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This thesis is presented for the degree of Doctor of Philosophy at Murdoch University, Western Australia, 2004
DECLARATION

I declare that this thesis is my own account of my research and contains as its main content work, which has not previously been submitted for a degree at any tertiary institution.

Chan Su Hoon
This PhD thesis is concerned with the social psychology of cooperative learning and its effects in cognitive and social-emotional domains. It comprises two main studies and two exploratory studies undertaken during two 10-day, 16-hour learning intervention programmes for Maths Word Problem-Solving (MWPS), respectively for 285 and 451 Grade-5 students in Singapore.

Study 1 used a quasi-experimental design to investigate the outcomes of task-structures in an Individual Learning condition and three dyadic Cooperative Learning conditions that varied in the key elements: positive interdependence, individual accountability and group goals. The results indicated that a Cooperative Learning condition with a high level of positive interdependence in combination with a low level of individual accountability resulted in significantly lower MWPS academic achievement and peer–self-concept outcomes than the other conditions; whereas the other Cooperative conditions with lower levels of positive interdependence did not differ significantly from the Individual Learning condition in MWPS academic outcomes but produced better peer–self-concept outcomes. The discussion theorises how task-structured positive interdependence in cooperative conditions can potentially be so rigid that it limits individual control in overcoming a dyadic partner’s error. In turn, this increases the likelihood that members of dyads would “sink together” (rather than “swim together”) –which appears to produce relatively worse MWPS academic outcomes as well as being detrimental to peer–self-concept outcomes. Therefore, optimal cooperative learning conditions for mathematics should allow interaction amongst student partners but not preclude individual control over any stage of the learning task.
Study 2 comprised three interrelated investigations of the effects of rewarding learning behaviours and the effects of ability-structures on Individual, Equals (homogeneous) and Mixed (heterogeneous) dyads. All children were eligible to be rewarded for their own MWPS academic mastery achievements, but comparison groups in each of the ability-structures were either eligible or not eligible to be rewarded for displaying target learning behaviours (LB-Rewards or No-LB-Rewards). The academic programme was based on Polya’s problem-solving strategies of understanding the problem, devising a plan, carrying out the plan, and checking the results. Children in all learning conditions were instructed to use these problem-solving strategies and, according to their differently assigned learning conditions, to use learning behaviours (LB’s) either ‘for helping oneself’ in Individual conditions or ‘helping one’s partner’ in Equals and Mixed conditions. In “LB-Rewards” conditions, teachers rewarded the children’s displays of the assigned behaviours for learning alone or learning together, whereas in “LB-No-Rewards” conditions they did not.

The investigation in Study 2a encompassed the same dependent variables as Study 1. The results indicated that for maths (MWPS), Learning Behaviour rewards were detrimental to Individual Learning conditions with significantly lower MWPS gains when the rewards were used compared to when they were not, whereas the opposite pattern was found for Equals where the effects of Learning Behaviour significantly enhanced MWPS outcomes. For peer–self-concept, effects varied across the Cooperative conditions’ Learning Behaviour rewards conditions. An exploratory analysis of High-, Low- and Medium-ability revealed patterns of the inter-relationships between ability-structures and effects of rewarding.

Study 2b is exploratory and involved traversing the traditional theoretical dichotomy of individual vs social learning, to develop a measure combining them both in ‘self-efficacy for learning maths together and learning maths alone’. The effects of
the various experimental conditions on factors in this measure were explored, allowing detailed insight into the complex, multi-dimensional and dynamic inter-relationships amongst all the variables. The findings have been developed into a theory of Incentive-values–Exchange in Individual- and Cooperative-learning, arguing that there are four main cooperative learning dimensions – “individual cognitive endeavour”, “companionate positive influence”, “individualistic attitudes development” and “social-emotional endeavour”. The argument is that students’ motivation to learn cooperatively is the product of perceived equalization of reward-outcomes in relation to each dyadic member’s contributions to learning-goals on these dimensions. Hence, motivation varies across ability-structures and reward-structures in a complex manner. A further proposition of the theory is that social-emotional tendencies and biases form a dynamic system that tends to maintain dyadic partners’ achievement levels relative to their ability-positioning.

Study 2c is exploratory and extends Study 2b by illustrating its Incentive-values–Exchange theory. Samples of children’s written descriptive reflections of their experiences in cooperative dyads are provided to illustrate the point made about the children’s relationships and effects on each other for each of the factors on the individual- and cooperative-learning scales. As such, this section of the thesis offers a parsimonious explanation of cooperative learning and the effects of various learning conditions on the integrated cognitive, social and emotional domains.

Practical implications in light of the study’s findings of optimal conditions include the possibility of practitioners more closely tailoring cooperative learning conditions to meet the academic or social-emotional needs of learners at specific ability levels. Future directions for research include testing some of the learning dimensions and proposed theoretical configurations for them using controls identified by the statistical analyses together with qualitative observations, and further developing new
methodologies for investigating the social-psychological causes and consequences of learning motivation.
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LIST OF ACRONYMS

CTEHP = Committee on Techniques for the Enhancement of Human Performance

D = Dimension¹

Fem = Female

H = High-ability

IA = Individual Accountability

IAc = Individual Accountability Control

Jigsaw-DT = Jigsaw-(Dyadic–Task-structure)

L = Low-ability

LB-Rewards = Learning Behaviour Rewards

M = Medium-ability

MWPS = Maths Word Problem Solving

PI = Positive Interdependence

SDQ = Self Description Questionnaire

SDQ-I Peer = Self Description Questionnaire for Peer–Self-concept

SDQ-I Maths = Self Description Questionnaire for Maths–Self-concept

SLQ = Student Learning Questionnaire

SLQ-Individual = Student Learning Questionnaire, Individual Learning section

SLQ-Cooperative = Student Learning Questionnaire, Cooperative Learning section

SLQ-Alone-&-Partnered = Student Learning Questionnaire, both parts

¹This acronym for “Dimension” is only used in the index, indexed results of Study 2b’s “Exploratory propositions”, and as a cross reference in Study 2c.
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CHAPTER 1

INTRODUCTION

1.1 The Field of Cooperative Learning

The field of cooperative learning is built upon the premise that it can be used to enhance both academic excellence and affective development (Schmuck & Schmuck, 1997), although it is recognized that learners need to be trained to cooperate and that the learning context must foster cooperation for a cooperative approach to succeed and be superior to the standard individualistic approach (Committee on Techniques for the Enhancement of Human Performance [henceforth referred to as CTEHP, 1994]; Johnson & Johnson, 1989; Slavin, 1995). It would appear that in educational contexts, especially amongst teachers, there are many proponents who are very optimistic about using cooperative learning methods. There are widely published and circulated ‘how-to’ models, in particular, Johnson and Johnson’s Learning Together method, Aronson’s Jigsaw method and Slavin’s Jigsaw-II method, that are a testimony to the popularity of these ideas amongst many teachers, and which also indicate high levels of interest maintained by policy-makers (e.g., CTEHP, 1994) for the use of cooperative learning methods.

In the field of psychology, interest in cooperative learning is very high and intersects theoretically with a number of psychological paradigms. For example, Slavin (1996) discusses various intersections reflected in contemporary instructional and research methods, which are: Motivation, Social Cohesion, Cognitive development and Cognitive elaboration. As a field, psychology is tending to understand that various paradigms can complement each other rather than treating them as necessarily competing. Some of the existing approaches to cooperative learning developed out of those paradigms are as follows. In the field of motivation, Slavin in particular emphasizes the use of group goals as
the basis of rewards. In the area of social cohesion, efforts have been made to build esteem through group challenges such as in Outward Bound courses that may also have an academic component (Brookover & Erikson, 1975; Marsh, 1990) or in structuring heterogeneous groups to interact with project tasks (Cohen, 1982, 1984; Sharan, 1980). Classroom environments where group tasks are set and social interactions demonstrate peers’ concern for each others’ welfare and shared accomplishments have been found to be positively associated with high levels of peer liking, self-esteem and standardized achievement test scores (Battistich, Solomon & Delucchi, 1993). In cognitive development, Mugny and Doise (1978) have conducted research into heterogeneous ability groupings. In relation to cognitive elaboration, Webb has researched the role of elaboration by more competent peers in dyads, and effective help-seeking and helping behaviours (1982a, 1982b, 1989, 1991, 1992); and a number of programmes to structure elaboration have been developed to support low-achievers, for example, Palincsar and Brown’s (1984) reciprocal teaching method.

1.2 Shortcomings of Research to Date

Despite the high levels of interest in cooperative learning, there remains an urgent concern that there has been insufficient empirical testing of the efficacy and generalisability of the commonly used cooperative learning methods. Some of the better designed research into cooperative learning has found that without carefully structured programmes, the method can reduce achievement in academic performance as well as exacerbating problems of peer interactions and social status issues (Bossert, 1988; Cohen, 1994a, 1994b; Monteil & Huguet, 1999; Slavin, 1996; Tudge, 1989; Webb, 1992). However, the field is frustrated by the fact that little is known about the actual mechanisms that would explain the apparent

1.3 Research Aims

The present research has several aims. One is to further the social-psychology field’s understanding of the mechanisms that lead to improved academic and social-emotional outcomes in cooperative learning situations. A second aim is to identify conditions for eliciting optimal outcomes in relation to academic performance, peer acceptance and affective reactions. A third aim is to develop a theory of cooperative learning that integrates learners’ cognitive, social and affective domains. With the study being run in Singapore, a further incidental aim is to add to the field’s knowledge about the success or failure of a cooperative programme in a non-Western country.

1.4 Setting the Scene: Singaporean Context

The location for the study’s investigations is in Grade-5 primary school maths classes, and although the present research is not cross-cultural, a brief description will be given of the Singaporean context before explaining the structure of the thesis.

