difficult when people do not get along."

I said, "I did try to group you in friendship groups as much as I could, so you would feel psychologically safe."

Dan, "Yeah, more familiar."

I said, "I didn't want to introduce all this new stuff and have you work with unfamiliar people. We paused here."

Dan, "I wish I said more on the tapes."

I went through the transcripts and showed him what he said. He laughed and said the words again.

Dan, "Hey look, I said..." he showed his friends around us what he had said on the transcripts.

Dan, "I would like to talk now though."

I said, "Ok, so we can talk!"

Dan, "I think we got better at working in groups. We improved with experience."

I asked, "So was there a difference after we talked about roles and [social norms] and how to solve problems?"

Dan, "The only difference was, we got better because we had more experience."

I said, “Yes, I was careful to not let the ‘before’ stage last for more than three lessons because I did not think it was fair to let you go on too long without any structure.”

Pause

I said, “I suppose you would eventually sort out a structure in your groups, but I wanted to find a way to do this from the start. Do you think the structure I introduced improved the way your group worked?”

Dan, “It was good. Like the different learning styles.”

He was trying to remember what I actually introduced.

I said, “It is also pretty important that you all have the same goals too, rather than going in different directions.”

We talked about goals and dealing with conflict in groups and the role of a leader. It seemed that he was summing up what he learned from the experience. He did raise a valid point, however: would structure naturally emerge in the collaborative learning groups without intervention? I suppose this is like the argument about discovery learning. Yes, but it is probably not expedient.

The member checks have confirmed that these students were feeling varying degrees of anxiety. They were placed in a potentially stressful situation of solving a mathematical problem in a limited time frame with the expectation of having to present a solution. They had been given no information about allocating roles or social norms nor had the Reflective Action Learning Cycle been explained. After examining the data, it seemed likely that the level of anxiety experienced by this group of students was unprecedented. I had not expected competent students to exhibit so much anxious behaviour in a simple problem solving activity. I chose this problem because it had multiple solutions and was not especially challenging.

As a participant/researcher in the classroom where my contributions are not neutral, I was so preoccupied by providing assistance, posing careful questions which scaffold student understanding, encouraging and understanding the multiple directions the students were exploring to solve this problem that until I was actually able to step outside the classroom, and simply observe, I was not fully aware of the dynamics and underlying issues. While member checks have provided credibility to my interpretations, they have also highlighted the importance of providing structure to students working in collaborative learning groups.

Anxiety Example 2

Other interactions underpinned by anxiety seemed to have been displayed by Group Y during the second lesson of the navigation assignment. Group Y was comprised of 4 members; Millie, Mal, Jude and Rae. Millie and Mal were competitive and achievement oriented students. They usually display high levels of conscientiousness, loyalty and

respect. It is likely that these students would be anxious to do well in the assignment. Jude was a quiet student who had consistently passed all Advanced Yr 10 Mathematics assessment tasks. She was fully involved in the activities of the group during this assignment, but in a less verbal way. She did not readily seek assistance in the course of a lesson and I usually had to initiate discussion regarding any assistance she might need. Rae's interactions had not featured in these excerpts; she was physically removing herself from the group at this stage and later requested to change groups. Rae did not portray confidence. She was attempting to combine an alternative schooling pathway with her mainstream classes and had elected to study Yr 10 Advanced Mathematics. It is likely that Rae would have been feeling anxious that she could not keep up with her group. She had much to gain from the scaffolding of concepts occurring within the group, but it is unlikely that she would have let the other students know when she needed an explanation.

Data was collected over a 50 minute lesson. It was the second time these students had worked together as a group. During this session, Group Y requested that I check their solution and verify that they were correct on 8 occasions, and they asked other groups what question they were up to on 5 occasions. On 6 occasions the group members stated that they thought their answers were incorrect. Some examples of this are as follows.

Transcript 2 Group Y (2/5/2012)

Mal: "I thought you were coming to us next!" (23:35)

This comment is directed to me as I walk by to assist another group.

I go to Group Y and explain how to proceed with the question.

Millie: "Is that all we have to do?"

I confirm this.

I explain the question in further detail to reassure the students.

Mal: "Just tell us if we are doing it right,"

Millie: "I need to work on my drawings, don't I?"

This comment was directed to me as if Millie was seeking some constructive criticism, when in fact her diagrams were adequate.

Transcript 3 Group Y (2/5/2012)

Millie: "It says to make a simple drawing, have I done that?" (33:00)

Millie: "I think we are doing it wrong!"

I said: "No, you are correct," (32:51)

Mal: "That's good!"

I explain the drawing and the co-ordinates to verify this. (33:08)

Millie: "I think we are doing it wrong,"

I said: "No, you're not"

Transcript 4 Group Y (2/5/2012)

Mal: "Luke, what are you up to?" (42:05)

This question is directed to a student in another group.

Millie: "They are only up to question 8 or 9, we have done more than anyone else,"

Mal: "They are catching up now though," (42:23)

I notice that they are experiencing difficulty.

I asked: "What are you up to?"

Mal: "We are on question 10,"

Millie: "We are dying!"

Mal: "Yes, we are very confused,"

I elaborate: "Yes, well, you are on the harder questions," (43:33)

As the classroom teacher, I interpreted the first two interchanges as examples of teacher dependency; where students go directly to the teacher rather than interacting with each other and using the resources of the group. The interactions of Group Y show that they possibly were seeking reassurance from me and other groups by the high number of requests for affirmation. As the long-term teacher of this group of students, I had found that they felt secure when they have reliable and trusted leadership. Therefore, in the interaction examples given above, Group Y seems to be showing symptoms of performance anxiety. They were possibly fearful and most likely needed reassurance. They called for more information from me and affirmation from other groups, which could have been provided by a group leader. A group leader would possibly provide reassurance, a sense of safety and direction. In the absence of a leader they sought more factual information from the teacher which did not resolve the problem of anxiety (Brown, 2000).

Member Check (13/02/2013)

After reading through this paragraph with Mal, I asked her if she had been feeling anxious when working on this assignment.

She laughed and said that she remembered it quite well, and she agreed: "I was worried that I would not do well in the assignment."

I asked if she was feeling insecure or unsure of what to do?

Mal: "I was unsure. I did not feel confident and I do not like getting it wrong."

Member Check (15/02/2013)

I asked Millie if she agreed with my interpretation of how she was feeling.

Millie: "I agree with you. We like to know that we are doing it right. I like to feel secure. I learn best when the teacher explains it first. I like reassurance,"

Member Check (15/03/2013)

I read through this section with Jude and asked her if I had interpreted her behaviour in the class accurately.

Jude: "I agree that I do not like interrupting people or asking for help when I can see the teacher is busy. That is one of the reasons I really liked doing group work because we were all up to the same thing at the same time, so when you ask a question, you are not interrupting people. Rae was finding it really difficult to keep up because she was doing some vocation subjects and she missed a maths lesson every week."

Near the end of the lesson Group Y had a difference of opinion about whether they had completed enough work to submit their assignment. Irritability usually accompanies an unexpressed anxiety of the group session concluding and having to accomplish a satisfactory ending (Brown, 2000). Group Y worked until the last second of the allocated time. This anxiety is illustrated in the following excerpt.

Transcript 5 Group Y (2/5/2012)

Mal: "We can find the other one, find the circumference of the small circle"(46:40)

There is urgency in Mal's voice.

Millie: "Why don't we finish, we have done the most compared to other groups"

Millie was trying to wind things up here. She has confirmed this in a member check (15/02/2013).

Mal: "No, why not finish another one!"

Mal is very persuasive and is pushing to do the best she can.

Millie: "Oooh Kaaaay"

Millie has acquiesced. She showed this by drawling her response.

Mal: "How do you find the circumference again?" (48:00)

Mal is persevering, even though she is unsure and really needs her group's support.

Millie patiently goes on to explain the method.

Millie: "Two times pi times r," (48:18)

Mal: "I was close!" There was a bit of nervous laughter from Mal here. She is trying to sound happy but she is actually quite tense.

Mal: "Well, now we have found the radius!"

Mal: "[Jude], will you add this up for me on the calculator?" This sounded a bit like an order and Jude gets on the task, she inputs the figures and operation into calculator and reads out the answer. (48:50)

Millie: "That's fine isn't it?" (49:20)

Jude: "Yep"

Millie: "Yep, It's just there and [Mal] is just writing it down for us," (49:50)

Millie is very calm, conciliatory and is clearly trying to keep things on an even keel.

Mal: "Wahh, what's the point!" Frustration and desperation are communicated in Mal's tone, she is confused and not sure what to write.

Millie: "If you can't finish it, I will just staple it together,"

Millie said, "I just felt we had done as much as we could. The questions were getting pretty hard," in a **Member Check (15/02/2013)**

Mal: "Hmm, I do not want to do that."

Mal was still reluctant to relinquish her incomplete assignment, although she could appreciate Millie's logic.

Millie: "I don't want to do any more, let's staple it. Where is it all?" (50:00)

This was a statement and nobody argued.

SUMMARY

The data in Phase 1 provided evidence predominantly for one major theme: 'Anxiety'. The types of Anxiety can be categorised more specifically as follows.

Early anxiety which may occur when a group is trying to sort through what they have been asked to achieve in a time frame. This can be manifested in removing oneself physically and psychologically from the group, by engaging in distracting behaviours or being angry and giving orders or simply by being passive and non-communicative.

Performance anxiety which may occur with students who want to perform well in an assignment and seek external reassurance and validation from the teacher and other groups which they see as competitors. This can manifest in negative self talk, self doubt and seeking additional information from the teacher.

Conclusion anxiety occurs when the session is about to end and individuals in a group may be concerned whether they have completed adequate work to submit their group assignment. Members may appear irritable, tense and have minor disagreements.

CHAPTER 5

PHASE 2

INTRODUCTION

This chapter has 3 major sections:

1. Learning Materials
2. Analysis
3. Summary

This phase was two weeks in duration and comprised two 70 minute lessons.

Roles, social norms and the Reflective-Action Learning Cycle had been as explained in detail in Chapter 2.

LEARNING MATERIALS

Two types of learning material were presented to the collaborative learning groups.

1. A group assignment which was in context of the curriculum topic being covered
2. A problem solving activity

The curriculum topic being studied by the class was Trigonometry. In Phase 2 the topic included using the Sine Rule, finding the exact values of sine, cosine and tangent for the angles of 0° , 30° , 45° , 60° and 90° . The material presented was from the text book, from a distributed sheet.

In the assignment, students use a drawing they have made of a unit circle and also a manufactured model of the unit circle called a 'Trigmaster' to complete a given table of values from 0° to 360° for $\sin \theta$, $\cos \theta$ and then $\tan \theta$. From these students construct the circular functions of $y = \sin \theta$, $y = \cos \theta$ and $y = \tan \theta$.

The problem solving task was not related to the curriculum material. The problem is known as 'Jumping Kangaroos' There are 3 female kangaroos travelling one way along a narrow mountain path and three male kangaroos going the other way. They stop with 1 space between them. Kangaroos can jump so they can pass each other following two rules:

1. Jump but only forwards, over one going the other way and into a vacant space
2. Slide into a vacant space directly in front of where you are standing

Students act out this problem using 7 chairs in front of the room. The number of jumps, slides and total moves are counted. Then in groups the problem is modelled with disks. Students then alter the number of kangaroos involved and record the moves on a given table. They are asked to find a rule and express it using algebra.

Number of kangaroos at both ends	1	2	3	4	5
Number of moves					
Number of Jumps					
Number of slides					

At the conclusion of the session one student from each group reported on the solution/findings of his/her group.

Structuring Phase 2

At the beginning of Phase 2, students viewed a presentation which covered the following areas using discussion and brief, clear descriptions, this has been explained in detail in the Methodology Chapter 3.

1. A discussion prompted by the question: “What are the problems of working in a group?”
2. What research reveals as the problems of group learning
3. How these factors can be overcome.
4. Characteristics of an effective group
5. Discussion of: What is your learning style? (We all categorised ourselves)
6. Rotating Roles
7. Process for Problem Solving
8. Conversational Space
9. Social Norms

During all lessons of Phase 2 of the research, students were asked to rotate the roles of leader and recorder, and a poster of the social norms was displayed on a wall of the classroom. In a problem solving lesson the Reflective-Action Learning Cycle was displayed in the classroom. A tape recorder was placed on tables in different collaborative learning groups on a rotational basis to sample the types of verbal interactions taking place. The purpose of the recorder was to gauge the quality of interactions after roles, social norms and the reflective-action learning cycle had been introduced.

ANALYSIS

The group interactions that occurred in Phase 2 suggest strongly that the collaborative learning groups become more self-reliant. It was immediately apparent when comparing Transcript 1 where no initial request for assistance was sought from Group Y to define the problem and organise the task. In fact, very little assistance was sought by either group in the interaction samples collected in Phase 2. This statistic stands in stark contrast to the 8 requests Group Y made for my assistance in Phase 1. I certainly made no reference to the incidence of teacher assistance requests to the class during the data collection phases, because the high level of reassurance sought by Group Y was not evident until the analysis phase of the research. This contrast is illustrated by comparing the start to two transcripts in Phase 1 with Group Y to the start of a Phase 2 sample with Group Y.

Phase 1: Group Y working through routine problems (19/4/2012)

Mal: "Will you please help me?"(00:26)

I helped Mal label the sides of the triangle.

Mal: "Oh I see what I did wrong. I was using tan instead of sine." (01:33)

Millie: "I have a question too, please, what line are we trying to find?" (01:46)

I helped Millie interpret the question and draw the required diagram from the worded question. (02:40)

I helped the students in Group Y put calculator into degrees mode rather than radians.

Phase 1: Group Y working on an assignment on Earth Geometry (2/5/2012)

Millie had me check her solution. Her group is well advanced through the required questions of the assignment compared to the progress of other groups. (00:16 -02:16)

Millie is seeking verification from me and I reassured her. This took 2 minutes. I gave Millie an easy way to remember which direction is longitude and which direction is latitude.

Mal: "Ok we are up to Question 6,"(03:39)

Mal: "I will read this.... we need to draw a circle. Where is the circle stencil?What radius do we use?.... Please ourselves?..... I think we have to make a triangle."(03:55)

In Phase 2, the interactions in Group Y could be described as examples of 'active participation.' The discussion observed in the group was collaborative and tended to be problem focussed. The students were demonstrating self reliance by working to understand the task themselves, producing a document to record their findings and by providing help to each other and staying focussed on finding a pattern in the gathered data.

Phase 2: Transcript 1 Group Y Problem Solving (3/5/2012)

In Group Y, Millie is repeating the steps so they can be recorded on a table.

Millie "Jump, slide, jump slide..." (01:00)

Mal: "Jot down the steps."

Mal is speaking to Jude.

Jude: "Yeah, I am just trying to work it out."

Jude is recording for group Y.

Jude: "Can you show me how to do it just one more time?"

Millie: "Yes, just one more time,"

Jude: "I get to a certain point and I just get stuck."

Millie: "You never get stuck."

Jude: "Can you show me where I am going wrong" (1:14)

Mal: "You just keep working at it."

The high level of encouragement provided by the group for each other in Phase 2 interactions is likely to be evidence of the collaborative learning groups validating each other's input. The participants seemed to be listening to each other and building on each other's understanding. This may have been a response to one of the social norms introduced which stated: 'Build on one another's ideas'. The interpersonal skills demonstrated in both Phase 2 transcripts suggest that the Group Y had high levels of group cohesion because the members probably felt like their contributions were being valued. The collaborative learning groups seemed to be developing reliance on intrinsic motivation rather than dependence on extrinsic validation. These demonstrations of encouragement and congratulatory comments were absent in Phase 1 data. In Phase 1, the students communicated that they were possibly anxious and were doubtful of their own and their group's ability to solve problems or complete routine questions. Some examples

of Group Y's self reliance evidenced in their support of each other through encouragement is shown in the following excerpts.

Transcript 2 Group Y Problem Solving (3/5/2012)

Millie: "I started going backward. Just leave it there and I will tell you the next move"

The students seem to be enjoying gathering the data; there is a lot of laughter.