Singapore is an island in South-East Asia with a population of 3.26 million people. The cultural influences are predominantly Chinese as reflected in the population breakdown of ethnicities: Chinese 77%; Malay 14%; Indian 8% and “Others” who include Eurasians 1% (Statistics Singapore, 2000). The Singapore government advocates a knowledge-based economy to counter the island’s vulnerability from having few natural resources. Thus, the country’s education policies emphasise mathematics, which is crucial to developing technological skills and innovation.
Singaporean schools have a number of interesting characteristics. Mathematics (the focus subject of the present research) is highly valued. Children’s achievement levels in mathematics are amongst the highest in the world. For example, the Third International Maths and Science Study conducted by the International Association for the Evaluation of Educational Achievement in its ranking of 38 countries placed Singapore 1st in Maths (and 2nd in Science). The Singapore Ministry of Education (MOE, 2000) has analysed its relative Mathematics performance as follows:

Table 1:1.
Proportion of Students in the International Top Half of Mathematics Achievement (A Selection of Countries)

<table>
<thead>
<tr>
<th>Overall Ranking of Country</th>
<th>Country</th>
<th>% Students in Top Half</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Singapore</td>
<td>93%</td>
</tr>
<tr>
<td>2</td>
<td>Korea</td>
<td>91%</td>
</tr>
<tr>
<td>3</td>
<td>Chinese Taipei</td>
<td>85%</td>
</tr>
<tr>
<td>4</td>
<td>Hong Kong SAR</td>
<td>92%</td>
</tr>
<tr>
<td>5</td>
<td>Japan</td>
<td>89%</td>
</tr>
<tr>
<td>19</td>
<td>United States</td>
<td>61%</td>
</tr>
<tr>
<td>20</td>
<td>England</td>
<td>58%</td>
</tr>
<tr>
<td>23</td>
<td>Italy</td>
<td>52%</td>
</tr>
</tbody>
</table>

The figures show that the relatively high performance is comparable with a number of other Asian countries in the region and superior to overall standards in USA and parts of Europe. The good performance is accounted for by the Singapore Ministry of Education, MOE (2000) that states:

*The significant value which parents and the community place on education, the excellent work of our teachers and principals, the high access to IT and other resources at home and in school and the rigorous curriculum in*
Singapore schools are among the key factors contributing to Singapore’s good performance. (p. 1)

Primary and secondary schools offer a bilingual education in the language of instruction, English, which is taken by each child together with their nominated mother-tongue language (Mandarin, Malay or Tamil). From Grade-1 onwards, the school system has subject-specialist teachers and there is a nationally standardized curriculum. Following examinations in English, the Mother-Tongue language and Mathematics at the end of Grade-4, primary school children are streamed. The approximate proportions, according to 1998 figures by MOE (2002), indicate that the majority of classes are mainstream catering to a broad range of medium-ability children (approximately 72%), and some schools also offer streams for the very high-ability students (approximately 19%) or very low-ability students (approximately 9%). As such, Hing, Lee, Ng and Chew (1999) characterize Singaporean schools as being founded on a competitive system that is regarded as being “meritocratic”. Values of hard work and educational attainment are widely upheld. For example, students of all ability levels attend holiday programmes known as Vocation Learning Camps which schools offer regularly in the full range of subjects. This is a cultural value that appears to the researcher to contrast with Australia where few students would participate in revision courses during school holidays unless they were previously underperforming and where secondary school holiday enrichment programmes are mainly intended for the highest performers.

Singapore-based research into cooperative learning is relatively new. Note that it is difficult to conduct research during term times in examinable subjects and the present research was conducted as Mathematics classes in Vocation Learning Camps holiday programmes because in the Singapore context this is one way to encourage a large numbers
of schools to participate in the research (cf., Chin, Teh & Fong, 1988). The present studies’ Mathematics classes included students only from classes in the medium stream, and this is likely to make the cohort of participants comparable to students in USA and UK research studies, at least with regard to high-ability and medium-ability students.

The majority of Singaporean cooperative learning research studies have taken place in Social Studies classes (Hing, Lee, Ng & Chew, 1999; Lee, Chew, Ng & Hing, 1999; Lee, Lim & Ng, 1997; Lee, Ng, Phang, 1999; Ng & Lee, 1999). To date, findings are that the academic benefits derived from cooperative interventions are “minimal” although this may be on account of the students’ awareness that the subject is not examinable (Hing et al., 1999; Lee, Lim et al., 1997), or “whatever positive impact [cooperative learning] might have had on the pupils was not sufficient to override the more pervasive effects of competition and examination demands” (Lee, Ng & Lim, 1997, p. 73). Chan (2000) investigated outcomes for Maths Word Problem Solving using computer-based–instruction comparing academic outcomes for Individuals, and Mixed- and Equal-ability dyads. Findings suggested that individual- and cooperative-learning resulted in equivalent academic achievements, and when cooperative-learning conditions were compared, Mixed-ability dyads were found to be optimal for both partners in Grade-5 and for the lower-ability partner in Grade-3 with no significant difference for the higher-ability partner in comparison to Equal-ability conditions and Individual conditions.

Another study in Singapore by Chin et al. (1988) was conducted on a Vocation Learning Camp to investigate the effects of cooperative learning on attitudes towards Maths and English for Secondary-1 (Grade-7) students of below-average ability. It found no significant differences on academic performance between cooperative- and individual-learning for either subject or for either male or female students. However, the study found
improved attitudes by female students in cooperative conditions towards learning Maths and by male students in individual conditions towards learning English.

In accordance with an American legacy of cooperative learning being considered an alternative to the possible harmful effects of competition, and regarded as a potential vehicle for achieving humanistic goals, the research into cooperative learning in Singapore has not been confined to academic outcomes but has also investigated some affective outcomes. One Singaporean study investigated self-esteem, which was not found to improve from cooperative learning but resulted in the children perceiving work to be less difficult when they studied cooperatively than when taught through direct instruction methods (Lee, Lim & Ng, 1997). A study of friendship choices in cross-race heterogeneous groups had mixed findings (Ng & Lee, 1999); and a study of achievement, attitudes towards the subject and classroom climate in Grade-5 Social Studies classes (Lee, Ng & Phang, 1999) found that cooperative methods may be beneficial for maintaining positive attitudes towards the subject, which declined in the control class that used direct-instruction; that cooperative learning was beneficial for lower-ability students especially on improving their test scores on recall items, and that there were no significant differences in classroom climate. In summary, Singaporean research into cooperative learning methods tends to follow recent Western patterns although its interest is much more recent. Its research has been less able to establish superior outcomes from cooperation for academic performance, and to date there are no reported interventions that have resulted in successful outcomes in both academic and affective domains within the same programme.

1.5 Thesis in a Nutshell: Synopsis of Each Chapter

The thesis has a central aim which is to explicate the effects of cooperative learning on the cognitive and social-emotional domains.
Following this introduction, Chapter Two will provide an overview of the historical development of social psychology, and how research and educational goals in the twentieth century in USA were highly influential on the contemporary body of knowledge and concerns in the newer and more global field of cooperative learning.

Chapter Three will present the first of two quasi-experimentally–designed studies that were used for the data collection for all parts of this thesis. It was not possible to randomly assign subjects to experimental conditions since they were students who already belonged to classes for holiday programmes in particular schools. However, the classes were randomly assigned to the study’s learning conditions. In Study 1, comparisons were made of learning conditions for three cooperative conditions (with students assigned to learn in pairs) and one individual condition. All of the conditions had varying task-structures and reward-structures that in turn led to varying levels of arguably essential elements of cooperation: positive interdependence, group goals and individual accountability (e.g., Johnson, Johnson & Holubec, 1994). These conditions were compared in relation to the outcomes for a cognitive measure of academic maths word-problem-solving and affective measures of peer–self-concept and maths–self-concept. The findings of this study indicate that some cooperative conditions attained maths academic achievement equivalent to (but not significantly better than) the individual condition, and one of the cooperative conditions had significantly worse academic outcomes. However, the study identified how the incorrect balance of the essential elements of cooperation can be detrimental to academic achievement. Furthermore, it identified which balance of those essential elements is optimal for outcomes in academic maths- and peer–self-concept. The study also raised questions about the construct validity of the maths–self-concept measure for cooperative learning outcomes. Study 1’s findings about optimal cooperative learning
conditions, and some of that study’s unanticipated limitations, informed a subsequent study comprising three parts that are each described in separate chapters.

Chapter Four will present the second quasi-experimentally–designed study. Study 2a compared individual-learning and cooperative-learning–dyadic conditions in relation to: the efficacy of rewarding learning-behaviours to elicit dyadic cooperation; and effects of Individual, Equal (homogeneous) and Mixed (heterogeneous) ability-structuring in conditions; as well as in exploratory analyses of effects of High, Medium and Low-ability levels. The outcomes for learning-behaviour rewards, ability-structuring and ability-levels were compared in terms of the same dependent variables as in the previous study.

It will be seen that learning-behaviour rewards (over and above academic performance rewards) may be less beneficial to the MWPS outcomes of Individuals-LB-Rewards, compared to the beneficial outcomes of Equals-LB-Rewards, and possibly may be beneficial to Mixed pairs although these pairs differed little on whether or not they were rewarded. The exploratory analyses of High, Medium and Low ability students reveal some ability-level differences. It will be argued that taking ability structures into consideration, learning behaviour rewards need to be used strategically.

Study 2a’s findings of the effects of learning-behaviour rewards on Peer-Self-concept will show that the main differences are between Individual-No-LB-Rewards’ slight gains and Equal-No-LB-Rewards’ losses. It will be argued that gains or losses are not necessarily unidirectional for academic MWPS and Peer-Self-Concept outcomes. The next two parts of Study 2 will contribute more specific descriptions of cooperative learning that are useful for understanding of these findings.

Chapter Five will present Study 2b, in which a new affective measure was constructed and analysed. Following on from Study 1, which found Maths-self-concept measures to vary between cooperative learning conditions but not with actual levels of
academic maths gains, it was recognized that an affective measure that has a stronger association with academic outcomes would be needed, and perceived self-efficacy was chosen as being a better measure in this regard. Furthermore, the measure needed to address issues identified in Study 1 of the inadequately defined differences between social and individual learning, reflecting a long-standing issue in social psychology with the problem of needing to rely on individual assessment. This was addressed by the measure being developed with items about perceived self-efficacy to learn mathematics both alone and with a partner.

As such, a questionnaire, “Student Learning Questionnaire of Perceived Self-efficacy for learning maths alone and learning maths with a partner” (SLQ-Alone-&-Partnered) was constructed. It comprised two parts, firstly for scales of Individual Learning Factors and secondly for scales of Cooperative Learning Factors. It was administered before and after the learning intervention to ascertain whether there were changes in children’s self-efficacy in relation to their experiences in the particular learning conditions and ability levels (as described for Study 2a above). The findings were used in conjunction with the quasi-experimental studies, and provided insight into the multiple dimensions of the cognitive and affective outcomes associated with learning-behaviour–rewards and ability-structures.