Mal: "That was pretty good, Millie!"

Millie has received affirmation from her group.

Mal: "Let's go over it again though,"

This is a directive statement. Mal is communicating that she wants clarity in the moves.

Jude: "I think we are going under 16 moves here! Jump, slide ,etc "

Millie: "You have a go, you are better at it than me anyway," (4:15)

Joe is from Group Z.

He heard Jude's comment and compared his results to hers. He was surprised to see how much Group Y's results differed from his own and realised they had made an error. He explained to Group Y how they should be working through the problem.

Joe: "You have to do all of them, see? You have to work out the pattern!" (5:00)

Mal: "Ok, then, let's do it again. Ok, write it down there,"

Millie: "Slide, jump, slide. That's it!

Mal: "That was 3 moves. Now we go with 2 on each side,"

Millie: "Go with two,"

Millie is saying the moves out loud.

Jude: "Come on Millie, come on!"

This is said in a really encouraging and supportive tone.

Transcript 3 Group Y Problem Solving (3/5/2012)

Mal: "I am so pro!"(8:29)

Mal is using positive self-talk, she is likely to be feeling successful and capable. She is calling herself a professional.

Jude: "How did you do that and how many jumps did that take you?"

Member Check (13/02/2013)

After reading through the excerpts, I made a comment to Mal, "You sounded really positive. What were you feeling when you were solving this problem?"

Mal: "I felt a lot more confident in this lesson. That is because I really understood what I was doing,"

Member Check (15/02/2013)

Millie: "We were not as worried. We felt we could do it ourselves,"

The positive affirmation provided by Group Y to each other and to themselves did not seem to belie any anxious feelings. The interactions in Phase 2 testify that Group Y was more self sufficient and was providing affirmation and validation to its members. The group seemed to be displaying a more confident and proactive disposition. The member checks have confirmed that the students in Group Y were feeling more confident even when they had not interpreted the problem correctly. This dramatic change could be attributed to the inclusion of roles, social norms and the Reflective-Action Learning Cycle into the group dynamics of the collaborative learning groups. In the teacher/researcher's journal notes, I noted;

Effective team management is complex and multifaceted. Structure is essential if students are to feel autonomy and connected to the group. I am observing that roles and social norms = structure. (7/5/2012)

While Group Y did not seek assistance from me, the group did obtain some valuable but unsolicited assistance from Joe, a member of Group Z.

Group Z was not sampled in this data. In the Teacher/researcher journal notes I made the following observations about Group Z on the first day of data collection in Phase 1. Group Z had 4 members: Ellen, Joe, Rock and Luke.

Teacher/Researcher Journal (16/4/2012)

Initially the organisation of Group Z was adopted by the only female member, Ellen. She did not allocate tasks but her voice was clearly heard above the other 3 male members. There was a lot of fighting to gain a share of the attention in Group Z. Initially, Joe said the problem was too easy, suggesting that it was

beneath him to participate. Generally, though, the participants in Group Z were highly motivated and interested in the new arrangement of the classroom and fully engaged during the whole of the lesson.

At the conclusion of the research it was clear that there were differences of opinion, perspectives and learning styles in Group Z. Although these were probably present in all groups in varying degrees, these conflicts were hidden from me and became more detrimental because they were not readily available to be worked through and resolved. The group lacked cohesion because the silent conflicts were not properly handled and were quite destructive to the group. As the teacher of this class, I observed that this group contained some of the academically smartest students in the class. They were socially mobile, confident, and flamboyant and, in retrospect, this group potentially had too many leaders. The group interview at the end of the study revealed deep divisions.

Group Discussion Transcript (6/6/2012)

I asked: "Would you like to see me incorporating group work into lessons in the future?"

Rock: "I think it is good doing group work when you are getting started, but you need to then break up and do it by yourself. Our group worked well but, I think I still work better by myself."

Luke: "I think it is good to have a balance. Our group worked in two parts, Joe and I worked and Ellen and Rock talked."

Joe: "We did not work very well because Ellen is a distracter and Rock is dopey,"

Ellen: "I liked doing group work because if someone is stuck with something the teacher does not always have time to help. I work well by myself but feel more at ease in a group because it is more motivating,"

Unsolicited comment (1/8/2012)

Luke: "I do not even want to be in a class with Joe next year because he always gets it wrong and yells out the answers and annoys the hell out of me."

Conflict has been a predominant issue with some groups. While controversy and conflict are expected to be part of all groups (Brown, 2000), a group that takes responsibility for its own dynamics recognises conflicts as they emerge, and in allowing them to emerge sees them in the perspective that they can usually be resolved so that neither party loses. Hidden conflicts are more detrimental because they cannot be worked through and have the capability of undermining the cohesion of the group (Brown, 2000). Open conflicts were also a part of Phase 2 data: one student requested a change of group and another participant became a member of a number of groups for different periods of time.

It is possible that lack of respect for the differing learning styles of the members in Group Z may have caused some of the observed conflict. I considered the different learning styles of the students when I allocated the members of each group and made the decision to present some information about learning styles to the class. At the beginning of Phase 2, I introduced four overlapping learning styles- Diverging, Assimilating, Converging and Accommodating- and we discussed what style might best describe each class member (Kayes, Kayes & Kolb, 2005). While research suggests that groups with mixed learning styles perform better, I felt that students needed to feel psychologically safe in their groups and I took care not to isolate students from their friends. I considered the possibility that if students understood the potential positive effects of having different learning styles in groups, they might be more prepared to take risks and work in mixed groups. In an ideal group, students benefit from recognising and capitalising on their strengths and analysing style differences to resolve conflicts; further intervention would need to occur in Group Z for this to be realised and is outside the scope of my research (Kayes, Kayes & Kolb, 2005). This aspect of group learning is one that I would like to explore further in the future.

SUMMARY

The data in Phase 2 provided evidence for one major theme: 'Group self-reliance' and also showed the emergence of conflict which pre-empted some intervention conversations on the topic of 'Group Goals'. Group self-reliance became an emergent theme and was evidenced in the dramatic reduction of requests for assistance by two sampled groups for the teacher to provide additional information and affirmation and in the reduction of the incidence of comparisons of progress sought by the sampled groups with other groups. The sampled groups seemed to show a greater level of resourcefulness and appeared to know how to begin working on a given assignment or problem.

Phase 2 saw the emergence of three types of conflict:

Open conflict where all group members and the teacher are aware that there are differences of opinion and learning styles within groups. These are open and can be acknowledged. These are positive experiences where the group is able to develop valuable problem solving skills which can be beneficial for future group functioning.

Closed conflict which is not open to be discussed and is destructive to group functioning and future working relationships.

Conflict arising from a dissonance in personal goals with group goals. This has the potential to arise for many different reasons, however in Phase 2 it arose from the quite different needs and aims of the students in a group. One group could not provide for the needs of one member and had strong goals that were being met for the other three members. This was a clear and acknowledged dissonance between personal and group goals which required addressing.

Phase 2 of the research was pivotal; the researcher wanted to nurture and promote positive learning and empower the groups to deal with open conflicts and goal dissonance. This required some intervention. The intervention included a presentation on the influence of having a shared group purpose on group functioning, and a conversational space was provided in groups with directed focus questions.

CHAPTER 6

PHASE 3

INTRODUCTION

This chapter has 3 major sections:

1. Learning Materials
2. Analysis
3. Summary

After a week had elapsed the collaborative learning groups resumed. This data set represents a sample of the interactions obtained from the collaborative learning groups who had experienced group dynamics before the structure of roles, social norms and the Reflective-Action Learning Cycle had been introduced and had experienced working in groups with this knowledge and structure. As a response to the observed behaviours of the participants of the study I decided to focus on learning goals in a short presentation before the final phase of data collection in collaborative learning groups.

Teacher/Researcher Journal (3/5/2012)

I have observed that for certain tasks, like minded students with similar learning goals have sought each other out.

In the early stages of collaborative learning, gaining a shared clarity of the group's goals and an alignment of the individual and group's purpose promotes more effective group functioning (Kayes, Kayes & Kolb, 2005). The issue of developing a collective purpose and shared goals was addressed by creating a conversational space in the classroom before Phase 3.

LEARNING MATERIALS

A simple problem was presented to the collaborative learning groups: "How many squares can be found on an 8 X 8 chess board? A suggested table of results was explained to students. They were asked to find a pattern.

Structuring Phase 3

At the beginning of Phase 3, students received a presentation which focussed on developing a common group goal. The concepts were explained simply in a succinct set of slides accompanied by a simple verbal explanation.

1. What sort of group have you been?
2. A team that cannot see itself is actually flying blind
3. To develop a shared self-image a team needs to develop a shared conversational space.
4. Members need to be receptive and respect each other
5. The goal of your group is to learn from your experience
6. Create the group you want to be.

ANALYSIS

The theme of group self-reliance is well evidenced by the data in Phase 3. There also appears to have been an increase in the productivity of the sampled group compared to the data collected in Phases 1 and 2. It is possible that the increased productivity and reduction of the lengthy periods of off-task discussion which had been present in Phase 1 and 2 data could be in response to a shared clarity and consensus about the groups learning goals. One of the causes of social loafing often lies with group members who are privately pursuing their own goals and have little commitment to the group goals (Kayes, Kayes & Kolb, 2005). In addition to these themes, I had observed the application of the Reflective-Action Learning Cycle in the context of the problem and an increased level of tolerance in the collaborative learning groups. The Phase 3 data is primarily from Group W, which was comprised of 3 students: Harrison, Brian and Jeff. One student, Diego, was absent from this group on the day of the data collection. Also represented in the transcript are Rick and Amy from Group X and Millie and Mal from Group Y.

Group Self Reliance Example

In this excerpt, Jeff was the leader and Brian was the recorder. There was evidence of role clarity; the students seemed to know how to start and what structures needed to be put into place. They seemed to know what they should be doing and were prepared to stick to it. The task was not easy, however, because not all group members were contributing to the problem solving task and needed to be reminded of the group's goals.

Transcript 1 Groups W and X (30/5/2012)

Harrison and Brian were laughing and making sound effects to stop my tape recording which I had just placed on their desk.

Harrison made motor bike noises.

Harrison: "Look it is a speedometer," (1:30)

Rick to Harrison "Shut up!"

Rick is from Group X and he was trying to work on the problem in his group.

Jeff: "Quiet. Who does that? So Immature!"

Jeff was trying to control Harrison

Jeff: "Ok, Let's start shall we?"(2:04)

Jeff had the attention of Harrison and Brian.

He pointed to the table which asked for the number of 1 X 1 squares on a chess board.

Jeff: "Ok, that's 64, ja?"

Jeff said to Brian: "Ok you're working on this. You are scribbling."

Jeff is allocating the role of recorder.

Brian, "Ok, 64. The start one was 64? Then there is like..." (2:20)

Jeff: "The next biggest square is a 2 X 2."

Brian: "With 4?"

Jeff: "Yes that's the next biggest square with 4 squares in it," (2:33)

Jeff was taking control of the group and getting them down to work.

They seemed to be able to concentrate on the task. The roles and social norms did appear to give students a framework to start work almost immediately. The students also appeared to have a shared understanding of the role descriptions of leader and recorder.

Transcript 2 Group W (30/5/2012)

Jeff and Brian were trying to work out how many 2 x 2 squares are in a chess board.

Jeff was explaining, he was not completely correct and would realise it later. He was ensuring all group member's understood the concepts and supporting his

ideas by giving reasons. This appeared to evidence the social norms which were part of the Phase 2 and 3 interventions.

Brian was preparing to enter the number of 2 x 2 squares onto the table. He was looking for confirmation from Jeff.

Jeff: "Yes, let's put 16, cos, see just look there is 1,2,3,4. So 4 times 4 is 16," (2:50)

Jeff had the correct concept that the numbers of squares in the length will be the same as in the width.

Brian: "Oh yes, yes"

Jeff: "And the next bit is about 3 X 3 squares so that is..1,2..."

Harrison makes a few noises into the microphone then starts making engine noises again.

Jeff: "Shut up, it is not a blooming motorbike!"

Harrison continued to giggle. (3:10)

Jeff appeared frustrated.

Jeff: "You know I am not a scientist!"

Jeff was trying to keep Harrison on task.

Jeff was becoming frustrated with Harrison's off task behaviour.

Member Check (13/2/2013)

After discussing this with Jeff later, he said he did not want to be group leader any longer and swapped.

Jeff explained: "I was frustrated and just didn't want to deal with Harrison, I wanted to concentrate on the problem. Brian did not want to be leader at first, but I talked him into it. So I stopped being the leader."

In a separate discussion Brian informed me:

"We just wanted Harrison to shut up. I became leader to keep peace."

Keeping group members on-task when they appear to have a different agenda is not an easy task and Jeff and Brian were solving this problem themselves. I was unaware of the difficulties they were having with Harrison and actually reminded them to work collaboratively.

Transcript 3 Group W (30/5/2012)

I said: "I want a collaborative group not just two people working together"

Harrison makes motor bike noises enthusiastically.

Brian: "Harrison, stop pretending to be a motorbike." (4:08)

Harrison: "I am trying figure out how.."

The students appeared to understand their role descriptions and by changing leaders they attempted to manage the problem of off-task behaviour. Group W was displaying group self-reliant behaviour.

Productivity Example

In this example the tape recorder was facing Group Y; this provided evidence that most groups were making very positive progress with the problem. They appeared to be interested and involved in the problem solving process. There was less teacher dependency, students were making a lot more of their own decisions and managing their own off-task behaviour. Group Y, which had members Millie, Mal and Jude and Group X, which had members Amy, Rick, Ed and Dan, were situated close to each other.

Transcript 4 Groups X and Y (30/5/2012)

The recording started in the middle of a conversation. (5:30)

I said to Millie, "So you are saying, the number of 8 X 8 squares is? So, how many 8 X 8 squares are there?"

Millie: "We are not up to it."

Millie panicked a little because I was asking her to work backwards through the table of results.

Rick answers: "There's 1."

I said: "So there is 1, how many 7 X 7 squares can you fit in there, in different positions?"

Mal: "Is this right?"

She was showing me how she was calculating the number of 7 x 7 squares. She showed me her method.

I said: "Yes, it is very, very easy, when you get it."

Mal: “Wow that’s ...very, very.. I love it!” (6:03)

Millie: “Wow, yup it is just like that!”

I said: “There is actually a very clear pattern.”

Amy: “I know the pattern. I know the pattern!”

Amy was singing this. (6:13)

Transcript 5 Groups W and X (30/5/2012)

Group W had also been working productively on the problem. They had made progress but they had not yet found an overall pattern but were very close.

Jeff had been concentrating quite hard on the project. (6:51)

Brian had been actively observing and following what Jeff was doing.

Brian: “You might as well add one [to the table of results] as well, because it is a square as well.

The whole thing is a square!”

Jeff was writing things down. (7:15)

Member Check (13/2/2013)

I told Brian that that he had made an important discovery and I asked him what he was thinking at this stage. “Yeah, I figured it out, I was pretty happy!”

These examples are a sample of the improved productivity which was observed in the class in Phase 3.

Reflective Action Learning Cycle Example

In Phase 3, there was a significant development in group processing skills where there was evidence that the learning cycle was being utilised in Group W.

Transcript 6 Group W (30/5/2012)

I said: “So there will be the same number of squares across as down.”

I was confirming his understanding so that I knew I was explaining from a position of common understanding.

Brian: "Yes, see I drew them." (8:20)

Brian: "There is a 2 X 2, so is that one there." (8:32)

I said: "Yes, that is 1, and there is another one, how many more? You count them."

I was showing Brian and Jeff how the 2 x 2 squares overlapped.

Brian: "1, 2, 3.." (8:42)

Jeff: "4, 5, 6, 7!"

Brian: "7"

I asked: "So how many do you think there will be down here?"

Jeff: "7"

I said: "Yes, so seven sevens are..." (8:51)

Brian: "49"

Brian began recording in the wrong place.