The SLQ-Alone-&-Partnered analyses were used to develop a theory that learning has four main functions, each of which has a different pattern of optimal and detrimental conditions. A theory was developed out of social exchange and social comparison theories to suggest that learning motivation in dyads will depend upon learners’ perceived “Incentive-values-Exchange” where the incentives are not only teacher-directed rewards but include perceived opportunities to offer academic help and receive academic help. Although the study is exploratory, crucially it identifies the possibility that, in mixed-ability
dyads, gains in academic outcomes by the lower-ability partner may be matched by losses in peer-self-concept and vice versa, most likely because dyadic partnerships in classrooms lead to close comparisons between partners with different academic status. The analysis also points towards there being a dynamic system of mixed-ability interactions that lead to particular cognitive and social-emotional biases that serve to regulate and maintain students’ relative levels of academic and peer status, which will be the next challenge for the field of social psychology to address.

Chapter Six will present Study 2c, which is an exploratory analysis of samples from the children’s written reflective responses about their experiences in cooperative conditions. Reflective response sheets about what the children enjoyed most/least, found most easy/difficult, found most useful/least useful were constructed as a pedagogical exercise to support the programme. The response sheets were also used as a data source in Study 2c to illustrate theoretical points about cooperative learning made in Study 2b. Furthermore, Chapter Six will present the strengths, limitations and implications for practice and further research for all three parts of Study 2. This is followed by Chapter Seven, which will present the final general conclusions of the thesis.
CHAPTER 2

HISTORICAL PERSPECTIVES OF COOPERATIVE LEARNING: BEGINNINGS AND PIONEERS

The present thesis investigates the cognitive, social and affective outcomes of cooperative learning interventions that were run in Singapore Primary schools. The full range of investigative directions in the thesis is broad, and the purpose of this chapter is to contextualize the research by summarising and reviewing the contributions by key researchers and theorists. The thesis’s analyses were iterative, that is, the analysis and results of some studies informed and were informed by the analyses of the other studies. Thus, the present background description aims to be sufficiently broad to encapsulate the range of topics pertinent to each investigation without preemptiong the findings.

The chapter will serve as a background that aims to show how cooperative learning as a field of psychology originates from social psychology, which has a long tradition dating back to Triplett’s observations in 1898 of cyclists’ enhanced performances when they cycled together rather than alone. The cooperative learning field’s epistemological origins have not generally been derived from observation of learning contexts. Instead, cooperative learning concepts derived from theoretical and empirical studies of mostly adult human performance, group identity and group dynamics. They have nevertheless been taken up in the design of projects and research with goals of enhancing school and classroom experiences in relation to academic, social and emotional outcomes.

Much of the contemporary development of classroom applications of social psychology stems from research and theoretical developments occurring in the USA. This overview will synthesise arguments from several historical accounts about how the USA’s changing social and political climate during the 20th century affected various movements
concerned with the role of schools in developing competitive, individualistic or cooperative attitudes. This historical overview will be followed by a brief synopsis of the various perspectives from psychology that have influenced the contemporary interest in cooperative learning and its generalized humanistic goals for the shaping of students in academic, social and emotional domains. The American influence on particular models of cooperative learning and the contemporary humanistic goals for education are reflected in Singapore’s relatively recent interest in adopting cooperative learning methods, and hence relevant to this thesis.

2.1 Historical Overview

Several historical accounts of cooperative learning have been written. The account by Pepitone (1980) relates cooperation and competition to developmental psychology showing its relevance to other fields, including welfare, cultural and group influences on behavior such as eating, and especially cooperative learning in classrooms. Guerin (1993) offers an overview of the field of social facilitation that theorises about the effects of the presence of others, explaining for example how easy tasks can be completed in shorter time but harder tasks are completed with less accuracy. Webb and Palinesar (1996) provide an overview of studies related to the processes of interaction, specifically theorizing about group processes in the classroom. Schmuck and Schmuck (1988) also provide an overview of this field of psychology by pointing out relationships between the trends in research and the social climate of American ideologies and social history. That is, they discuss how the fluctuating trends towards and away from cooperative and individualized learning were based on political events and notions of capitalism and individualism, suspicion of Russian communism and cooperative organization, and the moderating influence between these two extremes of John Dewey in suggesting that cooperation was essential to democracy.
What is notable is that each historical account describes how particular theories or discoveries have had fluctuating acceptance in the social psychology field. It appears not to be unusual for a particular theory or concept to be developed but become obscured soon afterwards. Reasons for obscurity include the following: that the field did not consider the angle it offered important enough to study deeply, or that new ideas were contentious, or that the focus of general interest was on other research developments. Thus, important concepts in the field may not have been further developed immediately after they were discovered, and many became lost, although some reemerged later. The pattern of reemergence shows that very little in the field is completely original, but changing social trends mean that the findings and theories of previous research change in relative acceptance levels depending at any one time on how well they are already recognized and how suited the particular research findings are for informing current topics of interest.

This historical account will indicate key relevant studies, organizing them chronologically into decades, as far as the source literature makes possible.

2.1 Beginnings and Experimental Studies into the Nineteen-Twenties

2.2.1 Norman Triplett

Norman Triplett (1898) was one of the first researchers interested in the effects of the group on an individual’s performance. Triplett noticed that cyclists rode faster when in competition against other cyclists than when they were paced by motor-driven cycles or when they were timed riding the course alone (Forsyth, 1999).

Triplett’s first explanations to account for the faster times of paced competition races were mechanical reasons: e.g., shelter theory (i.e., the pace marker or leading competitor provided shelter from the wind) and the suction theory (i.e., the vacuum left behind the pace marker pulled the cyclist following it, along with it and so helped to
conserve energy) (Guerin, 1993). Triplett also suggested some psychological reasons: e.g., encouragement theory (i.e., friends often rode as pacers hence could offer encouragement to the cyclist) and “brain-worry” theory (i.e., cyclists in an unpaced race did poorly because they were full of worry as to whether they were going fast enough and hence this worry exhausted both the brain and the muscles).

Triplett’s preferred explanation, however, was a dynamogenic one – where creatures of the same species in each other’s presence can perform certain species-specific activities more effectively. Therefore, the bodily presence of another cyclist is sufficient to increase the competitive instinct of the cyclist thus freeing the nervous energy that he/she cannot of himself/herself release, leading to a higher rate of speed. The presence of others also is an inspiration to exert greater effort (Pepitone, 1980).

Triplett investigated these dynamogenic factors by requiring children to wind fishing reels that were clamped to a table, either alone or in the company of another child (Brewer & Crano, 1994; Feldman, 1995). Triplett concluded that children reeled the line more quickly in competition with another peer than when performing the task alone (Hogg & Vaughan, 1998). It should be noted that Triplett’s results were due to the effects of competition rather than only the effects of the mere presence of others; which in present day terms is considered a separate phenomenon of social facilitation (Guerin, 1993). Nevertheless, Triplett’s work marked the beginning of the study of competition and the effects of performance in the presence of others.

2.2.2 The German Educationalists

A few years following Triplett’s experimental work, educationalists in Germany looked to social psychology. They were concerned over the education of children, raising issues about whether children should study in class groups or alone, at school or at home
(Guerin, 1993). However, the majority of the experiments conducted were poorly designed and hence no firm conclusions could be drawn. These studies, however, raised important methodological and conceptual issues in the field (Guerin, 1993).

For example, Mayer (1904; cited in Guerin, 1993) conducted an experiment comparing children working alone or in groups in classrooms. Mayer concluded that the superior work found in groups was the result of ambition and competition. The experimental design was criticized, however, on the grounds that children in all conditions were never truly alone since the teacher was present. The problem raised by the critics was that, as pointed out in Triplett’s study, audiences (i.e., the teacher) could have affected performance. The critics argued that there had not been a proper control group for comparison, and a condition in which children were completely alone would have been required to ascertain what led to the superior performance in groups. However, it would seem that controlling for being alone is not a viable proposition because of observation limitations and ethical issues of not supervising children. The issue still has relevance to contemporary research design and conceptualizations of learning ‘individually’ as distinct from ‘cooperatively, but the field took a different direction.

In discussing Mayer’s (1904) study, Burnham (1905) raised the possibility that children compared their performances with those of other children. But it was almost fifty years later that the possibility of social comparison leading to better performances was theoretically advanced (i.e., by Festinger, 1954).

Another example of German educational research comes from Meumann (1904; cited in Guerin, 1993) who compared children working alone or in the presence of others on tests of memory. Meumann concluded that distraction from external noises such as whispering, movements and talk had few detrimental effects; instead it could possibly lead to children increasing their work output (as a result of compensation). However, the
presence of the teacher in the ‘alone condition’ was again criticized subsequent to Meumann’s work. It is notable that the study of distraction has become a widely used research concept, for example in more recent studies of social facilitation (e.g., Sanders, Baron & Moore, 1978).

2.2.3 Allport (1920)

In 1920, Allport made a distinction between the quantity and quality of performance. Corresponding gains and losses in the quantity of performance were referred to as social increments and social decrements respectively; while corresponding gains and losses in the quality of performance were referred to as the social supervaluants and social subvaluants respectively.

Allport further made a distinction between direct social interaction effects (i.e., individuals working side-by-side and hence receiving stimulation from the sights and sounds of others doing similar tasks) and co-acting or co-working effects (i.e., individuals performing similar tasks but not interacting). However, unlike Triplett (1898), Allport did not distinguish social interaction effects from the effects of passive observers (i.e., audience) (Guerin, 1993).

Another important step in the field of social psychology made by Allport was distinguishing the competitive notion of rivalry, which is defined as the “emotional reinforcement of movement accompanied by a conscious desire to win” (p. 262), from the notion of ‘social facilitation’. As such, Allport (1924a) coined the currently widely-used term ‘social facilitation’ to refer to direct social interaction effects. Following a series of word-association experiments, Allport (1924b) concluded that group situations facilitated better performance on tasks requiring overt responses (e.g., number of associated words offered by an individual – the quantity of performance). However, in contrast, social
facilitation hampered tasks requiring intellectual responses (e.g., arguments to support the association made between words— the quality of performance). Allport suggested that in order to maintain performance; particularly in tasks requiring overt responses in the presence of others, individuals need to increase attentiveness so as to overcome the distractions afforded by others. Note, however, that in more recent tests of maintenance of performance, social facilitation was found to decrease in effectiveness as work continued, even if the work required overt responses (Webb & Palincsar, 1996).

2.2.4 Gates (1924)

In 1924, Gates took a slightly different approach from the social facilitation research in investigating the effects of the presence of others on performance. Gates compared the performance of an individual working alone with the same individual working in front of either a small (size of four to six) or large (more than six) audience. Gates was criticized for not establishing proper controls to make such comparisons—the experimenter was present in all conditions. However, in an editorial note on her study, Allport (1924b) commented that based on Gates’s results, it appeared that individuals with poor ability initially improved more without an audience; and that those who were of high ability performed better with an audience. Allport recommended further research replicating Gates’s repeated-measures methodology.

2.2.5 Travis (1925) and Dashiell (1930)

Travis (1925) and Dashiell (1930) further tested the effects of an audience on performance. Both researchers attempted to ascertain if the mere presence of others who were not also engaging in the task (i.e., an audience) would facilitate or hamper an individual’s performance. Comparisons were made between the audience condition with various alone and/or co-acting conditions. Both researchers drew similar conclusions:
Individuals performing alone had the poorest performance; the audience condition was sufficient for individuals to perform better; and the combination of audience and competitive instruction had the strongest effect (Pepitone, 1980).

2.2.6 John Dewey

There was a shift from competition (which dominated early research into social aspects of learning) to cooperative research stemming from the influence of John Dewey. Dewey’s focus was on the process of learning rather than the product or content, and he emphasised the social aspects of learning and the role of schooling in preparing students to value democracy and live democratically (Noddings, 1989; Schmuck & Schmuck, 1988). He argued that if children were to live democratically, they would first need to experience democracy. Although not directly involved in education, Dewey (1916) did develop some of the ideals for curriculum and education’s role in teaching social values and morality that some of his contemporary educationalists began trying to develop in classroom contexts. Hence, Dewey’s work is reflected in educational movements taking up his proposals that classroom instruction should be centered on equipping children with skills on how to make choices, respecting the rights of others, relating to and empathizing with others and carrying out projects cooperatively (Schmuck & Schmuck, 1988).

2.2.7 Kilpatrick

During this period, interest in developing educational policies was still strong. Kilpatrick’s (1918; cited in Pepitone, 1980) synthesis of current pedagogy focused on a child’s purposeful activities, and was derived from explications of the law of effect by Thorndike and on the social environment as postulated by Dewey (Pepitone, 1980). Teachers across the USA who embraced the child-centered progressivism of the era gladly
incorporated this pedagogical methodology. In this time period, there was widespread effort to publish textbooks to put forth these values in the form of activity projects where a topic was introduced and each student was encouraged to contribute by following up an aspect based on their own interests. However, the changing social climate in America led to growing public opinion that such progressivist methods were too individualistic, in the sense of being laissez-faire (Pepitone, 1980).

### 2.3 The Nineteen-Thirties

In response to the voices raised against laissez-faire individualism in Depression America, cooperation became a less favoured alternative than competitive individualism. According to Pepitone (1980), this was not so much caused by educational concerns about cooperative methods of learning, but rather was a reflection of the political and economic climate that reflected back into educational goals. Industry-backed public awareness campaigns associated freedom with individualism. They proposed that the American way of life required freedom to pursue personal interests unhampered by controls such as forced cooperation, and branded outside interference as un-American. Notably, then, this aspect of the USA’s social climate of the 1930s revolved around issues of freedom to compete. That is, the economic capitalist ideals of America were based upon competition, and these were matched with extreme suspicion of communism and collectivist philosophies. Such a political position was reflected in suspicion of schools using methods that demanded cooperation and suppressed competition.

#### 2.3.1 May and Doob

In 1937, May and Doob re-theorized the issues relating to competition and cooperation, and reviewed the research in the field. May and Doob claimed that a framework of guiding concepts with definitional distinctions was essential for reviewing
and organizing research in the field. There were a total of 24 basic postulates, which will be illustrated with two examples. Postulate 5 states that “individuals compete with one another when they are striving to achieve the same goal that is scarce and when they are prevented by the rules of the situation from achieving this goal in equal amounts.”

Postulate 6 maintains that “individuals cooperate with each other when they are striving to achieve the same or complementary goals that can be shared and when they are required by the rules of the situation to achieve this goal in nearly equal amounts."

May and Doob also maintained that cooperation and competition do not constitute polar opposites. This proposition went unheeded in research even during later decades. They also proposed that “human beings of original nature strive for goals, but striving with others (cooperation) or against (competition) are learned forms of behaviour.” (May & Doob, 1937; cited in Pepitone, 1980; p. 14)

In regard to the American school system, May and Doob recommended the use of competitive structures in classrooms to mirror that of the competitive culture.

2.4 The Nineteen-Forties

In response to the need for classification and selection of soldiers in World War I, there were dramatic developments in the methodology of intelligence testing. Measurement of personality traits and social attitudes began to follow suit in the subsequent decade (Pepitone, 1980). The sudden attack on Pearl Harbour (World War II) led to the establishment of many wartime agencies to meet a variety of needs created by war. Thus, some of the research into coping with group needs in war began to influence social psychology.
2.4.1 Kurt Lewin

Kurt Lewin was one of the advisers to a wartime agency, the Office of Strategic Services (OSS). Lewin’s role was to advise the agency on how to alter the habits and tastes of Americans during wartime, while there were food shortages. Lewin had been studying the effects of social pressures on eating habits of children in the nursery school at Cornell University during pre-war periods (Pepitone, 1980). In contrast to behaviour modification models, which focused on historical antecedents of a person’s behaviour, Lewin emphasized the direct effect of the present situation on an individual’s behaviour. In Lewin’s analysis of children’s eating problems, he considered the forces that were moving the child towards and away from food, for instance, a child’s respective likes and dislikes of special foods, and the functions of increasing attractiveness by the use of specific punishments for not eating (Lewin, 1943). Such analysis prompted questions such as: which forces would have to be changed in the life space of the child to lead to a change in eating habits.

Lewin used similar concepts and inquiry methods in relation to adult food habits to those he had used with children. He mapped out the steps an individual takes in decisions on processes related to eating, beginning from the initial source (e.g., market or garden) through a series of decisions until a food product reaches the table. Lewin’s first focus of enquiry was always to understand the forces that were operating in the life space. To change an individual’s eating habits, for instance, he would ask what would make an individual eat a recommended food or resist change? (An example of why a person might resist is that, for some, cod liver oil may have an unpleasant odour.) The next question was to ask how the constellations of forces might change. Lewin realized that in the case of food, discussions with individuals and agreement to try out new foods led to a greater
change than providing intellectual information about the virtues of these foods (Pepitone, 1980).

From the above example, there are several notable features of Lewin’s field theory. In considering forces that act in an individual person’s life space, the individual is seen against an environmental background. Thus, the focus is on the interaction between the individual with the environment, a movement and action within it and/or with potential to change. As a theory of social dynamics, field theory can be applied to a variety of problems but its strength is that it also furnishes implications for action (Pepitone, 1980).

Lewin’s shift in interest from studying individual dynamics moved to group dynamics and, out of his concern about the threat to democracy abroad, he began to study democracy at home. In 1945, Lewin established the Research Center for Group Dynamics (RCGD) in the Department of Economics and Social Sciences at the Massachusetts Institute of Technology (MIT) where he continued his study in group dynamics. He was interested in action research methods (Pepitone, 1980). He conducted a major experiment with 10- and 11–year-old boy scouts. The leaders were trained to respond in ways that were autocratic or in ways that were democratic. The study found that autocratic leadership removed individual initiative within half an hour, leading to apathy among the boys. Lewin was also a social visionary in that he did not accept notions of minorities’ problems as having any meaning without considering its counterpart majority problems, and he said, “The Negro problem is a problem of the Whites, the Jewish problem, the Christians” (Lewin cited in Pepitone, 1980; p. 20). Lewin’s theories also inspired an impressive number of major action research projects in the 1940s including a study of interracial housing, which was undertaken by Deutsch and Collins (1951).
2.4.2 Morton Deutsch

Morton Deutsch, a student of Lewin’s at MIT, developed a conceptualization of cooperative and competitive conditions. He theorized that in cooperative conditions group members’ goals are promotively interdependent (striving with each other) whereas in competitive conditions groups’ members are contriently interdependent (striving against each other). Deutsch’s studies comparing the learning processes of students found that student involvement did not vary whether the structures were cooperative or competitive. However, he claimed that cooperative groups display superior group process that was reflected in various productive measures: “Cooperative groups displayed more coordinated effort, more division of labour, more acceptance of others’ ideas and suggestions, more agreement in general and more helpfulness and fewer communication difficulties”; whereas “students in competitive groups showed more obstructive and aggressive interaction, especially on the human relations problem” (Pepitone, 1980, p. 23). Relevant to the present thesis, Deutsch recognized that competitive and cooperative conditions did not exist in any pure sense, but in many situations (or in the perceptions of people in a given situation) cooperation and competition are combined.

2.5 The Nineteen-Fifties

The number of studies in the field of small-group experiments reached a record high in the 1950s. For example, Festinger (1954) focused on the source of normative pressures in small groups and Asch (1956) focused on the conditions under which individual conformity occurs. Perhaps the most relevant research for contemporary understandings of cooperative learning from the 1950s is Sherif’s study of the creation of intergroup competition and its resulting consequences. Sherif also studied how friendly relationships could be restored.
2.5.1 Sherif

Sherif (1966) conducted a field experiment at three summer camps in 1949, 1953 and 1954 for young boys (11- and 12-year-olds), who were unaware that they were part of an experimental study. The basic structure of each experiment consisted of three general phases. In the first phase, the boys were engaged in activities that required interdependent interaction (e.g., outdoor hikes, dividing labour to cook meals). This in turn led to the increased group cohesiveness and the formation of friendships. The second phase consisted of dividing the camp into two groups; deliberately separating the pre-formed cohesiveness and friendships that were established in phase one. The newly formed groups were kept isolated from each other—living in separate cabins and engaging in separate activities. The third phase consisted of bringing the two groups together to engage in a set of competitions with each other; where prizes and trophies for the tournament were offered.