I pointed this out: "But that's 2 x 2, though."

Brian: "So 2 X 2, that's 49." (8:58)

I said: "Remember, now you check your theory. The thing is you need to experiment, you need to discuss, you need to develop an idea; which you are doing, and now you test it!"

Brian: "Yes."

I continued: "You have made an estimation, now you check it. You just check one more, and if it works out, well, you know you have got it!" (9:15)

Harrison: "So, if we figure it out, how do we know it is right?"

I explained: "Because you will know if the next one is correct. You have just shown me the exact problem solving process. You have made a generalisation, I just heard you." (9:34)

Harrison: "But it may look like it is correct, but it may not be unless we know the actual answer."

Harrison is not confident with his own judgement and possibly is reliant on an external source telling him he is correct. He is not sure when he is right and is

possibly used to being able to look up the answers at the back of the book.
Testing a generalisation as validation is part of the Reflective-Action Learning Cycle.

I think this was a timely explanation of the Reflective-Action Learning Cycle in the context of the problem. This was very powerful because it was more meaningful to students to see it working rather than to just have it explained. I could see there was evidence of progress and students could ask questions in context. The members of Group W seemed to be meta-learning. They were beginning to understand that there were processes that explained what they were doing that could be useful in the future. While Harrison may have been struggling with the problem solving task, he wanted to be part of the group, not necessarily a contributing part, but he was able to see how things were done. One of the justifications for using collaborative learning groups in Mathematics is the scaffolding of learning that occurs by peers so that the learning outcomes are improved for a greater number of students in the classroom. It is likely that Harrison cared more about what his peers thought about his behaviour than he cared about my opinion. Group W were quite tolerant of each other and therefore all members probably felt included. They are making progress with the chess board problem and are sticking to their roles descriptions. Even when Harrison overtly complimented Brian deliberately excluding Jeff, who probably did most of the work, tolerance was in evidence. Brian said in a Member Check:

Member Check (13/02/2013)

“Harrison was smiling when he said this. It was a joke.”

Example of Tolerance

Transcript 7 Group W (30/5/2012)

Harrison: “Brian is a genius.”(10:27)

These overt compliments of Brian deliberately exclude Jeff, who probably did most of the work.

There was quiet in this group now. Other groups are quite vocal as they express what trends their data is showing.

Harrison decided he would like to be a motorbike again.

Jeff tried to stop him.

Harrison: “But I like being a motorbike!”(10:46)

Brian: "Stop being a motorbike!" (11:09)

Brian: "Is 6×6 ...so 3×3 is 9.. so now we just add them together?" (11:48)

Brian: "So get a calculator, is Harrison going to do it in his head? Motorbike man?" (12:12)

Harrison: "146"

Brian: "172"

Jeff: "It's 210?"(12:36)

Harrison: "Every time I play chess, I'm going to be, I wonder how many squares are on this board? 210!" (12:46)

I was winding up the task: "Ok, time is nearly up."

Jeff: "204, You got it wrong!"

It was indeed 204 because: $1+4+9+16+25+36+49+64=204$

Group W was satisfied that they had solved the problem. Jeff told me later that he felt very proud of his efforts in this problem solving task. A compilation of the reflections of the members of Group W in the group interview was very positive.

From the Group Interview (6/6/2012)

I asked: What did you think Jeff?

Jeff: Working in a group had its ups and downs.

I said: What were the ups?

Jeff: It was good working with smart people. Working with smart people is very inspirational.

I responded: What were the downs?

Jeff: Having to be the leader.

I asked: Did you notice any differences before and after I explained group dynamics to you?

Jeff: Before it wasn't easy to work in a group, but once you explained it, it was much easier.

Then I directed a question to Brian: What do you think, Brian?

Brian: I wasn't aware of working in groups before, but now I understand group work.

I asked: Is there anything more you would like to add?

Brian: It is better to work in groups because you get more help when you cannot get the teacher. You get sick of waiting for the teacher. I got more help. I like working in groups more than working by myself.

I directed a question to Harrison: What do you think Harrison?

Harrison: I like working in a group. I like it that everyone puts into it. It makes it easier to work it out. It is a better way of doing stuff.

Observing an increased level of tolerance for different learning styles and ability levels in Group W in Phase 3 was a welcome outcome, particularly after having earlier observed a lack of tolerance in Group Z. The world is a highly competitive place and ideally a learning environment should be accessible and nurturing. It is a relief for me, as the teacher, to observe evidence of scaffolding and tolerance for our more vulnerable students.

Member Check (15/03/2013)

Jude and I read through the themes and examples in Phase 3. She seemed to be reflecting on her experience in Year 10 and comparing it to the senior mathematics she is currently studying.

“You kind of miss group work this year, there is no time to interact with each other. It was better in a group because we were all at the same place at the same time. Kids can explain things differently to each other, although sometimes the teacher is better.”

Jude seemed to want to talk so I decided to ask her some more questions about how the relationships in her group affected productivity and self reliance.

“Your group worked very well together, you showed tolerance and respect for each other, your group also improved a great deal over the phases. Do you think group self-reliance and productivity might be associated with the empathic quality of relationships between group members? Are the girls better at this than the boys?”

Jude thought about this.

“I do think girls have a different style and work together better as a team. We were more equal and took turns being the leader and recorder, even in the same session. I saw how the boy’s groups worked. Boys have a more dominant style and they like to be right.” She said this with a gentle laugh.

SUMMARY

The data in Phase 3 provided evidence for multiple strong themes:

1. Group self-reliance
2. Productivity
3. Application of the Reflective-Action learning Cycle
4. Tolerance

These themes are all positive and desirable from the point of view of the teacher/researcher. All themes will be discussed in further detail in Chapter 7.

CHAPTER 7

CONCLUSION

INTRODUCTION

In this research study, I was an active participant, and my teaching contributions to the lessons constituted part of the sampled data in a number of ways: in the scaffolding, in the classroom interventions, in the questions posed and in the excerpts selected for member checks. Clearly my position was not neutral, I was invested in my research and found merit in what could be achieved through presenting lessons in a way that allowed students to construct their own knowledge. I continue to gain much satisfaction from implementing what I have learned in this research. The enthusiasm that students communicate to me when they are empowered as active participants in the construction of their knowledge seems to have few socio-economic boundaries. It is my privilege to have been able to conduct this research through the trust invested in me by the schools in which I have served and by the students I have taught.

In this chapter I discuss the results of each phase of my research and I answer my research questions. I provide an overview of the aspects of my research that worked satisfactorily and the areas that did not work as well as expected. There were unexpected outcomes of my research which fit into both categories. I discuss how conducting this research has influenced the way that I now present and reflect on my lessons in the mathematics classroom and the way that I perceive feedback from students. Finally, I suggest directions in which future research could be explored.

APPROACH TO THE RESEARCH

Constructivist theory was both the focus and method of this research. My research methodology is classified as interpretive (Taylor, 2014). I describe my role as a 'reflective practitioner' who values the contributions of human interactions in their cultural context. The quality standards of social research were applied as discussed in Chapter 3. Initially I was inundated by a huge amount of live data and had to force myself to continue despite feeling overwhelmed. I was not able to complete the interview transcripts and analyse the data until the end of the school year, so there was no danger of my analysis influencing the assessment of students. I was able to approach the process of grounded theory analysis with an open mind created by the distance of time between the collected data and being actively involved with teaching the students. Once the themes were established in the data the answers to my research questions clearly emerged.

WHAT DID I LEARN IN PHASE 1?

It seems pertinent to address this question by reflecting on my research questions. I will respond to the first research question and present my findings systematically with justification, but the evidence can be found in Chapter 4 and the raw data can be found in Appendix 3. Research question one asked:

What were the quality of group interactions in collaborative learning settings in my mathematics classroom before I introduced roles, social norms and the reflective-action-learning-cycle?

This question makes me want to define the word 'quality'. What do I value in a collaborative learning group in a mathematics classroom? The definition is complex and I have reviewed the research on this issue in Chapter 2 and in Chapter 4. For the purpose of this discussion I describe quality interactions as follows: Interactions which indicate that all group members are contributing, when there is evidence of active listening and that group members build on one another's ideas; when students are scaffolding the understanding of others through explanations and when a shared understanding is achieved. The quality of the interactions has been used as an indicator of the effectiveness of the functioning of the group.

The social interactions in the classroom during Phase 1 of the research provide evidence that the major underlying climate in the collaborative learning groups was 'anxiety'. I focussed on two groups in Phase 1 (Appendix 3) and observed the entire class (Chapter 4). The analysis indicated that anxiety was widespread across the class. The types of anxiety I encountered were sorted into three types with the taxonomy provided by Brown (2000).

Firstly, I encountered evidence of 'early anxiety'. This was evidenced by students removing themselves physically and psychologically from the group. Also occurring were low-level distracting and off-task behaviours and anger and order-giving by self-appointed group leaders who were experiencing frustration with their group's contributions. Passivity and non-communicative stone-walling behaviours were in evidence in this phase of the research.

These behaviours occurred when the groups were trying to sort out what they were required to achieve in a given time frame. There was confusion before the task had been unpacked and a level of uncertainty as to whether groups had the requisite skills to solve the problem. Individual students withdrawing and giving excuses and displaying distracted behaviour indicates that the student were feeling compelled to operate out of their comfort zones (Brown, 2000).

An inexperienced student group leader may resort to giving orders and chastising others because of their apparent lack of focus and their own frustration. Their anger might be a manifestation of the leader's concern that the group might not reach a satisfactory conclusion in the time frame.

The second type of anxiety that was evidenced was ‘performance anxiety’. This was manifested in students continually seeking external reassurance and validation from the teacher and other groups rather than accessing the resources of their group. Students demonstrated that they viewed other groups as competitors. Their communications displayed that they were fearful and needed reassurance which could have been provided by a group leader giving them direction. In the absence of a group leader, seeking more factual information about a problem was not going to solve the problem of anxiety (Brown, 2000).

The third type of anxiety I observed was ‘conclusion anxiety’. In the transcripts, the students disagreed whether or not they had completed enough work to submit their assignment. They displayed an irritability with each other which was manifested by the anxiety that they may not have achieved a satisfactory ending to the assignment. They worked productively until the last second of the allocated time and relinquished their final work reluctantly. Their interactions communicated to me that they were trying to extract and display every possible piece of understanding before submitting their assignment. The students confirmed that they were feeling insecure and disliked getting things wrong.

The member checks I conducted confirmed that students were feeling varying degrees of anxiety throughout Phase 1 of the research. They were placed in a potentially stressful situation of solving a mathematical problem in a limited time frame with the expectation of having to present a solution. They had been given no information about allocating roles or social norms nor had the Reflective Action Learning Cycle been explained. I had not expected mathematically competent students to exhibit so much anxious behaviour in a simple problem solving activity. I had chosen this problem because it had multiple solutions and I considered it to be not especially challenging. I have already stated that my position was not neutral in the classroom. I was so preoccupied with providing assistance, posing careful questions which scaffold student understanding and encouraging and understanding the multiple directions the students were exploring to solve this problem that, until I was able to simply observe, I was not fully aware of the dynamics and underlying issues. The level of anxiety displayed by my students astounded me.

WHAT DID I LEARN IN PHASE 2?

In the second phase the data was generated after a group discussion and some group learning theory was introduced, as detailed in Chapters 3 and 5 and in Appendix 2. The second research question can now be addressed: How does the quality of the group’s interactions change in collaborative learning groups in a mathematics classroom after roles, social norms and reflective-action learning cycle have been introduced?

The predominant theme emerging from analysis of Phase 2 data was ‘group self-reliance’. This was evidenced in the dramatic reduction in student requests for assistance of the teacher to provide additional information and affirmation, and reduction in the frequency of comparisons of progress sought by the sampled groups with other groups. The sampled

groups appeared to know how to begin working on a problem and relied more on the resources of the group to solve their problems and provide positive feedback and encouragement.

There were certain outcomes from the research that were less desirable; for example, there was quite a lot of conflict within the groups. I made a concerted effort to select the collaborative learning groups naturally from the classroom where students were comfortable and had a sense of psychological safety. By now I was aware that by placing students in an unfamiliar situation where they were asked to work in a group to produce a solution to a mathematical problem was already challenging and was possibly compounded by the teacher providing no preparatory skill development. Even though I tried to minimise potential problems by choosing psychologically safe groups, I found that conflict did occur. I felt that it was necessary to research this area further and conduct some intervention. In the literature I found techniques where conflict could be turned into a positive learning experience in groups. Rather than overtly discuss this with the whole class, I chose to discuss this with the groups who were clearly experiencing conflict. My intervention was successful except that I found hidden conflict which was far more destructive than open conflict. Open conflict is open to be solved, but hidden conflict is concealed and not able to be processed readily. It became apparent to me that it is important to be prepared for conflict resolution when working with groups because it is a likely outcome.

There was evidence of conflict arising from dissonance between students' personal goals and their group goals. Dissonance has the potential to arise for many reasons, however, in Phase 2 it arose from the difference between the needs of the individual students and the learning goals of the group. One group could not provide for the needs of one member and the other three members had quite strong congruent learning goals, so one student requested to leave the group (see Chapter 5). This indicated to me that it was an appropriate time to empower the groups to deal with open conflicts and goal dissonance. I decided to conduct a class discussion on goals and present some theory on the influence of group learning goals on group functioning (see Presentation 2 in Appendix 2).

WHAT DID I LEARN IN PHASE 3?

In the early stages of collaborative learning, gaining a shared clarity of the group's goals and an alignment of the individual and group's purpose promotes more effective group functioning (Kayes, Kayes & Kolb, 2005). The issue of developing a collective purpose and shared goals was addressed by creating a conversational space in the classroom before Phase 3, and is discussed in detail in Chapter 6.

The theme of self-reliance is well evidenced in the analysis of the data in Phase 3. The leaders of the groups were prepared to manage more aspects of their group's functioning than they were previously prepared to undertake. There appeared to be increased productivity and a reduction in the lengthy periods of off-task discussion. These observations could have been a response to a shared clarity in group goals and a

consensus about the learning goals of the group. The introduction and practice of using clear roles and social norms did appear to give students a framework to start work almost immediately on the problem. Students appeared to have a shared understanding about the role descriptions of each group member. There appeared to be a seamless fluidity between the group members who held roles in two groups, and they switched these positions within one session which showed me they possessed an equitable view of the role positions within the group. It is difficult to keep all members on-task without crossing the line into the zone of being an authority figure which may be too much to ask of a student in a collaborative group learning activity. This was alluded to in member checks in Chapter 6 and was one of the causes of these role switching situations.

REFLECTIVE-ACTION LEARNING CYCLE IN CONTEXT

It was satisfying to see the students using the Reflective Action Learning Cycle to explain the steps they were using to solve the problems they were given. They were beginning to understand that there were processes that explained what they were doing and that the skills could be taken away and applied to other situations. This appeared to be an example of meta-learning where students were able to discuss the methods they were using to solve the problems expediently in groups.

WHAT WAS I HAPPY WITH IN THIS RESEARCH?

I was surprised that there was clear progress in the ability students displayed to work collaboratively to solve problems, complete assignments and support each other in working through curriculum material. Through the data analysis process of grounded theory analysis I felt able to answer the second research question: “How does the quality of interactions change in collaborative learning groups in a mathematics classroom after roles, social norms and reflective-action learning cycle have been introduced?” Amongst the groups there was a high level of encouragement of each other and positive self-talk in Phase 2 and 3. Students were validating each other’s input and developing a shared understanding. There was a clear change in the quality of the interactions in the collaborative groups compared with phase 1. The students appeared to feel a greater level of satisfaction from working in groups largely because their contributions were being valued. The groups were beginning to rely on intrinsic motivation rather than depending on extrinsic encouragement. Students displayed encouragement and congratulatory comments which were largely absent in Phase 1. Member checks confirmed that they felt more confident even though they did not interpret the problem correctly in Phase 2. This dramatic change could be attributed to the inclusion of explicit instruction about roles and social norms. The students sampled in Phase 3 recounted their feelings of satisfaction at being able to solve the problem, and the group interview results were very positive.