As the tournament went on, there was strong competition between groups and intergroup hostility mounted. This later generalized to situations outside the organized tournament. The intergroup relations deteriorated so dramatically in two experiments that it had to be concluded at this phase. For example, when the two groups came together for a meal, one group would throw food at the other.

In one experiment, however, it was possible to proceed to the fourth phase, where the two groups were provided with superordinate goals (i.e., desirable goals that are unachievable by one group effort only). Therefore, to achieve these goals, the two groups had to work cooperatively with each other. Sherif reported that such cooperation reduced the intergroup hostility and possibly future conflicts between them.

Sherif’s study substantiated Deutsch’s findings that positive interpersonal behaviours are characteristics of cooperation; and negative behaviours are characteristic of competition. Sherif also extended Deutsch’s research by describing the processes by which
intergroup relations were established and suggesting possible methods to change undesirable relations – that is, intergroup hostility can be created by strengthening within-group interdependence and through competition with other groups; while intergroup hostility can be reduced and prosocial behaviour increased by the establishment of interdependence between groups through superordinate goals and cooperative tasks.

In 1954, Festinger presented a formal theory on social comparison. The theory focuses on what individuals seek to find out about others to help achieve their own goals. The theory is by no means hedonistic but instead it attempts to depict individuals’ pursuit to understand themselves and others. The theory postulates that in the absence of being able to gather objective information on themselves, other people serve as standards of “veridicality” (truth/evidence).

In the 1950s, social comparison theory was not used as a basis for explaining competition and cooperation in groups despite some studies suggesting its relevance. For example, Stendler, Damrin and Haines (1951) studied a group of eight second-graders, who were required to paint two murals over four days. Rewards were provided for painting. In the cooperative condition, children were rewarded so long as their mural was good enough to be hung in the classroom. In the competitive condition, only the child with the best mural was rewarded.

Stendler et al (1951) reported that in the competitive condition, two children asserted their inadequacies at painting at the outset. During the painting sessions, children in the cooperative condition tended to break into subgroups and work together. These children were observed to be chatty among group mates, full of humor and often seen praising each other’s work. In contrast, children in the competitive condition tended to work alone and were less friendly in their interactions with others.
Much of the research on competition and cooperation focused on the effects of goal structures (particularly the goal of rewards) on group cohesiveness. These studies (Gottheil, 1955; Grossack, 1954; Phillips & D’Amico, 1956) indicated that in competitive conditions there was less friendly behaviour and cohesiveness amongst the group, particularly if only one child could win the game and was consistently a winner in games (hence always rewarded). In contrast, children were friendlier and there was more cohesiveness in cooperative groups that could aim for shared rewards.

### 2.5.2 Thibaut and Kelley (1959)

By the end of the 1950s, social psychology was moving away from interpersonal dynamics towards social exchange theories. For example, a number of theorists, amongst whom Thibaut and Kelley (1959) were influential, took into account individual motivation of partners or group members from the recognition of mutual benefits in relationships.

Thibaut and Kelley (1959) conceptualized motivation in social interactions in terms of gains and losses – individuals are motivated to maximize their gains and minimize their losses. This motive governs their behaviour in relation to whether they cooperate with their partner or group or leave the relationship. People in a partnership will compare the possibilities with other alternatives of which they are aware, and only if both perceive they can profit (or perceive they have no better alternatives), will they cooperate. It is interesting that they note that to some extent schools are not situations where the relationships are entirely voluntary although they are more voluntary than prisons; similar observations have also been made by more recent commentators, such as Slavin (1996).
2.6 The Nineteen-Sixties

2.6.1 Proliferation of Social-Exchange Theories

The social-exchange theories proliferated but had little direct application to educational concerns at the time. This is probably due to them describing mostly adult relationships in work-related exchanges, affiliative exchanges and affectionate exchanges, and these contexts are not always easily applicable to understanding children’s social dynamics in school settings. However, the theories’ conceptualisations of motivation are worth briefly considering and have had some obtuse influences on the cooperative learning field.

In a social-exchange, individuals make a conscious or unconscious calculation of the consequences of their interactions as a cost-reward ratio. From this, a major principle predicting motivation is the mini-max strategy whereby a good outcome for an individual is minimal costs with maximum rewards. At the very least, an individual would prefer an outcome with no loss, and ideally with some profit to themselves. Hogg and Vaughan (1998, p. 464) explain, “It is possible for two people in a relationship both to be making a profit and therefore gaining satisfaction.”

According to Forsyth (1999), each individual in a group or dyad assesses their outcomes taking into account exogenous factors of each individual’s resources such as skills and abilities, and taking into account endogenous factors (which in this study’s concerns would be the processes of learning or cooperating). These factors are not intrinsically rewarding or costly but are subjectively evaluated as such by the individuals involved. The factors may also be evaluated differently by different partners in a relationship, with an example factor being unsolicited advice that is prone to being valued more highly by the donor than the recipient. Foa and Foa (1995, cited in Hogg & Vaughan,
1998, p. 462) described relationships that involve an exchange and listed six types of resources:

1. Goods – any products or objects;
2. Information – advice, opinion or instructions;
3. Love – affectionate regard, warmth or comfort;
4. Money – any coin or token that has some value;
5. Services – activities of the body or belonging to the individual; and
6. Status – an evaluative judgement that conveys high or low prestige.

How these resources translate into the rewards and costs of interactions is explained by Forsyth (1999, p. 107-8). He lists rewards as, “including acceptance by others, camaraderie, assistance in reaching personal goals, social support and comparison information, exposure to new ideas and opportunities to interact with people who are interesting and attractive”. He lists costs as “time, money, energy and the like” as well as any necessity to deal with people who are difficult, such as being boring or selfish.

The notion from social-exchange theories that individuals are motivated to maximize their gains was an aspect that may have influenced the directions of research into school learning motivation, albeit appropriated and subsumed into behavioural paradigms and reinforcement models, such as in the present study’s investigations of rewards outcomes. However, to date, most research focuses on the teacher controlling the rewards and there appears to have been little direct reference to such theories of exchange between partners in social psychology research into cooperative learning. On a conceptual level, it cannot be denied that analyzing exchange between partners would be a more complex undertaking.
2.6.2 Growth of Educational Projects for Social Equality

During the late 1960s (after the assassinations of Martin Luther King, Jr. and the Kennedys and during the Vietnam War) American social concerns were centered on civil rights. Two separate movements emerged: equal educational opportunity and humanizing the dehumanized schools (Schmuck & Schmuck, 1988). Schools were accused of not providing equal educational opportunities, particularly to the poor, ‘the blacks’, and girls and women. Schools were also accused of fostering inhumanity by neglecting the emotional well-being and self-esteem of students. The use of competitive instructional techniques was criticized as it promoted differences between students and deemphasized the human side of interaction (Schmuck & Schmuck, 1988; Webb & Palincsar, 1996). Cooperative instructional techniques, on the other hand, were identified as one possibility for improving interpersonal relationships, emotional well-being and self-concept of students, and reducing prejudice. This led once again to the swing away from competitive instruction to the emphasis on individualized or cooperative learning instruction (Pepitone, 1980; Webb & Palincsar, 1996).

In the late 1960s, the tightening of the USA economy led to the reduction in research grants. The economy may also have influenced research designs. Most of the research employed game-theoretical models which are based on the premise that the choices made by each player in experimental games are motivated by the need for maximizing gains and minimizing losses. The strategy employed by each player also determines the success or failure of the game.

There are many variations in the set up of experimental games. For example, games can be set up to depict ‘contrient’ competitive situations; when the interdependence between players is contrient, one person’s gain constitutes another person’s loss. Games can also be set up to reflect ‘promotive’ cooperative situations. For instance, one set up
could be that both players need to make choices that would bring gains, otherwise risking losses, to both.

Wrightsman, O’Connor and Baker (1972) reviewed 1100 studies that employed game experiments. The most striking finding, which is consistent throughout most studies, is that players do not always behave rationally – they do not always want to maximize their gains and minimize their losses. For example, sometimes, players prefer to take a loss to maximize the differences between themselves and their competitors. Game experiments have been criticised for being artificial. For example, the choice of behavior is dependent on whether the rewards constitute real currency or play money (Gergen, 1969). There is also the absence of real communication between players making it a highly artificial relationship (Gergen, 1969). This in turn raised concerns about whether game experiments can be used to understand competitive or cooperative behaviour in the real world (Vinacke, 1969).

Madsen and his associates investigated children’s choice interactions (i.e., competition or cooperation) using dyadic games (Madsen, 1971; Kagan, Spencer & Madsen, 1972). An example of a dyadic game is the cooperative board game. This game comprises a movable pointer with several strings attached to it. Each child is given two strings, one for each hand. There are target spots in front and at the sides of each child. The pointer can be easily pulled to a child’s target spot when he/she is performing the task alone. However when two children pull simultaneously in the opposite direction, it is difficult to move the pointer to the target spot. Hence to be successful in the game, children need to coordinate their pulls and refrain from pulling in opposite directions.

Nelson (1970; cited in Pepitone, 1980) conducted a study with 5- to 10–year-olds using the cooperative board game. Nelson reported developmental trends – five–year-olds had unequal interaction patterns allowing the assertive child to pull the target to his/her end,
and by contrast, six–year-olds were most competitive, preventing either child from winning by them pulling simultaneously in both directions. On the other hand, 8- to 10–year-olds were significantly more cooperative than 5- and 6–year-olds.

Nelson’s study is a reminder that while the use of adult social psychological theories can be useful in formulating questions about interpersonal understanding of the child (Shantz, 1975), studies of children in the social psychology field that combine a developmental and social perspective may allow a more complete understanding of the issues (Pepitone, 1980).

2.7 The Nineteen-Seventies

In the 1970s, there appeared to be a confluence among different academic disciplines: education, anthropology, social psychology and developmental psychology; uniting in an attempt to understand the child. There was also recognition that legislation pertaining to social integration in schools (where previously they were segregated) was insufficient on its own to improve interpersonal relationships among diverse ethnic groups. Therefore, several pilot programmes adopting cooperative learning structures in classrooms were developed in response to the perceived needs of ethnic integration in newly desegregated schools. The ethnic groups are named in much of the literature as white/Anglo-American, black/Afro-American and Mexican-American. Cooperative learning structures were adopted as recommended by Allport (1954). According to Allport, the use of structures embedding equal status contact among its members and in the presence of common goals has the potential to bring about positive interpersonal relations, as compared to working alone or in competition, either of which may regenerate prejudice.

The three major approaches developed, based on Allport’s recommendations, were by Cook and his associates; Slavin and DeVries; and Aronson. All three approaches shared
a common methodological feature where small groups comprising various ethnic groups were assigned tasks for which group members were required to cooperate. Differences between the three approaches lay in the identified sources that were assumed to alter an individual’s attraction to groups. Cook attempted to increase member interdependence by revealing likeable characteristics of individual members to each other, Aronson by building interdependence into the structure and resources of the group’s activities, and Slavin and DeVries by manipulations of group and individual goals (Pepitone, 1980, p. 47).

In a series of studies based in classrooms and military training camps, Cook’s series of studies about improving attitudes towards members of disliked (ethnic) groups found that liking could increase if the members from disliked groups held equal status (and ability matching that status) and if the contact was cooperative and within a setting that favoured equality and egalitarian association among the participating groups. Whilst such findings were encouraging, it was also established that it is not sufficient for people from different races or ethnicities simply to get to know each other – because if a member of a disadvantaged ethnic group failed in a competitive structure, there could be unwanted effects of an increase in disliking which in turn could lead to problems such as scapegoating of members from disliked groups.

Aronson relied on the manipulation of the group activity – that is, the structure of the specific learning task. Aronson adopted an approach analogous to the assembly of a jigsaw puzzle. Each member in a group was given one segment of the class lesson and was responsible for learning and teaching his/her own part to other members. To facilitate the learning of the segment, students who had the same segment (across other groups) would first meet together to learn the material. Children would discuss the material with each other and later present it to their groups. Evaluations of the effects of Jigsaw learning have reported increases in self-esteem, better attitudes towards school and increased liking for
classmates (Blaney et al., 1977; Aronson, Blaney, Stephan, Sikes & Snapp, 1978; Aronson, Bridgman & Geffner, 1978).

In DeVries and Slavin’s (1978) team games tournament (TGT), each team consisted of a high achiever, two average achievers and one low achiever. Members within each team were to help each other learn the assigned content. Tournaments took place once or twice each week; and students from each team competed against students from other teams within the same ability range. The scores earned from the tournament by each team member were brought back to the original group – i.e., the team. Scores were summed for each team and the winning team was announced in a weekly classroom newsletter. Slavin (1979) reported that such approaches led to improved cross-race friendship choices. The cross-race team competition in TGT raises questions of the likely effects of decreasing the liking of members in competing teams. Slavin maintains that the competition component is vital for motivating individual students, and this is achieved through setting group goals and establishing individual accountability, which will lead to the acceptance of lower-status members by the rest of the group.

Pepitone points out another crucial problem for the field of cooperative learning about these programmes that aim to increase acceptance through social interactions: “Each of these three programs attempts to create these conditions [for acceptance], and evidence points to their success in doing so. However, the question may be raised as to the effectiveness of these programs in regard to pupil [academic] achievement” (Pepitone, 1980, p. 50). In other words, there are multiple outcomes to learning, and finding the optimal approach in meeting more than one of them is difficult.

Several reviews were generated addressing research on the effects of cooperation and competitive learning environments (Deutsch, 1979; Johnson & Johnson, 1974, 1975; Michaels, 1977; Slavin, 1977). Deutsch believed that it was time to “communicate the
knowledge that we are accumulating about the consequences of different grading systems to teachers, parents and others who are concerned about the effects of schooling on our children” (p. 400). Johnson and Johnson (1974) focused primarily on the destructive effects of competition on children’s development. They believed that competition leads to anxiety, fear of failure, hostility towards competitors, sabotaging others’ efforts to win—that is, generally, competition inculcates the value that winning is all that matters. In contrast, inculcating cooperative behaviour leads to prosocial development – of helpfulness, supportiveness and respectfulness.

However, awareness of the difficulties with cooperation was also beginning to be addressed. Some earlier research has suggested that competition can be more effective than cooperation. For example, Clifford (1972) pointed out that competition increased performance, particularly on mechanical, skill-oriented and simple tasks. It is notable that Clifford’s own research in learning of problem-solving tasks (typical of classroom activity) indicated that competition either had no effect or hindered learning. Deutsch (1979), too, concluded that neither the competitive nor the cooperative system is intrinsically more motivating and that task-requirements, situational determinants, cultural values, or personality characteristics may predispose an individual to respond differently to cooperation and competition.

Concurrently with these social psychology developments in the seventies, sociology was developing as a field and was recognizing the role of educational institutions in reproduction of social-class status. For example, Bourdieu and Passeron (1977) identified systems of “unequal selection” to educational and career opportunities that were based on an individual child’s existing levels of “cultural capital” determined through stages of initial class membership that affected objective probabilities of access to primary school, then secondary school’s various streams, then higher education’s various programmes and
eventual class membership based on the vocational use of academic qualifications. That is, those with fathers whose vocation was farm worker have less objective probability of succeeding in attaining professional science, arts, law, medicine or pharmacy careers than those with fathers whose vocation was in the professions or at senior executive levels.

Another area of research into cooperative learning during this period was in cross-cultural comparisons. Cross-cultural differences were noted in a series of studies conducted by McClintock and his colleagues (McClintock & Moskowitz, 1976; McClintock, Moskowitz & McClintock, 1977; Toda, Shinotsuka, McClintock & Stech, 1978) involving the use of two-choice decomposed games (i.e., game experiments). The methodology is as follows: two children sit face to face with each other separated by a game board. Two smaller boards are attached, each with a yellow half and a blue half. Each child is assigned one coloured half. These half-boards have five holes into which a predetermined number of marbles were placed by the experimenter, and children take turns in making choices for themselves and their partner about the distribution of marbles. The outcomes of those choices for an individual and that of their partner were then studied. Four classes ascertain an individual’s preference: maximizing one’s own gain (individual choice), maximizing joint gains (collaborative choice), maximizing relative gain (competitive choice), or maximizing competition (rivalrous choice). McClintock investigated the choices of children in Flemish-Belgian, Greek, Japanese, Mexican-American, Anglo-American societies. Only boys (second through to sixth grade) were studied. The results indicated that competitive choices increased as a function of age in each culture. Cross-cultural differences were also noted: Japanese boys were the most competitive and Belgian boys the least. Anglo-American boys fell in the middle after Greek boys.
2.8 The Nineteen-Eighties to Present

Schmuck and Schmuck (1997) argue that during the 1980s, there was a marked decline in the USA federal government’s appetite to enforce civil-rights legislation written in the previous decade, and federal funding for what had come to be termed ‘effective’ school improvement was cut back. Instead there was a national drive for academic excellence and once again, according to critics, a de-emphasis of the affective processes and interpersonal relationships (p. 9). An issue, at present, is that the choice of an instructional approach: competition, cooperation or individual is mostly left to the teacher’s discretion, since social integration no longer appears to be a priority. Nevertheless, Schmuck and Schmuck note that a more established interest in the educational sector had developed for cooperative learning, perhaps due to the claims that it can facilitate both academic excellence and affective development (Schmuck & Schmuck, 1997, p. 11).

Certainly, this interest in cooperative learning is evidenced in the body of educational materials advising teachers about cooperative teaching methods and how to train children to cooperate in classroom settings. Johnson and Johnson who developed the “Learning Together” model (1975, 1994, 1999) and their colleagues are the most well known proponents of cooperative learning (Good & Brophy, 1991; Natasi & Clements, 1991; Stipek, 2002). The Johnson and Johnson team identify five essential elements for cooperation – positive interdependence, individual accountability/personal responsibility, face-to-face promotive interaction, interpersonal and small group skills, and group processing (e.g., Johnson, Johnson & Holubec, 1994). Classroom applications have been developed into a number of researched and refined approaches, some of which have already been mentioned in this background account. That is, it appears that classroom approaches to cooperation that were developed with a view to allowing social integration of ethnically disadvantaged minorities were adapted for the more general goal of enhancing the
academic and social development of all students. Among the best known methods in contemporary education circles are Group Investigation developed by Sharan and Sharan (1976), the Jigsaw Classroom developed by Aronson and colleagues (1978) and various other student team learning methods developed by Slavin and colleagues, including Team-Games Tournament (TGT) by DeVries and Slavin (1978), Student Teams Achievement Division (STAD) (Slavin, 1986), Jigsaw II, and Team-Assisted-Individualisation (TAI) (Slavin, 1985), all of which are reported to have achieved impressive results (Good & Brophy, 1991).

As well as drawing on previous programmes, psychology’s more typical concerns of individual development have been researched in relation to harnessing opportunities that may be available through cooperation. For example, peer tutoring has been investigated as a better way of optimizing individual outcomes or achieving a wider overall positive outcome for an entire class than relying on only the teacher’s tutoring role (Good & Brophy, 1991). One example of an interesting direction in cooperative learning is identifying where structures intending to elicit cooperation may in fact be detrimental. For example, where the context introduces additional opportunities for close comparisons that may draw attention to the differences in competence and status, this may have detrimental social-emotional ramifications. Bossert (1988) warns that low-achieving students, who are most consistently found to benefit academically from cooperative learning, are at a serious risk from this social-emotional effect. Thus, in seeking optimal learning conditions, it is becoming clear that the verbal interactions between dyadic members can be either beneficial or detrimental, and this affects children of all ability levels. For example, Webb (1991) found that in mathematics classes, students in dyads benefit from clear explanations in response to their requests for help and have their progress impaired if their partner’s explanations are unclear or simply tell the answer. This is not only a problem for medium
and low-ability children in mixed dyads, but surprisingly was found to have just as great an effect on high-ability homogeneous dyads who appear to overestimate their combined level of understanding and reduce their checking behaviours (Webb, 1991).

In other research, efforts have been made to elicit the power of social dynamics in order to build the self-concept of under-achieving male adolescents through group challenges such as in Outward Bound courses, some of which have also been adapted to have an academic component (Brookover & Erikson, 1975; Marsh, 1990).