In my journal notes, cited in Chapter 5, I observed that team management and structure was vital if students were to experience group autonomy and connection with their group. I attributed the improvement of the group functioning to the introduction of roles and social norms to the groups. The Reflective Action learning Cycle gave students a framework to start working almost immediately on a problem (see Chapter 6), and students appeared to have a shared understanding of the job description of the group leader.

Tolerance of different learning styles was a welcome outcome in some groups. It was good to see that the group learning environment became more accessible to more vulnerable students and that their understanding and opinions were valued. I introduced some theory on overlapping learning styles with the intention of promoting tolerance and inclusivity in groups. While research suggested groups with mixed learning styles performed better (Kayes, Kayes & Kolb, 2005), I felt that students in their adolescent years would feel more psychologically safe if they were not isolated completely from their friendship groups. An example of this was provided in Chapter 4 when a student chose to move from her group because she could not keep pace with them. She had much to gain from their scaffolding but did not want to let them know she needed clarification or further explanation.

The effectiveness of the member checking process was an unexpected and beneficial feature of my research for a number of reasons detailed below. The member checking process required me to seek out students in the school grounds and make appointments with them to show them the transcripts and my interpretations. It was very time consuming and put me in a vulnerable position because I was making inferences about their feelings. The process was, however, welcomed by all students who willingly shared their time and opinions. They added valuable confirmations, elaborations and interpretations that would have been inaccessible to me in other research methodologies. It proved to be an example of triangulation in action. The perspectives they shared allowed me to see my research from a different perspective, kept me grounded and made me justify the methodology I had chosen. I used this process to challenge inferences arising from my grounded theorising. My intention was to understand the meanings behind human behaviour, and the understanding was enhanced by a joint contribution (Glaser, 2007).

The member checking process provided closure for the students who participated and also a conversational space for them to discuss their own learning. After discussing my research with the students, I have been impressed with the level to which students have been able to discuss their own learning. I felt the whole experience was quite valuable in terms of meta-learning because it was an unexpected outcome which emerged from the research.

WHAT WAS I NOT HAPPY WITH?

Absenteeism in the classroom caused some fluidity in the groups. There were students who infrequently attended class due to managerial arrangements which might include seeing the school counsellor, the curriculum co-ordinator or year level co-coordinator. Some students were dominant members of a group and were absent on a critical day of recording which changed the dynamic of a group. I often felt that the reflections of these students were based on only a partial experience.

One of the concerns emerged from my transcription process was that I did not have access to all the interactions for the entire lesson. If I have the opportunity to repeat this research I would record every group and look for common themes between the groups during each phase of the research. There may have been differences between the groups within each phase that I have not identified.

I used a journal during and after each lesson to record my perceptions of the classroom climate but these were always on the run, jottings made in the lesson and after the lesson in the course of the crowded school day. While I reflected in my journal in the evenings, I ask the question: Was it enough? If I conducted my research again I would allocate much more time to my journal.

Conflict is inevitable and will surface in all groups (Brown, 2000). I experienced examples of both open conflict, where students clashed, and repressed conflict, which was hidden and could not easily be dealt with. Repressed conflict can be very destructive because the students do not openly express their ideas and so the group proceeds not realizing that conflict exists, but as frustration sets in because for some reason, nothing seems to be accomplished. I was not fully aware of the underlying issues because the student described in this scenario kept quiet when he disagreed. He was sceptical of the leader's competence and later mentioned that he wished the group member would "shut up" because he always "got it wrong." In retrospect, the group members were competing for attention and this polarized the group. I was not able to intervene because the situation was hidden from me and I suspect the experience may have impacted on their opinions of collaborative learning. There were instances of blaming and name calling in the group discussion (Appendix 4). Earlier intervention may have alleviated the situation but this did not occur because I did not monitor all groups to the same extent and the information was not communicated to me until after the research data was generated. Conversely, from a Grounded Theory perspective the negative experience these students had remains valid data and should be taken into account because it was their experience of collaborative learning setting. This data forms a 'joint distribution' of majority cases contributing to the grounded theory and minority deviant cases which are important and potentially form non-preconceived, unobserved latent patterns. Exploring the cases that deviate from a theory guards against a researcher developing a self-fulfilling prophesy.

The student reflection questionnaires that I spent many hours carefully designing, proved to be a waste of time. The five point scale was not fully understood by the students who circled positions quite arbitrarily. The questions often positioned students into wanting to

give the 'right' answer. The information I collected from the questionnaire was of little relevance and discarding it was quite a freeing experience. In her account of her journey in learning classic grounded theory Carol Roderick (2009) recounted the same experience:

One day I arrived at an interview and realized that I did not have my interview guide and demographic questionnaire. After a moment of panic, I asked a student simply to tell me about being a graduating student. The interview flowed well and I learned more in this interview than I did in all the others because I was listening differently. At this point, I ceased using my interview guide. (Roderick, 2009, p318)

Glaser (2007) stated that many researchers who begin to use grounded theory analysis continue to use standard data collection techniques but shed them when they find they interfere with generating theory. This describes my experience with my student reflection questionnaires. The time I allocated to the groups discussing and reflecting on the questionnaire became a 'conversational space'. Introducing opportunities for a conversational space allowed students to reflect on their experience and evaluate the efficacy of their group. The questionnaire gave them a framework and the time to do this which was valuable.

BEFORE AND AFTER GT

Figures hold an important place for many mathematics educators. Calculations are beautiful things and they provide a single unarguable answer. Qualitative data gathered in social situations, however, have never held this position, they are malleable, and I have always suspected that sweeping generalisations can overlook the deviant cases which are just as important as the majority cases. So when it was suggested to me that I explore Grounded Theory as a methodology, it was like sowing seeds on fertile ground. My research of Grounded Theory began broadly and I encountered rigid procedures and confusing terminology. Wider research led me to *The Grounded Theory Review Methodology Reader* (2004-2011), and I began to see that 'all data is data'. The revelations of Glaser (2009) suggested that novice researchers used Grounded Theory successfully because, in their view, more preconceived methods did not fit, work or give them relevant answers. I faced my transcripts with trepidation but with an open mind. There was initial confusion and then patterns began to emerge and a 'eureka' moment followed. Had the interactions I grouped together uncovered common causal statements which indicated a main concern? I gathered evidence and submitted my case to my supervisor with energised enthusiasm. My first Grounded Theory had emerged from my data analysis.

What the novice has to offer GT is openness: being open to the emergent. They are not yet formed in a method or a substantive area to any extent. They are still free to forsake the preconceived....Novices often because of openness, see patterns quicker and of better fit and relevance than the experienced do because

of their normal forcing of previous categories and models. (Glaser, 2009, p212 & 215)

My readings in GT have made me realise that I was on a new journey. I wanted to learn more about this exciting method of research and wanted to share and discuss my experience with others who had experienced a similar journey.

When I began my Masters course work, I was told that to clearly see what is happening inside a classroom you needed to step outside. To the contrary, I have found that interacting with small groups of students in their natural setting gave me the strongest position to observe and document what was happening from a comprehensive knowledge of the research topic and questions (O'Toole & Beckett, 2010).

HOW HAS THIS INFORMED MY TEACHING?

When does my research cease? Will life ever be the same as it was before I experienced Grounded Theory? The answers are 'never and no'. I commenced my research from a position of wanting to learn more about an area that interested me in teaching Mathematics.

From this research I take the following understandings:

- of how to scaffold collaborative learning in groups;
- that contextual and collaborative learning can be effective and motivating in the mathematics classroom;
- that simple roles that students understand can be easily introduced and provide structure and improve group autonomy and satisfaction;
- that simple and clear social norms introduced to a group give group members a framework to use to help solve problem that arise in collaborative learning settings;
- that the Reflective Action Learning cycle gives students a framework to help them solve problems;
- that collaborative learning is dynamic and improves with experience;
- that time to reflect and discuss group performance is vital for group learning skills to improve;
- that problems will arise in collaborative learning groups and how these are solved expands the dimensions of learning experience for the teacher and students alike;
- that not solving a mathematical problem does not mean that learning has not taken place or that the process has not been satisfying; and
- that being receptive to positive and negative feedback will help me modify and improve my skills in scaffolding collaborative learning in my classroom.

I began implementing what I learned from my research while I was still conducting member checks and although, I have changed my work place, I am still implementing and developing skills in collaborative learning groups.

WHAT FURTHER DIRECTIONS WERE SUGGESTED BY MY RESEARCH?

There are many directions I could pursue to deepen my understanding of how to improve collaborative learning in the mathematics classroom. I could not answer some questions because they were out of the scope of my research. In Chapter 5, I discussed that I introduced information on learning styles with the intention of promoting tolerance in the collaborative groups. Research has suggested that groups with mixed learning styles perform better (Kayes, Kayes & Kolb, 2005). I did not form the collaborative groups using mixed learning styles, instead I chose to preserve a level of psychological safety by placing the students in groups not far from where they naturally sat in the classroom. In an ideal group, students benefit from recognising the strengths of their different perspectives and using this to solve conflicts. Structuring groups according to learning style in the mathematics classroom is an area that I would like to pursue in the future.

In my last member check in Chapter 6, I discussed whether the empathic quality of student relationships could be associated with group self-reliance and productivity of the group. Jude (p. 58) and I discussed whether the gender of the group members might affect the quality of empathic relationships between members. She thought that the girls worked better as a team than the groups with all-male members and rotated the roles with less conflict. This is an interesting observation and it suggests the possibility of more research.

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APPENDIX 1: LESSON CONTENT

Earth Geometry Application Assignment ~ 10 CAS Assignment

Show all working and diagrams

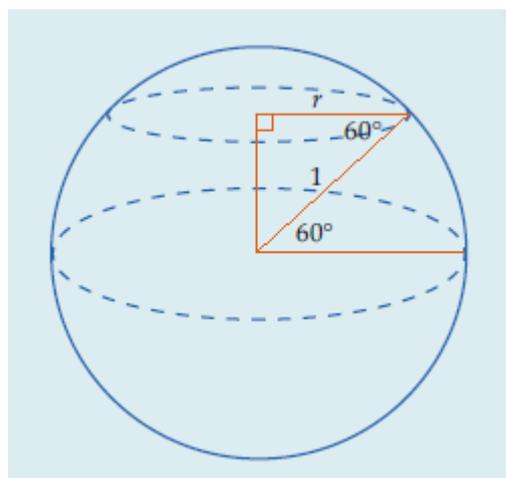
1. The Equator and meridians of Longitude are all great circles. The meridians go through the poles. Make a drawing of the meridians of longitude on the spherical Earth.

Meridians are measured degrees East and West from Greenwich, in England, where it is considered to be 0° . This is the prime meridian.

2. Given that the earth has the radius of approximately 6375 km, find the circumference of the Earth.
3. Parallels of latitude are all small circles (except for the equator).

The degrees of Latitude are measured North or South of the centre of the Earth.

Given the radius of the earth is 6375 km, find the radius of the small circle on the latitude of 60° north as shown on the diagram to the right.



4. Find the circumference of the small circle on the latitude of 60° north.
5. A point “A” on the earth’s surface has the co-ordinates, $(30^\circ\text{N}, 25^\circ\text{W})$. What is the latitude, and what is the longitude?
6. Make a drawing of the two points A and B on the earth’s surface: A $(30^\circ\text{N}, 25^\circ\text{W})$ and B $(20^\circ\text{N}, 25^\circ\text{W})$. Find the distance in degrees between the two points.
7. Using the degrees in question 6 as a fraction of 360° , find the distance between the two points in kms to 2dps accuracy.
8. Calculate the distance between the two points: C $(85^\circ\text{S}, 89^\circ\text{E})$ and D $(46^\circ\text{S}, 89^\circ\text{E})$ which are on the same meridian of Longitude. (Make a simple drawing of this situation first.)
9. Two cities Beijing and Rome are on the same small circle, Beijing is $(40^\circ\text{N}, 120^\circ\text{E})$ and Rome is $(40^\circ\text{N}, 15^\circ\text{E})$, Make a simple drawing of this situation.
10. Find the radius of the small circle that Beijing and Rome are on.
11. Find the circumference of the small circle with the latitude of 40°N that Beijing and Rome are on.
12. What is the angular distance between Beijing and Rome?
13. By expressing the degrees as a fraction of 360° , find the distance between Beijing and Rome in km to 2 dps.

14. Using the reference map and your knowledge of triangles, find the distance between Sydney and Los Angeles. Include an explanation and your calculations and diagrams.

10 CAS Mathematics: Trigonometry

The Unit Circle and Exact Values Assignment

1. On an A4 sheet of 2mm Graph paper (portrait) construct a Cartesian Plane (x and y axes) in the approximate centre of the page. The origin should be placed on cm grid lines. Using the origin as the centre, draw a circle with the radius of 5cm. Ensure the circle cuts accurately on the 5cm mark on the x and y axes. Label the axes and the circle intercepts at ± 1 .

/1

2. Using a protractor mark in the following angles at the origin made from the x axis in the first quadrant: 0° , 30° , 45° , 60° , 90° , 120° , 135° , 150° , 180° , 210° , 225° , 240° , 270° , 300° , 315° , 330° , 360° .
These angles are measured anti-clockwise. Keep work accurate and use a sharp pencil. The angles should extend as far as the edge of the unit circle.

/1

3. Read the x co-ordinates of where the angles meet the unit circle and complete the following table. (correct to 2 dps) /2

angle	X co-ordinate	Cosine of angle	Y co-ordinate	Sine of angle
0				
30				
45				
60				
90				
120				
135				
150				
180				
210				
225				
240				
270				
300				
315				
330				
360				

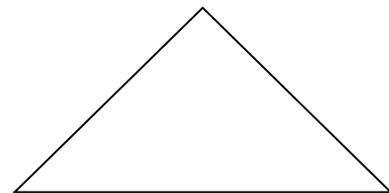
4. Fill in the y co-ordinate of each of the angle end on the unit circle and complete the table. /2

5. Use your calculator to find the cosine and sine of each angle correct to 3 dps, what statement can you make about your findings? /4
6. Construct a tangent to the circle, parallel to the y axis, which touches the Unit circle where $x = +1$. In the first quadrant only, extend the angle lines so they meet the tangent outside the Unit Circle. Fill in the table below giving the y co-ordinate of each point where the angle lines meet the tangent. /2

angle	Y co-ordinate	Tangent of angle
0		
30		
45		
60		
90		

7. What did you notice about the values of 60° and 90° ? /1
8. What statement can you make about the tangent of different angles? /1
9. On a separate sheet of graph paper, positioned landscape, scale the y axis from +1 to -1 and place the angles 0° to 360° along the x axis. Plot the positions of the sine and cosine curves and join with a smooth curve. /4
10. Assume the triangle opposite is an isosceles triangle with base length 1 unit and 2 angles of 45°

- a) Label the angle sizes.
- b) Drop a perpendicular bisector to the base from the top corner.
- c) Use Pythagoras to find the length of the perpendicular bisector.



- d) Use your knowledge of trigonometry to find the surd value of the sine, cosine and tangent of 45°

These are called the exact values.

(Show all working)

/4

11. a) Draw a triangle with the angles 30° , 60° , 90° , the hypotenuse is 2 units and the shortest side is 1 unit long. Label the triangle
b) Use your knowledge of trigonometry to find the surd value of the sine, cosine and tangent of 30° , 60°

/4

12. Present the exact values in the following table:

angle	sine	cosine	tangent
30°			
45°			
60°			

/2

APPENDIX 2: POWER POINT PRESENTATIONS

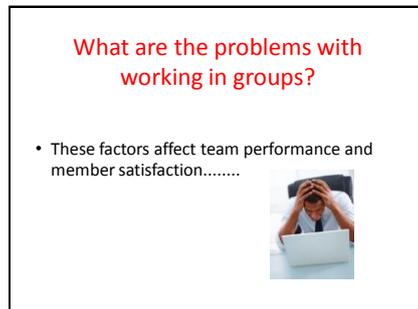
Presentation 1.

Slide 1



Introduction to the theory of working in Collaborative Learning Groups.

Slide 2



What are the problems with working in groups?

- These factors affect team performance and member satisfaction.....



This was a brain storming session where students offered their opinions on what were the factors that had a negative effect on the group's performance.

Slide 3

Common problems with group learning?

- Some people do not pull their weight
- Over dependence on a dominant leader
- Social loafing..... blah blah blah
- Failure to express true feelings *groupthink*
- No-one takes responsibility
- Wasting time instead of getting the job done



The class contributions were summarised as themes that had been representative in many different research projects. The major salient themes were presented as simply as possible.

Slide 4

Negative factors can be overcome

- When you **learn** through your experience
- Develop your teams
- Conversation space (Reflection)
- Leadership roles
- Social norms (Rules)

Possible solutions had been suggested from different researched sources and summarised as simply as possible.

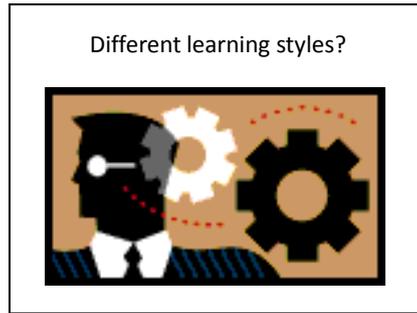
Slide 5

Effective teams have.....

- **A**ims: Shared purpose
- **R**oles that are rotated : Leadership can be learned, but a teams progress needs to be managed
- **M**embership: Mixed learning styles, respect, diversity
- **P**rocess: Well established process
- **A**ctions to ensure the purposeful involvement of members, social norms, rules
- **R**eflection: Conversational space, feedback

So what does an effective Collaborative Learning Group look like? An acronym was used to describe some of the major features of a successful team.

Slide 6



Learning Styles were introduced to foster a tolerance of students who may learn differently and contribute to group learning in a different but equally valuable way.

Slide 7

The slide is titled "What is your learning style?". It contains four colored boxes, each describing a learning style with its characteristics and potential career paths.

Diverging:	Assimilating:
<ul style="list-style-type: none">brain stormuse concrete experiencereflect and observehave broad cultural interestsimaginative and emotionalinterested in peoplelisten with an open mindaccept personalised feedbackwork well in groupscould specialise in the Arts	<ul style="list-style-type: none">use abstract conceptsreflect and observeput information into logical formless interested in people and more interested in ideasmay have career in Science or Informationenjoys lectures and learning by readinglike having time to think things through
Converging:	Accommodating:
<ul style="list-style-type: none">use abstract concepts and experimentfind practical uses for theoriesdeal better with technical tasks than with social issuesmay have careers in technology and specialist trade areaspracticalthese people will be able to fix it!	<ul style="list-style-type: none">use concrete experience and experimentuse hands-on experienceuse gut feelingsenjoy challenging experiencescarry out plansrely on people for informationhave action oriented careerperhaps in marketing or sales.

We used this overlapping and cyclic framework to self analyse our learning styles and to comment on other class members. This was an accessible and very enjoyable activity which was intended to promote tolerance.

Slide 8

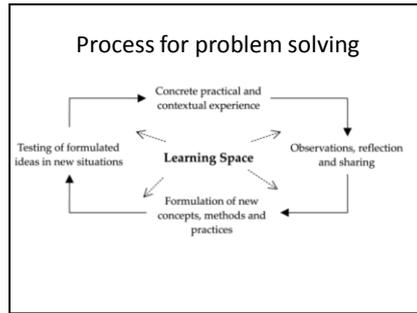
The slide is titled "Rotating Roles:". It lists two roles with their descriptions. At the bottom right of the slide is a circular icon with three arrows forming a clockwise cycle, representing the rotation of roles.

Rotating Roles:

- **Leader:** This person guarantees all group members take part.
- **Recorder/Presenter:** This person records the major decisions of the group and reports on these at the lesson conclusion.

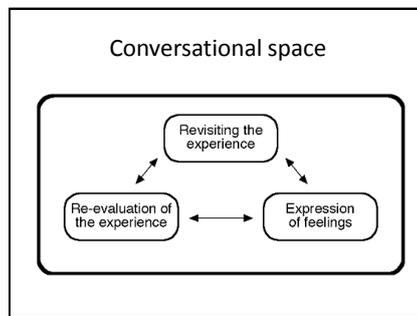
I had simplified the roles to the very basic minimum. These role descriptors needed to be very simple and easily understood so that they did not make the natural flow of group learning clunky in any way.

Slide 9



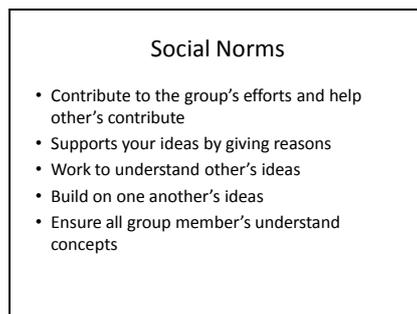
The Reflective Action Learning Cycle provides a simple framework for student to follow when solving problems and highlights reflection as an integral part of learning. I thought it was important to present the idea of problem solving as a simple diagram.

Slide 10



Reflection and discussion are valuable learning tools where ideas are discussed and modified. The explicit presentation of the social aspects of learning emphasizes the inherent value of group learning.

Slide 11



Rather than allocating a number of lessons to the development of group rules, the social norms or descriptions of optimal behaviour in collaborative learning groups was researched and presented to the class to use.

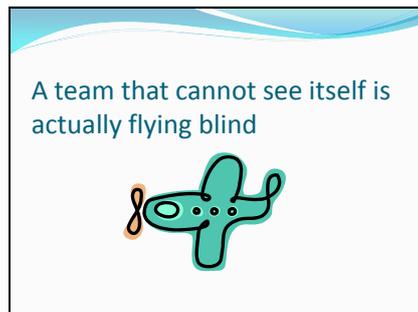
Presentation 2.

Slide 1



After 3 lessons of working in collaborative groups and before the final lesson, I provided students with the opportunity to reflect on how they thought their grouped was functioning. Whether or not the group was meeting the learning goals of the group and the individual members.

Slide 2



The importance of reflection is to identify what is working and what could be changed to improve the effectiveness of group learning.

Slide 3



The importance of tolerance and inclusivity is being emphasised here so that all participants feel their goals and opinions are valued by the group. When all group members share the group goals purposeful learning is a real possibility.

Slide 4



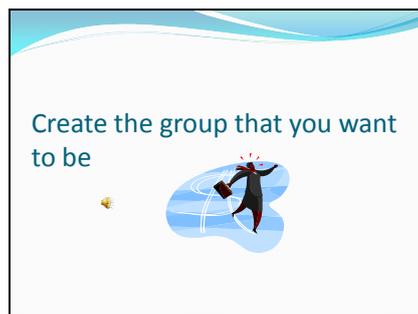
Tolerance and reciprocity is being emphasised in this slide. This was because I could sense some disharmony in some groups.

Slide 5



The simple goal of Collaborative Learning Groups is to learn more effectively through sharing ideas.

Slide 6



This final slide was intended to be motivational.

APPENDIX 3: RESEARCH DATA

QUALITATIVE DATA COLLECTED IN PHASE 1

The data collected in Phase 1 includes my interpretive commentary. The research methodology is best described as Classic Grouped Theory (CGT) detailed by Carol Roderick in the Grounded Theory Review Methodology Reader (2009).

Phase 1: Transcript 1

<p>Before 19/4/2012 Students are Mal, Millie and Jude from Group Y. The tape recorder is placed on the table of group Y and starts recording as students are asked to work in their groups.</p>	<p>Group Y: working on Curriculum concepts in CL groups from text book including worded problems and puzzles on the topic of Trigonometry</p>
<p>Direct Quotes, Evidence of Interactions, and the time they occurred within the tape recording.</p>	<p>Interactions and some interpretation of evidence. Commentary from the group interview and teacher journal notes</p>
<p>Mal: "Will you please help me?"(00:26) Teacher helps student labelling the sides of the triangle. Mal: "Oh I see what I did wrong. I was using tan instead of sine." (01:33) Millie:"I have a question too, please, what line are we trying to find?" (01:46) Teacher helps student interpret the question and draw the required diagram from the worded question. (02:40) Teacher helps student put calculator into degrees mode rather than radians.</p> <p>When the teacher leaves the group, the students become distracted by the tape recorder. Discuss parts of questions, and make statements about their progress through the curriculum material. Mal: "I have not finished. I have no-where near finished," "It is really hot," (06:54) "I just want to go to bed," "Do you have to work tonight,"</p>	<p>Students go directly to the teacher rather than interacting with each other and using the resources in the group. (2 examples)</p> <p>Off task discussion shows that: No-one is taking responsibility for keeping the group on task.</p>

<p>Student work quietly. “It is really hot! I am not in the mood for Maths!” (08:14) Jude: “What do we have to do?” Mal: “Try to find a triangle and an angle, whatever!” (08:41) Millie: “I am going to use the answers to help me get the right answer!” (08:27)</p> <p>Students want to listen to music and say it makes them relax. Mal: “It is so confusing,” “Oh, what have I done!” (10:01) Students continue to work quietly for a while. (12:15)</p> <p>Students begin an animated discussion about songs, passwords, netball, injections, clothes and being tired. (15:08)</p> <p>Jude: “Because I am so far behind, do I need to every question?” Mal, “Don’t do every question! Do every second question,” (16:02) Mal, “Jude, I got this one wrong,” “I forget how to do this,”</p> <p>“I found out what I did wrong...aww...I hate this shit!” (17:35)</p> <p>Millie “Miss M, would you please help me?” Not audible to teacher. Grr</p> <p>Millie: “Miss M, when you come back, I need your help,”(22:16) Teacher distributes the puzzles. Mal explains how to do the puzzles to the other students. (23:23) Teacher reads the worded problem to the student and explains how to attempt an open</p>	<p>Students becoming confused and frustrated</p> <p>Interactions show a lack of direction.</p> <p>Verbalising strategies</p> <p>Evidence that: Listening to individual music does not enhance on task discussion and interactions.</p> <p>Off task discussion is possibly evidence that the students are finding the level of the work too hard to be able to work through it independently.</p> <p>Asking study advice of the group.</p> <p>Students are asking for help but there is no evidence of scaffolding each other’s learning or creating a shared understanding.</p> <p>Interactions are with the teacher for developing an understanding.</p> <p>Generally the students in this group want to work but are not working on the same thing and are therefore not helping other.</p>
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<p>ended problem. It involves setting up simultaneous relationships. (25:37) Other students in the group do not take an interest in this problem and start discussion a TV program.</p> <p>Mal: "I hate..." Mal: "What did I do wrong here?" (28:44)</p> <p>Mal divided instead of multiplying when rearranging a trig ratio to solve a problem.</p> <p>Teacher explains how to use the solve function on the calculator.</p> <p>Millie: "I just got a negative number. Is that ok?" (33:51) Teacher: "Er no, shall I just write it out for you?" Millie: "Yes please," Teacher explains on a unit circle where the negative answer came from. Students start talking about what questions they had trouble with, and other topics like their favourite lollies and their passwords. Then back to their trigonometry.</p> <p>Teacher asks other groups if they want any help.</p> <p>Jude: "I am pretty sure I know how to do this ,Lucy!" (37:52) She begins working individually.</p> <p>Students begin talking about netball uniforms. (40:00) for 2 minutes</p>	<p>Interactions are all with the teacher when the student is having difficulty.</p> <p>Good teacher interactions. Two examples.</p> <p>These more complex questions are the type of interactions students need to have with the teacher.</p> <p>Evidence that students actually do want to do their work but are not working together as a team. They may have different goals. It could be evidence that curriculum (text book) exercise are not as compatible with group work as problem solving tasks and assignments.</p> <p>This type of teacher question usually occurs when students are able to work without too much assistance. The question is an invitation to students who might be less assertive when asking questions.</p>
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<p>Millie and Mal begin working together on a problem (40:46) “Yay, I got that right!”</p> <p>Jude: “I have forgotten how to tell if it is SOH, CAH or TOA!” (41:26) Millie: Do you want me take this home?” refers to the puzzle sheet. “Just run me by what I have to do.” Mal: “I should do Ex. 6.3 and 6.4 for homework. Oh, that looks hard!”(42:00) Students begin to discuss the reflection sheet. Millie: “We have to discuss it, Ok I’ll write,” Millie: “Were we committed to this task?” Mal: “I’d say medium,” (42;19) Millie: “Ok medium, we were, don’t you reckon? We were kind of committed but we get side tracked a little,” Millie “Do you feel a part of this group?” Jude: “Yes” Mal: “I don’t!” Jude: “Come on Mal!” Mal,” That is a high rating!” Millie: “Oh well,” Millie: “Do we have a dominant leader?” “No not really, we talk together.” “No, we do not depend on a dominant leader,” “No” Millie: “Do we go off the topic?” Jude: “Yes, very easily!” Millie: “Your groups level of discussion where alternative methods are discussed.” Jude: “What does that mean?” Mal: “Do we discuss alternative methods?” Millie: “Medium” Mal; “We use our calculator,” Jude: “And our brains!” Millie: “Do we show support to each other?” Mal: “Yes, high, very high!” Millie: “Do we share solutions and answers?” The others agree. Jude: “Yeah but we do not like giving them a dead straight answer. We help them work it out!” Others agree audibly: “Yes” “Level of ... do we explain the answers to each</p>	<p>Evidence that students verbalise questions that no-one answers</p> <p>This interaction is being structured by the reflective questionnaire and is a reflective action process. It will structure future group experiences because students will be more aware of what they are expected to do in a CL group.</p>
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<p>other?"</p> <p>"Wow, I don't do that one!"</p> <p>Mill: "We do always check the answers don't we?"</p> <p>Others: "Yeah"</p> <p>Millie: "There we are, done!"</p> <p>(44:06)</p>	
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Phase 1: Transcript 2

<p>Before 2/5/2012</p> <p>Predominantly the students sampled are Mal, Millie, Rae and Jude from Group Y, however, also audible is group X with Amy and Rick and group Z with Luke, Rock, Jo and Ellen.</p> <p>The tape recorder is placed on the table of group Y and starts recording as students are already half way through the assignment.</p>	<p>Group Y Assignment on Earth Geometry Application of Trigonometry</p>
<p>Direct Quotes, Evidence of Interactions, and the time they occurred within the tape recording.</p>	<p>Interactions and some interpretation of evidence. Commentary from the group interview and teacher journal notes.</p>
<p>Millie has me check her solution. Her group is well advanced through the required questions of the assignment compared to the progress of other groups. (0:16 -2:16))</p> <p>Mal: "Ok we are up to Question 6,"(3:39)</p> <p>"I will read this.... we need to draw a circle. (3:55). Where is the circle stencil?What radius do we use?.... Please ourselves..... I think we have to make a triangle."</p> <p>Mal: "How do you work out..."(7:01) She asked this twice.</p> <p>Millie: "Well, I'll teach you." (7:10)</p> <p>"The sides must the latitude and longitude...." (7:18)</p> <p>Millie: "This is how I do it,"</p> <p>Jude: "Which is which?"</p> <p>Mal: "How do you work out..</p> <p>Millie "Maybe I've got them wrong!"(9:16)</p> <p>"It's too hard!" (10:06)</p>	<p>Seeking verification from teacher</p> <p>Teacher reassures Millie</p> <p>Teacher gives Millie an easy way to remember longitude and latitude</p> <p>Students are interpreting the question.</p> <p>Students organise themselves all students are involved in this process.</p> <p>Millie is teaching the others in her group.</p> <p>Students are sorting out the question.</p> <p>There is a lot discussion about understand how longitude and latitude work.</p> <p>Explaining to each other</p> <p>Lots of explaining and questioning.</p>