Schmuck and Schmuck (1988) point out that some USA researchers have undertaken cooperative research internationally, for example, with Sharan and various researchers from Israel. Some influential contemporary research into cooperative learning is undertaken in Europe, such as that by Monteil and Huguet (1999) on social comparison, and the collection by Volet and colleagues (in Volet & Jarvela, 2001) that appears to be making advances in researching the social context on psychological outcomes as well as exploring the affective dimensions of learning. It should not be forgotten that many of the foundation psychologists influencing education in general were European, such as the social-constructivist, Piaget, whose ideas are taken up in the USA and elsewhere in efforts to develop techniques to elicit high-order thinking and verbal elaboration (e.g., Webb & Palincsar, 1996). Internationally, however, it would seem that the problem identified by Pepitone of the field’s earlier research – that social and interpersonal effectiveness in specific aspects of group processing were not necessarily related to improved academic outcomes – is also prevalent in research conducted outside of the United States. Certainly, this appears to be the case in some of the few Singapore studies into cooperative learning (e.g., Lee, Lim et al., 1997). This similarity is not very surprising since much of the Singaporean interest in cooperative learning has been influenced by American research. For example, Johnson and Johnson’s materials are well-known by USA teachers (Antil,
Jenkins, Wayne & Vaday, 1998), and more recently are beginning to find their way into schools in Singapore (Lee, Chew, Ng & Hing, 1999). Thus, in Singapore, it would appear that interest in cooperative learning is influenced by Western research. However, there has been very little research into cooperative learning taking place in non-Western or Asian countries (Lee, Lim & Ng, 1997).

In Singapore, both the classroom applications and school-based research into cooperative learning are relatively recent even though interest is growing in the academic realms. A problem for classroom applications in Singapore is that access to schools to undertake research into cooperation may be difficult. For example, research in Singapore has most commonly been undertaken in social studies which is not an examinable subject (Hing et al., 1999), and existing studies in those subjects did not find any significant academic advantage in cooperation. However, the existing studies are not necessarily fully representative of the possibilities in Singapore for cooperative learning because its various pedagogical approaches have only recently begun to be of interest amongst some teachers (Lee, Chew, Ng & Hing, 1999).

This chapter has outlined the main influences on social psychology which have strongly influenced the newer field of cooperative learning. The investigations in this thesis take up contemporary goals of using cooperative methods of learning to optimise the overall development of all individuals in academic and social-emotional domains. In other words, it has no overt political or social agenda, but seeks to investigate a number of aspects of the social-psychological mechanisms that can explain the different or enhanced outcomes for cooperative learning methods or individual learning methods.
CHAPTER 3

STUDY 1: THE OPTIMAL CONDITIONS AND TASK-STRUCTURES FOR INDUCING SUCCESSFUL COOPERATIVE LEARNING WITH POSITIVE EFFECTS IN THE COGNITIVE AND SOCIAL-EMOTIONAL DOMAINS

3.1 Introduction to Study 1

Cooperative learning is an instructional technique that involves structuring the learning environment to encourage students to work together to accomplish shared goals (Johnson et al., 1994). Cooperative learning situations, compared with individual learning situations, have demonstrated higher student academic achievement outcomes across a wide range of age levels, ethnic and cultural backgrounds and subject areas (Bossert, 1988; Johnson & Johnson, 1989; Johnson, Johnson & Stanne, 2000a; Lee, Lim & Ng, 1997; Nastasi & Clements, 1991). Furthermore, cooperative learning is considered to have potential benefits beyond enhanced academic performance in the student’s social-emotional domain (Bossert, 1988; Nastasi & Clements, 1991). Extreme proponents even suggest that the latter benefits are able to ameliorate social problems, such as by countering racism (Cohen, 1993), or that it can even achieve social and political stability (Bossert, 1988; Deutsch, 1993; Putnam, 1993).

Although many studies have reported positive effects for cooperative learning, there have also been substantial numbers of studies that have found no differences between cooperative learning and traditional methods of instruction (Anderson et al., 1997; Cohen, 1994a; CTEHP, 1994). There has been criticism of the huge number of practitioner-
oriented articles about cooperative learning that ignore the findings of no differences, and treat cooperative learning as an academic panacea (Anderson et al., 1997; CTEHP, 1994). Furthermore, little is known about why or how cooperative learning may lead to positive effects (if such effects even exist) in academic achievement and socio-emotional health (Killen, 1998; Slavin, 1996). This is because, whilst theories abound (as do research studies of questionable quality), there are only a few studies that have been effective in “untangling the various interactional processes that are part of cooperative learning” (Bossert, 1988, p. 226). Therefore, the overall goals of the thesis will be addressed by Study One in the following general ways.

Study One is based on an experiment with Singaporean Grade-5 students in three types of cooperative-learning conditions and one individual-learning condition comparing outcomes in the academic/cognitive domain of mathematical word-problem solving (MWPS) and the social-emotional domains of Maths–Self-Concept and Peer-Self-Concept (using relevant sub-tests of Marsh’s 1990 Self-Description Questionnaire I, SDQ-I). The aims of Study One are to identify optimal conditions for cooperative dyadic learning, to elucidate the essential elements that contribute to any beneficial effects (Bossert, 1988; Knight & Bohlmeyer, 1990), and to begin developing an integrated theory of cooperative dyadic learning that accounts for multiple outcomes affecting the cognitive, social and emotional domains. The specific focus for Study One will now be explicated.

3.1.1 Theoretical Perspectives of Cooperative Learning

According to Slavin (1996), there are four main theoretical perspectives on cooperative learning: (extrinsic) motivation, social cohesion, cognitive-developmental and cognitive-elaboration. Sometimes the perspectives are treated as competing paradigms or models. However, Slavin regards them all as relevant dimensions that contribute to our
understanding of the effects of cooperative learning. These perspectives will be reviewed in turn.

The *motivationalist* perspective (e.g., Slavin, 1996; Johnson & Johnson, 1989) is that Positive Interdependence (structures whereby group members must sink or swim together) is the primary cause of purposeful and supportive intra-group interactions. As such, group member attitudes are “promotive” in encouraging others to perform appropriately so as to achieve shared goals. Such interactions in turn are considered to lead to positive outcomes of cooperative learning (CTEHP, 1994). Johnson and Johnson’s (1989) social interdependence theory assumes that motivation is generated by joint aspirations to achieve a common goal; and by being part of this mutual effort. Hence, unlike individualistic learning environments that motivate people to compete with each other, group members in cooperative learning situations are aware that they will “sink or swim together”. As such, people in cooperative learning conditions are more likely than those in individual learning situations to want each other to succeed and would also enjoy helping each other succeed. Slavin (1996) supports this view but takes a more pragmatic perspective arguing that intrinsic motivation is rare in the non-voluntary school setting and inducements of interdependent rewards for group goals can motivate cooperation (e.g., the present study will use certificates of recognition for teams that meet predetermined criteria to motivate cooperation).

The *social cohesionist* perspective draws parallels with the motivationalist perspective, in that it is the cohesiveness of the group that leads to the success of cooperative learning (Slavin, 1996). In essence, it is believed that students in cooperative learning situations will help one another learn because of improved liking and enhanced concern amongst group members. Social cohesion theorists (e.g., Aronson, Blaney, Stephan, Sikes & Snapp, 1978; Cohen, 1986, 1994b) tend to downplay the use of group
incentives arguing for intrinsic motivation rather than extrinsic motivation. They also propose that schools can enhance social cohesion by structuring reliance amongst students in heterogeneous gender and ethnicity groupings.

_Cognitive_ research in cooperation typically aims to apply the theories of Piaget, Vygotsky and Sullivan (Damon, 1984), and many studies are designed to understand learning in dyads more deeply. In the _Cognitive-developmental_ strand, some research investigates the role of Piagetian stage development – especially concrete operational or formal operational stages that follow the more limited ego-centric, pre-operational stage – and investigate associated mechanisms of cognitive conflict between peers and intellectual disequilibrium as driving forces behind development (Perret-Clermont, 1980; Mugny & Doise, 1978). Other studies aim to estimate the role of Vygotsky’s zone of proximal development in order to calibrate the optimal differences between peers for improved peer learning outcomes (Kuhn, 1972). Typically it is the cognitive-developmental strand that investigates outcomes of homogeneous or heterogeneous groupings, usually by ability or competence level (e.g., Doise, Mugny & Perret-Clermont, 1975, 1976), and sometimes including non-cognitive comparisons, such as gender (e.g., Kohlberg, 1966; Bearison, Magzamen & Filardo, 1986).

_Cognitive elaboration_ in cooperative learning is typically concerned with explaining the processes that make cooperation effective. Webb’s (1989, 1991, 1993a, 1993b) research demonstrates that the most positive predictor of achievement is the giving of detailed, elaborated explanations (i.e., the student who does the explaining is the student who benefits). “Cooperative scripts” (Dansereau, 1988) and “Reciprocal Teaching” (King, 1994; Palincsar & Brown, 1984) are examples of strategies designed for students in a dyad or group to take turns to be the “teacher” (explainer) and the “student” (listener). These strategies apply Piagetian socio-cognitive notions whereby the children who take on the
teacher role are motivated to refine their thinking in their own elaboration, and whereby the children in the student role have the advantage of hearing the description from a peer who can use an appropriate language level and also pitch explanations to a similar comprehension level (Damon, 1984).

In brief, the four perspectives identified by Slavin are not mutually exclusive since learning and cooperating are complex behaviours. It seems theoretically viable that rewards can be used to induce students to take the correct approach to cooperative learning, with partners wanting to help each other because of an awareness that they can sink or swim together. This recognition should in turn enhance the chances of successful interpersonal relationships occurring. Within successful relationships, dyadic partners should communicate in ways that are useful to their learning.

3.1.2 Varieties of Cooperative Learning Structures

There are several ways of structuring cooperative learning. Three structures will be briefly described: Learning Together, Jigsaw/Jigsaw II and Think/Pair Share. For more detailed information on these structures or on other cooperative structures, see Bohlmeyer and Burke (1987) and Good and Brophy (1991). Defining features include task structures, which assign specific student roles, and reward structures.