<p>“Well you see the Longitude goes up and down and the latitude goes across.” (9:33) “It is ready for you to draw,”</p> <p>Questions are being asked and answered continuously by the group members. (11:14) :</p> <p>Mal: “Copy that down,” (12:55) Millie: “So will I draw those?” Mal: “I need a better pen”</p> <p>Mal: “Guys, we need to finish number 14!”(13:45)</p> <p>“I am really confused. Let’s go to the next question,” (14:35)</p> <p>This group checks their progress with other groups. “Oh, we have done that!” (17:24)</p> <p>Millie: “I am not happy, I hate these,”(17:41) Mal: “Oh I have drawn this too long,” (18:00)</p> <p>Mal: “Ok, when we have done this question, we will need to go back and do the other questions.</p> <p>What if we square it?”</p> <p>Mal: “I thought you were coming to us next!”(23:35) I explain the question. Millie: “Is that all we have to do?” Teacher confirms this. I explain the question in detail. “Just tell us if we are doing it right,” Millie: “I need to work on my drawings, don’t I?”</p> <p>“Do I have to put the degrees in my calculator?” (23:43) Millie: “Does that look right?” I confirm this: “Yes” Mal: “Ok, we have done question 6 and 7 now,”</p>	<p>Common understanding seems to be aimed at through questioning.</p> <p>Students are active and developing roles There is lots of organising and stating and restating.</p> <p>Mal appears to be emerging as a group organiser.</p> <p>Jude seems to be emerging as the questioner.</p> <p>Students are working together and evaluating their progress</p> <p>If they get stuck, they go off task The amount of off task discussion is actually quite disappointing.</p> <p>They like to get help instantly.</p> <p>Students are active in the process of sorting out problems but work much slower than if the task was teacher directed</p> <p>This group has productive strategies</p> <p>Self organising</p> <p>Mal is very task oriented</p> <p>They are decoding the question and drawing a diagram.</p> <p>Comparing Comparison “What If” questions</p>
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<p>(25:33) Mal: "And the next one is actually the same, er, maybe it is not, draw a circle," Jude: "What are we up to?" "Question 8," "Put on the labels." "What do we have to find out?" "What is the question asking?" "What is the question?" "That is an odd question to ask!" They completed the question. "I think that is all we had to do," (29:00)</p> <p>"But have we answered the whole question?" Jude: "We have half an hour left!" (30:00) Mal: "That is good, Jude, because we can get all the questions done!"(30:34) One group member is left out and not being included. Rae says, "Could someone please tell me what is going on?" "Could we have some help please, Ms M?" "...Before you help, Rock!"(32:34)</p> <p>Millie: "We do not know what we are doing" Mal: "We are up to question 9" Amy in back ground "Could someone please tell me what the hell that is." Mal: "Where is 120° East? Miss M, have I got 120° in the right spot?" "Where is 40° North?"(32:00) "It says to make a simple drawing, have I done that?" (33:00) Millie: "I think we are doing it wrong!" Teacher, "You are correct," (32:51) "That's good!" I explain the drawing and the co-ordinates. (33:08) Millie: "I think we are doing it wrong," Me: "No, you're not"</p> <p>Mal: "We need to find the radius," Millie: "Of what?" Mal: "We need to find the radius of the small circle that Beijing is on." (34:16)</p>	<p>Rock is not connected with her group.</p> <p>Teacher has to settle down fairly off task and loud behaviour.</p> <p>Students require fast and effective responses from the teacher to be able to continue tp progress though the assignment questions</p> <p>Teacher cannot sit with one group for too long. They check how other groups have interpreted the question.</p> <p>Statements show evidence of: Reassurance being sought Validation being sought Confusion Verification being sought</p> <p>Verification being sought Comparing progress with other groups.</p> <p>Other groups are very off task. They are not able to make any decisions. They are very teacher dependant in all decisions.</p> <p>Teacher dependent Teacher has the main responsibility to monitor the noise level in the classroom. Many groups are not assuming responsibility for completing the assignment.</p>
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<p>I pose questions to prompt their understanding of the process. (35:00)</p> <p>I clarifies the task to the group.</p> <p>Group checks their progress with other groups.</p> <p>Millie: “We are stuck on question 10!”</p> <p>I say: “You are working on the harder questions now”</p> <p>I help the students draw a diagram from the worded problem. The students discuss the method they are going to use with me.</p> <p>Mal: ”I don’t know,”</p> <p>After I leave the group they are able to start working on the problem. I help students in other groups.</p> <p>Mal: “We have the diameter,” (37:04)</p> <p>Millie: “I don’t know what to do,”</p> <p>Mal: “I don’t know either,”</p> <p>Students work very quietly for a while.</p> <p>(42:05)</p> <p>Mal speaks to Luke in group X.</p> <p>Mal: “Luke, what are you up to?”</p> <p>Millie: “They are only up to question 8 or 9, we have done more than anyone else,”</p> <p>Mal: “They are catching up now though,” (42:23)</p> <p>I ask Millie: “What are you up to?”</p> <p>Mal: “We are on question 10,”</p> <p>Millie: “We are dying!”</p> <p>Mal: “Yes, we are very confused,”</p> <p>Me; “Yes well you are on the harder ones,” (43:33)</p> <p>Students and I find that Rome and Beijing are both on the small circle of 40degrees North. (43:15)</p> <p>These are drawn on a diagram. I use questioning methods to draw out the students understanding of the question.</p> <p>Me; “So I want you to find the circumference of the circle Beijing is on. You find it exactly the same way as you have found it in this question,”</p>	<p>Interactions show evidence of frustration. And a high level of teacher dependency</p> <p>Lack of confidence in their own decisions</p> <p>Students ask for clarification about the tapes.</p> <p>Teacher scaffolds</p> <p>Students show evidence of panic if they are unsure</p> <p>The students are not afraid to ask each other questions that they do not understand.</p> <p>They select the formula</p> <p>Again students like to know how they are progressing compared to the other groups.</p> <p>You think the students understand, but when they do it for themselves you find that they do not understand.</p> <p>Students struggle with applying simple formula to real life problems.</p> <p>Student questions are in context of a real life question.</p> <p>There is evidence that students do not understand the terminology of Mathematics when they are not working through routine</p>
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<p>(44:00) Mal: "Don't we have to find the radius?" Me: "Yes, you do" Mal: "So we find the circumference and then the radius?" Me: "Radius first," Mal: "How do we find the radius?" I show them. Me: "So has that helped you?" Millie: "Yes" (45:00)</p> <p>Mal: "So what is it? Cos? Cos 40?" Millie: "What is the radius?" Mal: "We are finding the radius," (46:00) Millie: "But what is that number?"</p> <p>Mal: "We can find the other one, find the circumference of the small..."(46:40) Millie: "Why don't we finish, we have done the most out of any group" Mal: "No, why not finish another one!" Millie: "Oh Kay"</p> <p>Mal: "How do you find the circumference again?" (48:00) Millie goes on to explain the method. Millie: "2 times pi times r," (48:18) Mal: "I was close!" Mal: "Well, now we have found the radius!" Mal: "Jude, will you add this up for me on the calculator?" In putting in calculator and reading out the answer.(48:50) Millie: "That's fine isn't it?"(49:20) Jude: "Yep" Millie: "Yep, It's just there and Mal is just writing it down for us," (49:50)</p> <p>Mal: "Wahh, what's the point!" Millie: "If you can't finish it, I will just staple it together," Mal: "Hmm, I do not want to do that."</p>	<p>problems.</p> <p>Do they feel isolated when working in a group?</p> <p>Do they lack confidence in their own judgements?</p> <p>Less teacher reliance allows students to gain experience interpreting a task.</p> <p>I am amazed of the variety of learning styles that become apparent in group work. How a variety of strengths can combine in a co-operative environment to be very effective. Mal is driven and competitive but needs support Mathematically. Millie is less driven but very systematic and has a deeper understanding of the underlying Mathematics,</p> <p>Mal really is solely motivated at present. It is not easy to work unsupported in the group when you do not have a strong conceptual understanding.</p>
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<p>Mal says this pointing to a question asking them to find a diagonal distance on the Earth's surface.</p> <p>Millie: "I don't want to do that either, let's staple it, where is it all"</p> <p>Millie: "What is the angular distance mean?"</p> <p>Mal asks Rock and Luke what question they are doing.</p> <p>Mal: "What are you guys up to?"</p> <p>Students commence talking about off the topic discussions.</p> <p>Students are aware that it is still recording.</p> <p>"Yeah, look we did it, quick, take a photo of it"</p> <p>They want to photograph their assignment.</p> <p>Assignments are handed in with the task sheet on the front and the names of all group members on the front.</p>	
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Phase 1: Transcript 3

<p>Before 23/4/2012</p> <p>Students are Amy, Rick, Dan & Ed</p> <p>Students are in groups</p> <p>Teacher explains the problem</p> <p>Informs students that they will be reporting their group findings to the class.</p> <p>Tape starts as soon as the students start working in their group.</p>	<p>Group X: working on Problem Solving in CL Adding the numbers from 1 to 100 finding a general rule for adding the numbers 1 to 10, 1 to 1000 and 1 to 10000.</p>
<p>Direct Quotes, Evidence of Interactions, and the time they occurred within the tape recording.</p>	<p>Interactions and some interpretation of evidence.</p> <p>Commentary from the group interview and teacher journal notes.</p>
<p>Amy: "I am not liking this," (1:38)</p> <p>Amy starts putting in her earphones.</p> <p>Rick: "No, you can't go away! Take that out, Amy, you are not going away"</p> <p>He is referring to Amy putting in earphones to listen to music.</p> <p>Amy: "No, I'm not going away...I think better when.."</p> <p>Rick: "No, take it out!" (1:50)</p> <p>Ed is playing with his pencil case zipper to see the effect on</p>	<p>Anxiety</p> <p>Trying to get team work happening</p>

<p>the tape recording needle. Rick: "Shh," He says to Ed. Rick: "This is not a good day to be recording!" Amy: "Ok guys, be normal please!" Rick: "Ok, now we have to like, find the sum of the numbers from 1 to 10 and figure out the formula," (2:27)</p> <p>Amy: "Ok, I have this thing going on in my head. , I have this thing going on in my head: you have 1 to 10 and you have this as the same number, so how many of those, then you add the amount, like.." Rick: "What was 10? What was 10?" Dan: "Let's just see what it equals first," Ed: "Fine, I'll do it," and gets out his calculator Rick: "No, don't do it on a calculator, we have to go up to 10,000. We have to figure out a formula."(2:39) Ed: "Fuck, oh sorry, I forgot where I was up to and I'm sorry,"(3:04) Ed is sorry he swore on the tape recording. Rick makes estimations. Dan makes estimations. Amy continues to calculate audibly. Ed whispers.. "I'm sorry" into the tape recorder. He is still trying to apologise for swearing. Amy: "Guys, be normal!" Rick: "Says you?" (3;10) Rick: "Ok, 55 plus 5 times 5, maybe that is the formula!! Dan repeats this Rick "Times 5 plus half" Amy: "I have an idea" (3:47) Rick: "Times 5 plus n divided by 2" Amy: "55 times 10" Rick: "55 times 10, 550, you just add a zero" (4:11) Amy: "And then there's...11, 12, 13, 14...." continues counting (5;13) Dan: "I keep stuffing you up, I am really sorry!" Amy keeps calculating. Rick begins being distracted Amy: "Yeah, well that would be 90!" Ed starts talking about a deep social issue external to problem at hand. (5:44) Dan is also involved in this deep discussion. Rick: "I forgot what my formula was!" Dan: "You forgot? We're sorry," They did not sound very genuine here. Rick: "My method did not work!"(6:02)</p>	<p>Anxiety Adopting leader position</p> <p>Shouted</p> <p>Taking opposite strategies rather than discussing them as a group</p> <p>Leader saying No to some methods</p> <p>Losing control of group</p> <p>Working well as a team</p> <p>Building on each other's ideas.</p> <p>Not taking ownership of the roles they adopted</p> <p>Not all students share the understanding of what is being explored</p> <p>A seems to be working fairly consistently.</p> <p>Other students come in and out of focus.</p>
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<p>Dan: "Your method did not work?"</p> <p>Students start singing make up songs.</p> <p>Rick makes statements of equality ...(6:33)</p> <p>Amy: "Oh no, it is not right!"</p> <p>Rick: "So 10 is 55...20 is times 5 plus half of 10..." (7:28)</p> <p>Rick: "Ok this does not work"</p> <p>They are sharing calculations.</p> <p>Rick: "I thought I knew but I don't" (8:23)</p> <p>I say: "Well, adding them all up is not the right way, right?"</p> <p>Rick: "You're sure it is not 5500?"</p> <p>Dan starts inputting again into the calculator.</p> <p>Amy checks her solution with the teacher.</p> <p>I say to Amy: "Well, you are actually right so tell me how you did it,"</p> <p>Discussion between students.</p> <p>Amy: "I am not sure I am right though," (9:12)</p> <p>Dan: "I could have stuffed up,"</p> <p>Amy: "Oh, I know I am wrong!"</p> <p>Rick: "After we got so excited"</p> <p>Ed: "OK, I like Maths!!!"</p> <p>Rick: "I don't know how to do this...(10:02)</p> <p>Rick: "Hey, is it against the rules if I Google it?" (10:14)</p> <p>Rick: "I tried to figure out a formula,"</p> <p>I confirm that this is the right approach: "Well, that is what we need to be doing but there are some helpful methods, like finding out the sum of the numbers between 1 and 10. (10:32)</p> <p>Rick: "I did start by looking at 1 to 10!"</p> <p>I say: "Just look at the numbers, just write them out...,"(10:20)"</p> <p>Amy: "Oh my God I just got it...no I did not!"</p> <p>Me: "Well, I am expecting you to just get it!"</p> <p>Amy: "Nooooo....."</p> <p>Me: "I am expecting you to get it, Amy!" (10:38)</p> <p>Some interchanges.</p> <p>Rick: "Yep, it is all on you Amy!"(11:15)</p> <p>Me: "It is not all on you..."</p> <p>Amy: "Because it goes, 3,4,5,6,7,8 Awwww I just..."(11:40)</p> <p>Amy: "I just thought.. I am so smart!"</p> <p>Dan: "Don't get really angry, Amy"</p> <p>Amy: "No, you see I am really tired!"</p> <p>Amy: "But, look it goes 3, 4, 5, 6, 7, 8, 9, 10... OMG I am a</p>	<p>It is 5050</p> <p>Deep focus Mutterings No sharing.</p> <p>Most students are very invested in the problem</p> <p>Amy is very close.</p> <p>I am helping Amy.</p> <p>Good to ask for assistance if you get really frustrated</p> <p>Encouragement</p> <p>Clues</p>
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<p>genius!!!” (14:07) Students not at all on task but think they are incredibly smart and clever. (15:21) Amy: “Ok, so if you kill me, you will have to present.” (16:41) Dan: “Well, what have we done?” Amy: “Nothing.” Dan, “Exactly!” Amy: “Here it is...”(16:53) 5 more minutes before presentations.</p> <p>Amy: “OMG, Lois is singing,” She is obviously listening to her IPod. (17:55) Ed: “Here is a dislike button for One Direction.” Rick: “What does it go up in, what is the formula?” Rick calls the teacher in a disrespectful manner. Amy talks about which band member she likes the best. Rick: “11 times 71 is something...” (19:57) I ask each group to be ready to present their material to the class. Group X is not ready to present any meaningful material.</p>	<p>Structuring</p> <p>Off task discussion</p> <p>Totally off task</p> <p>Interactions are probably an attempt for the group members to save face confronted by the situation that they could achieve very little progress with the problem.</p>
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QUALITATIVE DATA COLLECTED IN PHASE 2

The data collected in Phase 2 includes my interpretive commentary, relevant excerpts from the interview with group members, dated unsolicited quotes from the participants which they made regarding their research experiences. The research methodology is best described as Classic Grouped Theory (CGT) detailed by Carol Roderick in the Grounded Theory Review Methodology Reader (2009).

Phase 2: Transcript 1

<p>Phase 2 (After) 3/5/2012</p> <p>Students are Rick and Amy from Group X, and Mal, Millie and Jude from Group Y. Also Joe from Group Z.</p> <p>Tape starts immediately after the problem has</p>	<p>Group X then Group Y Problem solving of the task “Jumping Kangaroos” where students are asked to find a pattern in the numbers of jumps, slides and total moves.</p>
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<p>demonstration.</p> <p>Jude: “But then there’s two!”</p> <p>Mal: “It does not matter”</p> <p>Millie: “It does not matter, you can slide it back!”</p> <p>Mal: “There you are,”</p> <p>Millie: “You just have to count how many jumps we do”</p> <p>Jude: “But I thought we weren’t allowed to slide back” (This is correct)</p> <p>Amy bumped Millie,</p> <p>Amy: “I can’t get out, I’m so sorry”</p> <p>Millie laughs quite nervously, “Oh, that’s okay,”</p> <p>Mal: “I want to get better than last time!”</p> <p>Amy starts singing noisily into the microphone</p> <p>Amy: “Eeewwww... etc , hey hey hey...” (1:44)</p> <p>At this point in time, Amy begins to pay more attention to what is going on in Group Y and concentrate on the jumps and slides that Mal and Millie are working through (3:14)</p> <p>Mal: “Everything looks different,”</p> <p>Millie: “Start again?”</p> <p>Mal: “Ok , you go..”</p> <p>Mal looks at Amy.</p> <p>Jude: “Are we doing this together?” Jude is discussing the presence of Amy in group y.</p> <p>Mal: “I think so...” (3:29)</p> <p>Amy: “No offense, but I think you guys know more about what is going on,”</p> <p>Mal: “Ok, I think we do too”</p> <p>Jude: “I struggle”</p> <p>She is talking about recording the moves.</p> <p>Amy: “So what do you want me to do? Record it on here, so what? Slide. Record one?”</p> <p>Jude: “Yep”</p> <p>Amy seems to be recording more effectively than Jude and repeats each jump and slide verdict as she records it. She reaffirms decisions with occasional Yeps! (4:00)</p> <p>Mal: “Jump, slide, jump slide...oh shit start again”</p>	<p>Group x and y are close to each other in the classroom.</p> <p>Mal is talking about her group’s progress with problem solving.</p> <p>Amy has decided to replace Rae in Group Y. This is an unusual combination but they are working very constructively. So I let them do this.</p> <p>The leader role needs more clarity in this group</p> <p>Positive feed back</p>
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<p>supportive tone.</p> <p>Mal: “How can they all be lower than 16?”</p> <p>Amy: “Oopsies” (6:30)</p> <p>Millie: “This one is bad,”</p> <p>Millie: “That was terrible! It was our worst [solution]!”</p> <p>Millie: “I never know whether to ... jump, jump slide.. etc or ...”</p> <p>Mal: “I am so Pro!”(8:29)</p> <p>Jude: “How did you do that and how many jumps did that take you?”</p> <p>Discussion about working at McDonalds’ . This last a few minutes and involves a student from another group. (11:28)</p> <p>Students start playing with the recorder needle. A student starts making noises into the recorder. Mal asks to go to the toilet. Students complain they are hungry. (15:00)</p> <p>Millie: “I do not know the rule yet,”</p> <p>Teacher distributes a reflection sheet about the group activity. This can be discussed in the group but students are asked to fill it in individually.</p> <p>Mal: “Which ones do we circle?”</p> <p>Millie: “Any ones that you think.” (16:43)</p> <p>Thinking</p> <p>Millie: “Umm sharing ideas?”</p> <p>Jude: “We don’t always try new methods, though, do we?”</p> <p>Enter another teacher.</p> <p>Millie: “Mr Kent!”</p> <p>Amy: “Aw, he’s so cute!”</p> <p>Amy: “Hey Mr Kent!” (17:28)</p> <p>Non interaction time.</p> <p>Off task discussion about being fat.</p>	<p>This is a positive comment from Mal.</p> <p>While group y has been very self reliant in this problem solving session, they did not fully understand this problem and would have benefitted from some assistance. Millie has realised that they have not found any relationships in their results.</p> <p>Mr Kent is the Year Level Co-ordinator He is distributing permission slips for the year level city camp.</p> <p>Again, Jude is trying to obtain some discussion and consensus.</p>
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<p>Other groups are clearly still working.</p> <p>Mal returns and asks for a sheet to fill in.</p> <p>Jude: “We have to discuss this as well to see if everyone’s goals are the same. (21:42) Students appear to have stopped working in this group. (22:14) Equipment is returned and sheets submitted.</p> <p>Teacher explains about the group goals. If they are similar to your personal goals then the better a group will work as a team. (30:00)</p> <p>The 2nd part of the lesson is used for curriculum material. Navigation. Bearings</p> <p>Students are asked to draw a compass rose and students find this a bewildering request.</p> <p>Discussion of conventional bearings and True bearings.</p>	<p><u>Teacher notes on this lesson:</u></p> <p><i>Two students appear to be dissatisfied with their groups. Rae has left group y and has moved to a group with 3 boys (Group V). It is possible she feels more included in this group. I have noticed that she needs to feel that she can ask for large amounts of scaffolding. She told me she did not feel “smart enough” to work with group Y. This may be so, however, group Y also is quite achievement oriented which may not have matched Rae’s learning goals.</i></p> <p><i>Amy is also restless in her group. In our group interview Amy stated in the Group Interview on 6/6/2012 that:</i></p> <p><i>“[While] there were times that we got along, but mostly...well Rick and me...Rick and I have personality differences. We worked well, but I do not like us as a group. I don’t mind working in groups but I find it easier to work by myself the majority of the time because I get distracted easily. But it is a nice change to work in a group because you do not have to work all of the time. It is more spaced out, but you still work.”</i></p> <p><i>Teacher: Mal, did you notice any difference before and after when I explained group dynamics to you?</i></p> <p><i>Mal: We worked good, but we did get distracted. Before and after were the same for me.</i></p> <p><i>Millie: I did get a bit distracted before.</i></p> <p><i>Julie: I like working by myself and in a group, but I think working in a group helped me.</i></p>
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The following data was collected in the first lesson of the 2 lessons allocated to the assignment on Circular Functions.

Phase 2: Transcript 2

<p>After 7/5/2012 Students are Ellen, Millie and Jude A number of students were absent so this group formed.</p>	<p>Group y Assignment 2 : Drawing Periodic Functions</p>
<p>Direct Quotes, Evidence of Interactions, and the time they occurred within the tape recording.</p>	<p>Interactions and some interpretation of evidence</p>
<p>Teacher starts the session by reminding students to be aware of their roles. (0:18) The teacher the role of the leader to the students. (0:39)</p> <p>Ellen: “How is that 0.7?” (1:54) Millie: “Ok lets go back,” Laughter Lucy: “Oh I had it on the wrong one!” (2:12) Ellen: “135 degrees” Millie: “0.86, there are a lot of the same values,” Ellen: “180” Millie: “Errr...” Ellen: “That would be just zero, wouldn’t it?” Lucy: “Yep” Ellen: “So wait, Cos 180” Millie: “Minus one,” Ellen: “How does that work?” Jude: “Not sure,” Ellen: “Oh I get it because there is nothing going up and down but there is minus one across,” Millie: “Yup,” Ellen and Lucy together: “210” Jude: “Oh” (3:36) Ellen: “So that is x?” Millie: “Yes that is the first one so that is x” Ellen: “So that’s, 0.89? ” Millie: “Minus” Jude: “So, its, what? Cos 210?” Millie: “Yup” Ellen: “0.88? 0.89”</p>	<p>Leaders are established. Ellen is leading this group.</p> <p>Two students are using some Mathematics equipment called a Trigmaster to find the decimal sine and cosine ratios of different angles at the centre of a unit circle.</p> <p>Jude is recording.</p> <p>Students are really scaffolding each other.</p> <p>Students are affirming each other’s progress.</p> <p>Correcting and reinforcing</p>

<p>Millie: "Yup, minus" Ellen: "Oh no, minus 0.86! Or 87 actually!" Jude: "So we are pretty close!" (4:04) Millie: "Yep, we are doing alright! Our guessing is just a little bit off" Jude: "Was that 210?" Millie: "Yep, 210" Ellen: "0.5,0.6" Thinking Millie: "Yep" (4:20) Millie: "Right, 225" she shows Jude. Millie: "So that one, Minus 0.7" Jude: "Yep" Millie moves the needle of the Trigmaster to 225 degrees and Ellie is reading of the ratio. Jude is recording the value on the tables. Jude: "Cos 225 equals..." Millie: "Yep" Jude: "Minus 0.7" (4:40) Ellen: "Sin 225 equals minus 0.7, yes" Jude: "Yeah" Jude: "What is it? 225." Millie: "Yep minus 0.7 yep" Millie: "Umm.... 240?" (5:00) Ellen: "Minus 0.5" Jude: "Yup" Millie "5 and .we will do that in a moment." Ellen: "Minus 0.5 0.4 and .we will do that in a minute.." Millie: "Minus 0.5 and 0.525..." Millie: "Minus 0.5 and minus 0.85..." Ellen: "So minus 0.86" Jude: "- 0.86?" (5:16) Jude: "So Sin 240 equals..minus 0.86" Millie: "Yes" Ellen: "270!" Millie: "Where is 270?...Oh yeah" (5:30) Ellen: "That would be there" Millie: "Positive 1 you reckon?" Ellen: "No it would be minus 1" Jude: "No, it would be minus 1" Jude must be looking at the patterns in the data. Ellen: "Sin 270 is Minus 1 and Cos 270 is Zero!" (5:45) Ellen: "Far out!"</p>	<p>reinforcing</p> <p>These students are intensely involved in their learning</p> <p>The functioning of this group is very seamless. They function so well in their roles. They do not need to overtly state any social norms because they are collaborating so well. This is an assignment and although it is quite challenging they are able to support each other with no questions for the teacher.</p> <p>Excellent focus and self reliance.</p>
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<p>Ellen: "I do not get how that works though..."</p> <p>Millie: "No I do not get the full line.."</p> <p>Ellen: "And then so....zero? Minus one, minus one?"</p> <p>Millie: "Try Zero, try Zero" (5:05)</p> <p>Ellen: "It is minus 1!"</p> <p>Millie: "How did we get that wrong?"</p> <p>Jude: "Let's try 300"</p> <p>Millie: "OK"</p> <p>Ellen: "So it is 5 so it is 0.5?"</p> <p>Millie: "Yep"</p> <p>Ellen: "Cos 300 is 0.5"</p> <p>Millie: "And y is... like 0.8??" (5:18)</p> <p>Millie: "Minus 0.86"</p> <p>Ellen: "Minus zero point eight eight"</p> <p>Jude: "So Sin 300 is minus .87 (5:30)</p> <p>Millie: "So 7?"</p> <p>Ellen: "Yep"</p> <p>Millie: "And minus 7"</p> <p>Jude: "Yup"</p> <p>Ellen: "0.7 and minus 0.7?"</p> <p>Millie: "Yep"</p> <p>Jude: "So cos 315 equals 0.7 and sin is -0.7" (7:00)</p> <p>Ellen: "Right 330"</p> <p>Millie: "Is that tan?"</p> <p>Ellen: "No that is right, there,"</p> <p>Millie: "My eyes are going all weird now,"</p> <p>Ellen: "Yep, so.0.86, I reckon, yep it is 0.86."</p> <p>Jude: "Cos 330 equals 0.86?"</p> <p>Ellen: "Oh if you round it 0.87"</p> <p>Millie: "And then, sin is -0.5"</p> <p>Ellie: "Yup -0.5" (7:50)</p> <p>Jude mutters as she writes this down.</p> <p>Ellen: "Last one!"</p> <p>Millie: "Where is it? Oh!"</p> <p>Ellen: "So zero,"</p> <p>Millie: "Let's go with zero, no its 1! So sin lets guess zero! It will be zero, I bet you!" (8:10)</p> <p>Ellen: "Nup, I'm guessing zero!"</p> <p>Millie: "Zero, yep!" Laughs.</p> <p>Millie: "Right we have done all that"</p> <p>Ellen: "We have finished and the bell is going to go in .."</p> <p>Millie: "Right, we will continue this tomorrow"</p> <p>Ellen: "Yep Maths tomorrow." (8:30)</p>	<p><u>Teacher's notes from the lesson 7/5/12</u></p> <p><i>For certain tasks, particularly the assignment, I have found that students vote with their feet and tend to seek out like-minded students to work with.(students with congruent goals). Sometimes they form a sub-team within a group. This seems to be in response to an issue that they do not wish to discuss in the group. The climate for conversation in most groups is not developed enough to have them discuss issues and seek a resolution. Structuring a resolution process of these issues could be the focus of further studies. My observations are that team members who feel left out of the process and team decision making move away from each other. I have also noticed that students learning in teams need scaffolding to make progress with group learning skills, for example in goal setting. I provided a purposeful conversational space to discuss 'Goal Setting' and the impact it had on group functioning. This is the "After" stage so the students know that I am trying to develop their CL skills so this provides me with a platform to focus on a particular feature of CL groups. It would be hard to do this in a general classroom without observing CL groups closely and making an informed decision about what adjustments would be beneficial. Effective team management is complex and multifaceted. Structure is essential if students are to feel autonomy and connected to the</i></p>
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	<p><i>group. I am observing that roles and social norms = structure.</i></p> <p><u>Notes from the group interview 6/6/2012</u></p> <p><i>Teacher: Would you like to see me incorporating group work into the lessons I do with you in the future?</i></p> <p><i>Ellen: I liked group work. I work well by myself too, but I feel more at ease in a group. It is more motivating.</i></p> <p><i>Rick spoke to me on 1/8/12</i></p> <p><i>Rick: It actually helps me to understand when I explain things to someone else.</i></p>
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QUALITATIVE DATA COLLECTED IN PHASE 3

The data collected in Phase 3 included a response to the short inspirational presentation on shared group goals which was sought to repair areas which required some adjustment in the opinion of the teacher/researcher. The following collection of data contains a sample of Phase 3 interactions, relevant excerpts from the group interview and dated unsolicited quotes from the participants which they made regarding their research experiences. This research methodology is best described as Classic Grouped Theory (CGT) detailed by Carol Roderick in the Grounded Theory Review Methodology Reader (2009).

<p>Phase 3 (After) 30/5/2012</p> <p>Students are Harrison, Brian and Jeff : Group W</p> <p>A students was absent so this group formed, (Diego).</p> <p>Also represented are Rick and Amy: (Group X) and Millie and Mal (Group Y)</p>	<p>Problem Solving : Counting the squares in an 8 X 8 chess board</p>
<p>Direct Quotes, Evidence of Interactions, and the time they occurred within the tape recording.</p>	<p>Interactions and interpretive commentary. Excerpts from the group interview and some dated unsolicited comments made from participants during the research period.</p>
<p>One member of this group is absent: (Diego)</p> <p>Harrison and Brian are laughing and making sound effects to stop my tape recording.</p>	

<p>Harrison makes motor bike noises. Harrison: "Look it is a speedometer," (1:30) Rick to Harrison "Shut up!" Jeff: "Quiet. Who does that? So Immature!" He imitates Harrison Harrison: "It is recording you too!" Harrison is not bothered by being mocked. Rick makes a kind of monkey noise. Harrison: "And they have to save this for five years" Harrison continues to giggle.</p> <p>Jeff: "Ok, Let's start shall we?"(2:04)</p> <p>Jeff: "Ok, that's 64, ja?" He points to the table which asks for the number of 1 X 1 squares on a chess board.</p> <p>Jeff to Brian: "Ok you're working on this. You are scribing." Brian, "Ok, 64. The start one was 64? Then there is like..." (2:20) Jeff: "The next biggest square is a 2 X 2." Brian: "With 4?" Jeff: "Yes that's the next biggest square with 4 squares in it," (2:33) Brian: "So there is 4 times 4. What is 4 x 4?," Jeff: "That's 16," (2:40) Harrison: "Why don't we look it up?" He means on the internet. Jeff ignores this comment because he thinking about the problem solving task. Jeff: "Yes, let's put 16, cos, see just look there is 1,2,3,4. So 4 times 4 is 16," (2:50) Brian: "Oh yes, yes" Jeff: "And the next bit is about 3 X 3 squares so that is..1,2..." Harrison makes a few noises into the microphone then starts making car noises again. Jeff: "Shut up, it is not a blooming motorbike!" (3:10) Harrison continues to giggle. Jeff appears frustrated. Jeff: "You know I am not a scientist!" Harrison: " I will try to do it" (3:20) Jeff: "Well I am not a scientist!"</p>	<p>Jeff is the leader</p> <p>Jeff is trying to control Harrison</p> <p>Jeff is taking control of the group and getting then down to work.</p> <p>Jeff is allocating the role of recorder.</p> <p>There is evidence of role clarity here. The students know how to start, what structures need to be put into place. They know what they should be doing and are willing to stick to it.</p> <p>The roles, social norms and learning cycle do give students a framework.</p> <p>Jeff is explaining He is not correct but that will become apparent later. He is adopting the role.</p> <p>Jeff is trying to keep Harrison on task. I can see that Jeff is becoming frustrated with Harrison's off task behaviour. After discussing this with Jeff later, he said he did not want to be group leader and swapped.</p> <p><i>Member Check (13/2/2013)</i> <i>"I was frustrated and just didn't want to deal</i></p>
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<p>Silence while they are trying to work out how many 3 X 3 squares are in a chess board. Students are calculating quietly but audibly. Teacher: “Who is the leader of your group?”(3:50) Harrison: “Brian” Brian: “Yep, we all started, then Harry did this and then I did this,” (3:59) Harrison giggles. Teacher: “ I want a collaborative group not just two people working together” Harrison makes motor bike noises enthusiastically. Brian: “Harrison, stop pretending to be a motorbike” (4:08) Harrison: “I am trying figure out how..” Brian: “How?” Harrison: “What? Counting..” laughing (4:27) Harrison: “It is actually working quite well, I think..” Silence in the group for a while. Harrison: “Well so far what I have done is. There is 64 and we all know that. Then the one around there is 65. So now I am trying figure out how you can add 4 squares,” (4:50) Silence in the group.</p>	<p><i>with Harrison, I wanted to concentrate on the problem. Brian did not want to be leader at first, but I talked him into it. So I stopped being the leader,”</i></p> <p>Harrison does not even know who the group leader is.</p> <p>Students understand the language of roles and the role descriptions.</p> <p>I clearly need to give clearer role descriptions to the students. Now Brian is taking the leadership role.</p> <p>I realize now that this group is probably stumped at this point.</p> <p>I am starting to think that silence actually means nothing is happening.</p> <p>I think the tape recorder has been pushed to face another group.</p> <p>Group w is quite tolerant of each other and therefore all members probably feel included. They are making progress with the chess board problem and are sticking to their roles descriptions.</p> <p>There is less teacher dependency, students are making a lot more decisions for themselves and managing their own off task behaviour.</p> <p>There does not appear to be any anxious behaviour.</p>
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<p>Millie's group is very close to Amy and Rick's group. (5:30) Teacher to Millie, "So you are saying..the number of 8 X 8 squares is..? So how many 8 X 8 squares are there? Millie: "We are not up to it," Rick answers: "There's 1," Teacher: "So there is 1, how many 7 X 7 squares can you fit in there, in different position, yes?" Mal: "Is this right?" She is talking about her method. Teacher: "Yes, it is very very easy when you get it" Mal," Wow that's ...very, very.. I love it!" (6:03) Millie: "Wow, yup it is just like that," Teacher: "There is actually a very clear pattern,"</p> <p>Amy: "I know the pattern. I know the pattern!" (6:13)</p> <p>Ellen: "Is that 7? Is that right?" Teacher: "Err, no, that one is not right," Teacher goes on to explain it to Ellen. Teacher: "How are you going, girls?" To Mal, Millie and Jude. (6:37)</p> <p>Harrison starts talking loudly into the microphone. Harrison: "I have been since I was in year 5.." Harrison: "and I still am!" (6:41) Jeff: "What are you?" Harrison: "Annoying" and laughs</p> <p>Jeff: " I've done the most work here!" He sounds exasperated. Harrison: "I love talking to this thing! How many dots does it have on the mic?"(6:51)</p> <p>Jeff has been concentrating quite had on the project. Brian is observing and following what Jeff is</p>	<p>Most groups are making very positive progress with the problem and are interested and involved in the problem solving process.</p> <p>Harrison appears to be annoying Jeff at this stage. Jeff is quite a reasonable person and hard working. It is likely that he would not understand Harrison's behaviour and not be able to manage it.</p>
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<p>doing.</p> <p>Brian: “You might as well add one [to the table of results] as well, because it is a square as well. The whole thing is a square”</p> <p>Jeff is writing things down. (7:15)</p> <p>Harrison: “We should try to explain what we are doing to the microphone. We are trying to figure out more ways of finding squares on a chessboard, at the moment we have found 82,” (7:34)</p> <p>Teacher: “ So how are you progressing?”</p> <p>Brian: “Not that great,”</p> <p>Jeff: “We have done a lot of work,”</p> <p>Teacher: “So how many 8 X 8 squares are there?” (7:48)</p> <p>Jeff makes an inaudible answer.</p> <p>Brian: “7”</p> <p>May be he did not answer the question he was asked, but what he thought I would ask.</p> <p>Teacher: “ Er, one,”</p> <p>Teacher: How many 1 X 1 squares are there?”</p> <p>Brian: “64,”</p> <p>Teacher: “Yes 64. How many 7 X 7? 6 X 6, 5 X 5, 4 X 4” (8:03)</p> <p>Jeff: “Aw yeah”</p> <p>Teacher: “Did you work it out?”</p> <p>Jeff: “They are squares!” (8:12)</p> <p>Harrison: “ That’s what Brian said before,”</p> <p>Teacher: “ He was right,”</p> <p>Jeff: “ I was right! Yes!”</p> <p>Brian: “I was trying to do it like that!”</p> <p>Harrison: “That’s why we picked Brian as our leader,” (8:17)</p> <p>Harrison laughs: “Because he was a genius!”</p> <p>Teacher: “So there will be the same number of squares across as down,”</p> <p>Brian: “Yes, see I drew them,”</p> <p>Brian: “There is a 2 X 2, so that is one there,” (8:32)</p> <p>Teacher: “Yes, that is 1, and there is another one, how many more? You count them,”</p> <p>Brian: “1, 2, 3..” (8:42)</p> <p>Jeff: “4, 5, 6, 7!”</p>	<p>This is very positive and affirming</p> <p>They have not quite nailed the problem though.</p> <p>I can tell that Brian and Jeff are able to see how the number of squares fit across the length and width of the chess board.</p> <p>Understanding</p> <p>The learning cycle is in evidence.</p> <p>I think was a timely explanation of the problem solving process in the context of the problem which was very powerful because was meaningful to the students.</p> <p>There is a development in group processes here.</p> <p>You can see that there is evidence of progress</p>
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<p>Brian: "7"</p> <p>Teacher: "So how many do you think there will be down here?"</p> <p>Jeff,"7"</p> <p>Teacher: "Yes, so seven sevens are..." (8:51)</p> <p>Brian: "49"</p> <p>Brian began recording in the wrong place.</p> <p>Teacher: "But that's 2 X 2 though,"</p> <p>Brian: "So 2 X 2, that's 49," (8:58)</p> <p>Teacher: "Remember, now you check your theory. The thing is you need to experiment, you need to discuss, you need to develop an idea; which you are doing, and now you test it!"</p> <p>Brian: "Yes"</p> <p>Teacher: "You have made an estimation, now you check it. You just check one more, and if it works out, well, you know you have got it!" (9:15)</p> <p>Harrison: "So If we figure it out, how do we know it is right?"</p> <p>Teacher: "Because you will know if the next one is correct. You have just shown me the exact problem solving process. You have made a generalisation, I just heard you," (9:34)</p> <p>Harrison: " But it may look like it is correct, but it may not be unless we know the actual answer,"</p> <p>I think he wants to be able to look up the answers. However, he just does not listen to and understand what is going on around him.</p> <p>Teacher: "You should feel pretty safe, here, because I told you that is not hard, and your results confirm it,"</p> <p>Brian: "We know what to do,"</p> <p>Teacher: "That's right, you know the process, you are going to quite good problem solvers by the time I finish with you this year." (9:58)</p> <p>Jeff: "How do you know?"</p> <p>Teacher: "Because I have given this as a School Based Assessment in year 11 Mathematical Methods," (10:17)</p> <p>Harrison: "Brian is a genius"(10:27)</p> <p>There is quiet in this group now. Other groups are quite vocal as they express what tends their data is showing.</p> <p>Harrison decides he would like to be a</p>	<p>Unfortunately, not all students can probably understand what is going on here.</p> <p>Jeff told me later that he felt very proud of his efforts in this problem solving task.</p> <p>These overt complements of Brian deliberately exclude Jeff, who probably did most of the work. <i>Member Check (13/02/2013)</i></p> <p><i>"Harrison was smiling when he said this. It was a joke,"</i></p> <p>Harrison is completely out of his depth with this level of work.</p>
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<p>motorbike again. Jeff tries to stop him. Harrison: "But I like being a motorbike!"(10:46) Brian: "Stop being a motorbike!" (11:09) Brian: "Is 6 X 6 ...so 3 X 3 is 9.. so now we just add them together?" (11:48) Brian: "So get a calculator, is Harrison going to do it in his head? Motorbike man," (12:12) Harrison: " 146" Brian: "172" Jeff: " It's 210"(12:36) Harrison: "Every time I play chess, I'm going to be, I wonder how many squares are on this board? 210!" (12:46) Teacher: " Ok, time is nearly up" Jeff: "204, You got it wrong" Teacher asks students to fill in the reflection sheet. Brian;" Well I thought Harrison did a lot. Yes Motorbike man!" (13:00) Jeff: "Yeah, Harrison you did not do anything" Harrison: "I did some too!" Brian: "Hey Group w; Your group commitment to the project? 1, definitely 1" (13: 28) Jeff starts singing Here we go marching one by one. Brian: "Jeff, stop singing!" Harrison: "Level of membership your group felt" Jeff: "I felt like a member because I did it all!" Brian: "Excuse me, I got the message, you just used it!" (14:07) They start fiddling with the camera. Harrison starts making motor bike noises," Brian: "Do not copy Millie, you are such a cheater!" Millie," Oh yeah!" Mal: "Who is in your group Brian?" (15:27) Brian answers. Teacher asks for the after reflection sheets to be filled in..</p>	<p>$1+4+9+16+25+36+49+64=204$</p> <p>Harrison wanted to be part of the group, not a necessarily a contributing part, but he was able to see how things were done.</p> <p>The reflection sheets probably provide a conversation space, they also identify the features of group function which are valued by the teacher researcher so this reinforce positive group behaviours, but I do not think they provide an useful data</p>
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	<p><i>From the group interview 6/6/2012</i></p> <p><i>Tchr: What did you think Jeff?</i></p> <p><i>Jeff: Working in a group had it's ups and downs.</i></p> <p><i>Tchr: What were the ups?</i></p> <p><i>Jeff: It was good working with smart people. Working with smart people is very inspirational.</i></p> <p><i>Tchr: What were the downs?</i></p> <p><i>Jeff: Having to be the leader.</i></p> <p><i>Tchr: Did you notice any differences before and after I explained group dynamics to you?</i></p> <p><i>Jeff: Before it wasn't easy to work in a group, but once you explained it, it was much easier.</i></p> <p><i>Tchr: What do you think Brian?</i></p> <p><i>Brian: I wasn't aware of working in groups before, but now I understand group work.</i></p> <p><i>Tchr: Is there anything more you would like to add?</i></p> <p><i>Brian: It is better to work in groups because you get more help when you cannot get the teacher. You get sick of waiting for the teacher. I got more help. I like working in groups more than working by myself.</i></p> <p><i>Tchr: What do you think Harrison?</i></p> <p><i>Harrison: I like working in a group. I like it that everyone puts into it. It makes it easier to work it out. It is a better way of doing stuff.</i></p>
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APPENDIX 4: GROUP DISCUSSION

Group Discussion Transcript 6/6/2012 My questions will be in italic	Member Check 8/6/2012
<p><i>Teacher: What differences did you notice to how your group worked before and after I introduced group learning skills?</i></p> <p>Ed: I got more help when I was working in a team. I think it was most helpful when working on assignments.</p> <p>Brian: I got more help but I also got distracted.</p> <p><i>What did you think Jeff?</i></p> <p>Jeff: It had its ups and downs <i>What were the ups?</i></p> <p>Jeff: It was good working with smart people because they were inspirational.</p> <p><i>What were the downs?</i></p> <p>Jeff: Having to be the leader.</p> <p>Lee you came into the group when it was already established, What is your opinion of working in a group?</p> <p>Lee: I thought it was alright, because people have different styles of learning. So like, if you get someone who can work things out really fast in one area but might be slow in another area, so people who might be opposite in how they learn can actually help each other. Because I had missed some lessons, it was pretty good having some people who had actually done some of the stuff. It helped me learn.</p> <p><i>What do you think, Harrison?</i></p>	<p>Brian: Before this, I wasn't aware of working in groups, now I understand it.</p> <p>Jeff: Before group skills were introduced it wasn't easy to work in a group, but after it was explained, it was much easier.</p>

<p>Harrison: I agree with what Lee said. I like working in a group. I like that everyone puts into it. It makes it easier to work things out. It is a better way of doing stuff.</p> <p><i>Would you like to see me incorporating group work into the lessons in the future?</i></p> <p>Ellen: I liked doing group work.</p> <p>Rick: Group work is good when you are practicing for tests. Millie: When you work in a group, you just talk.</p> <p>Rock: I think it is good to do some group work, when you start a topic but then break up and do it by yourself.</p> <p>Ellen: I liked it because if someone is stuck with something, the teacher does not always have time to help.</p> <p>Millie: Yep, that happens to me!</p> <p>Luke: It is good to have a balance.</p> <p>Jude: I like both group work and individual work.</p> <p>Dan: Ummm, I think maybe before tests it is best.</p> <p>Brian: I like working in groups more than working by myself.</p> <p><i>What do you think Amy?</i></p> <p>Amy: Well, our group was very special. There were times when we got along, but mostly... well Rick and me....We worked well as a group but I do not like us as a group. I like you as people, but not as a group. (Dan looks horrified)</p> <p>Amy: I love you, Dan, don't worry! And Ed and I are besties! But Rick and I have personality differences; we have a mutual understanding of</p>	<p>Ellen: I work well by myself, but I feel more at ease in a group. It is more motivating.</p> <p>Luke: Our group worked in two parts: Joe and I worked and Ellen and Rock talked.</p> <p>Jude: I think that working in groups helped.</p> <p>Dan: I think that groups help other students a lot more, especially before tests.</p> <p>Amy: I don't mind working in groups, but I find it easier to work by myself for the majority of the time because I get distracted easily. But it is nice to work in groups for a change.</p> <p>Diego: I do not like working in groups. It is bad for education! It interrupts! I believe self paced is better.</p>
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<p>each other.</p> <p>Rick: Whaaat! I don't hate you!</p> <p>Amy: I said we have a mutual understanding.</p> <p>Rick: Alright, whatever you want to call it.</p> <p><i>Is there anything you want to add?</i></p> <p>Amy: Working in groups is better because you don't have to work all the time, it is more paced out, but you still work.</p> <p>Brian: It is better because you get more help when you can't get the teacher. You do get sick of waiting for the teacher.</p>	<p>Ray: In a group I learn how to do things, but then I like to do the questions on my own.</p> <p>Rick: It actually helps me to understand when I explain things to someone else.</p> <p>Joe: Our group did not work very well because Ellen is very distracting and Rock is pretty dopey.</p> <p>Mal: We worked well in a group but we did get distracted.</p> <p>Rock: Our group worked well, but I think I still work better alone.</p>
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