Johnson and Johnson’s (1994) Learning Together model of cooperative learning involves four to five students learning in heterogeneous groups. The intention of this approach is to encourage students from different academic achievement levels, gender, race or ethnicity to work together on a common task. A single worksheet or project is the final product to be submitted for group assessment. The students are rewarded (usually praise) according to how well they worked together and for their performance on the task (Good & Brophy, 1991).
The Jigsaw approach (Aronson, Blaney, Stephan, Sikes & Snapp, 1978) arranges tasks to which each student in a group (of five to six) is given information that no other member has access. Just as a jigsaw puzzle cannot be completed unless each piece is included, the task/assignment cannot be completed unless each member contributes (Good & Brophy, 1991). Slavin (1986) developed a variation of Jigsaw that he called Jigsaw II. There are three essential differences between the two approaches. First, in Jigsaw, the teacher provides information which students are to learn and subsequently teach other group members. In contrast, in Jigsaw II students meet in “expert groups” (comprising students required to master similar sections of the material before teaching other group members) to gather/learn information from resource materials (e.g., textbooks) (Nastasi & Clements, 1991). Second, the difference is that in Jigsaw, each member is provided with only one part of the material to be learned; whereas in Jigsaw II, each member learns all the material from the curriculum unit but develops expertise on a specific area (Nastasi & Clements, 1991). Finally, in Jigsaw, rewarding is based on individual performances of a final individual post-test; and for Jigsaw II, students are rewarded on the basis of both individual and group (combined) performances (Nastasi & Clements, 1991).

The Think/Pair Share method (Kagan, 1992) is less widely researched but has gained popularity amongst teachers (Good & Brophy, 2000). This method is usually embedded within large lessons or activities. It comprises four steps. First, the teacher poses a question or problem to the class. Second, students are given time to think by themselves. Third, students are to discuss their ideas with a partner and, fourth, the teacher calls on some of the students to share with the whole class their own (and their partner’s) thinking. Often the focus is on preparatory thinking processes rather than completed work projects, so rewards are not a main feature of this method.
3.1.3 Identifying the Key Elements of Cooperative Learning

Cooperative learning is one small branch of social psychology and various attempts have been made to define the optimal conditions for its efficacy. Although there are several theories on the optimal conditions for cooperative learning, there is contention in the field. Therefore, the literature will be examined and evaluated in order to try to determine which elements are optimal for cooperation and especially cooperative learning. A number of theorists have postulated what they consider to be the essential elements of cooperation including Lewin (1948), Deutsch (1949a, 1949b, 1962, 2000), Johnson and Johnson (1999) and their various colleagues (e.g., Johnson, Johnson & Holubec, 1994) and Slavin (1990, 1995). Johnson, Johnson and Holubec’s “Learning Together Model” is presently the dominant theory, and it comprises five elements.

3.1.3.1 Johnson & Johnson’s Key Elements of Cooperative Learning

“Learning Together” appears to be the best-known contemporary model of cooperative learning and is commonly cited in the field (Good & Brophy, 2000; Lee, Ng & Jacobs, 1997; Stipek, 2002). Marzano, Pickering and Pollock (2001, p. 85), for instance, identify David Johnson and Roger Johnson as the recognized leaders of cooperative learning.

Johnson and Johnson (1999) list five “essential” elements of cooperative learning which they argue may reflect various stages of progress in successful group interactions and for which they consider the first element to be the most crucial. (Marzano et al., 2001, p. 85, paraphrased) outline the essential elements as follows:

1. Positive interdependence (i.e., a sense by members in a group that they will either “swim or sink” together)
2. Face-to-face promotive interaction (i.e., members providing one another with effective help and encouragement)
3. Individual and group accountability (i.e., each member being required to contribute towards achievement of the group goal)
4. Interpersonal and small group skills (i.e., members enact effective communication and conflict resolution)
5. Group processing (i.e., reflection after a joint task by members of the group on how well the group is functioning and making effective decisions about what actions to continue or change).

3.1.3.2 Three Essential Elements for Cooperative Learning Drawn from the Broader Field

Even though Johnson and Johnson are the best known contemporary cooperative learning theorists and researchers, and even though there do not appear to be other substantially developed models, there has also been substantial criticism of some of their work. When their ideas are compared with those of a range of other sources in the field, three of their five elements stand out as being considered important in the most consistent or in the most theoretically convincingly way.

Positive interdependence

Lewin (1947, 1948), in developing his field theory of a dynamic whole of interdependence, thus identified a key element for optimising cooperative conditions. The notion of interdependence was developed further by Deutsch (1949a, 2000) as either: “positive interdependence” which means ‘sinking or swimming together’ and is typical of cooperative conditions; or “negative interdependence” which means ‘swimming only
insofar as another is sinking” and is typical of competitive conditions. Johnson et al. (1994) also stipulate that positive interdependence (PI) is the single most influential element of the essential five elements in their Learning Together model of cooperative learning. Johnson and Johnson (1990, p. 28) explain that interdependence can lead to competition when it is negative or lead to cooperation when it is positive, but for students to be interdependent there needs to be “outcome interdependence (goal and reward interdependence)”, otherwise the learning environment is individualistic.

**Individual accountability**

There is agreement in the concepts of Johnson and Johnson and of Slavin, that Individual Accountability is one of the more important elements in cooperative learning. However, how important this element is for cooperative learning to be successful remains in question. For instance, when comparing Johnson and Johnson’s Learning Together method with Slavin’s Jigsaw II, the latter appears to have more individual accountability than the former. That is, in Jigsaw II each member has a portion of responsibility assigned through the task structure and must uniquely contribute towards completion or success of the project, whereas in Learning Together projects, it is possible that one member in a group could do all the work (Slavin, 1995).

**Group goals**

Another of Slavin’s proposed key elements is Group Goals, which is sometimes included by Johnson and Johnson, as will be explained later. In fact, Slavin (1995) proposes that Group Goals shares equal importance with Individual Accountability as essential elements for cooperative learning. Slavin further argues, based on his meta-analysis of studies, that the studies that incorporated those two elements enhanced the achievement
outcomes of cooperative learning if group goals were also recognized through group rewards¹.

Group goals is a concept that receives unclear treatment in the cooperative learning literature. Even in the Learning Together Model, which has developed over time, the essential elements have minor variations in the wording, and it would appear that group goals has at some point been added in, possibly following Slavin’s lucid account of the field. For example, in Marzano, Pickering and Pollock’s list of Learning Together elements, there is *Individual and group accountability*, described as each member contributing towards achievement of the *group goal* (2001, p. 85); as such, the elements of Individual Accountability and Group Goals are blurred together, thus, differing from Slavin’s usage of those terms. As evidence of the minor variations in the evolving Learning Together model, in Johnson et al.’s earlier work, what was and has remained the third item on their list, is termed, “*Individual Accountability/Personal Responsibility*” (1994, p. 26), whereby Individual Accountability appears to be conceptualized as an element meaning personal responsibility with no mention of group goals. However, in their more recently dated lists this third essential element in their model is, “Clearly perceived individual accountability and personal responsibility to achieve the group’s goals” (Johnson & Johnson, 2000b). “Group Goals” therefore appears to have been appropriated into their Learning Together model’s essential elements but does not constitute one of their own categories of elements. It is likely that this also helped balance out the conceptually contradictory inclusion of an individualistic concept of “personal responsibility” in their model, when they were arguing that learning structures are either cooperative or individualistic. The main distinction between the two major theorists can be summarised as follows: according to Johnson and

¹ Damon (1984), on educational grounds defending a dominant argument in the field that intrinsic motivation leads to better long-term learning outcomes, disputes Slavin’s stand, (despite being based on meta-analyses of studies), that rewarding cooperative learning is an important factor.
Johnson, in their proposals since 1996 or thereabouts, group goals are an inherent aspect of the element of Individual Accountability where students in groups or dyads understand how they should learn together rather than alone. In contrast, according to Slavin, Group Goals is a separate element distinct from Individual Accountability.

Thus, derived from several sources with different approaches to describing the essential elements in the field, there appear to be three elements commonly (but not universally) recognized as necessary in optimising cooperative learning outcomes. Listed in what seems to be their recognized order of importance, they are: Positive Interdependence, Individual Accountability and Group Goals.

### 3.1.4 Varieties of Group Composition for Cooperative Learning

The field of cooperative learning has used both small groups and dyads. Much of the research has focused on small groups, including that of Johnson and Johnson and their colleagues – whose Learning Together model contributes to the theoretical underpinnings for this PhD research. Other research has focused on dyads, often in relation to work that takes a theoretical position focusing on specific qualities of interaction and communication, such as Webb’s (1992) theory and investigations of cognitive elaboration. As such, research on both small groups and dyads contributes to the relevant findings of the field. However, whilst most researchers generalise the findings of dyads to larger groups and vice-versa, such generalising is not without problems, and this should be borne in mind. Levine and Moreland (1998), for example, state that the relationships in small groups and dyads are different, with peers’ conflict and bargaining taking different forms. Forsyth (1999) explains dyads as a special type of group, as follows:

*Dyads have many unique characteristics simply because they include only two members. The dyad is, by definition, the only group that dissolves when one member*
leaves and the only group that can never be broken down into sub-groups (or coalitions). (Forsyth, 1999, p. 6)

Furthermore, Forsyth (1999) explains that the literature abounds with varied definitions of groups. The definitions vary in terms of their basis, which is the occurrence of communication, influence, interaction, interdependence, interrelations, psychological significance, shared identity and structure. These, of course, are all important dimensions that would each apply in their own way to dyads and to groups. Nevertheless, Forsyth points out a problem that occurs in all fields describing complex phenomena, that there are multiple relevant aspects and any single empirical study can only undertake a relatively narrow focus.

Research into whether groups or dyads are the most effective units of learning suggest that it varies according to subject area and the participants’ experience in cooperative situations. Much of the research demonstrating the effectiveness of various group sizes in cooperative learning has emanated from studies of social studies programmes (Aronson, Bridgeman & Geffner, 1978). Group sizes of 3-5 students have been found to be optimal in subjects such as social studies because the group can benefit from having access to more perspectives that they can take into consideration (Nastasi & Clements, 1991). However, it has been suggested that in learning approaches or subjects where active participation or practice are pertinent (e.g., revision or preparation work) (Nastasi & Clements, 1991), that dyads or small groups are optimal because each member in a dyad has more opportunity to participate actively than when being in a larger group (Jacobs, 1998; Nastasi & Clements, 1991). Another situation where dyadic or small group size leads to better learning outcomes is where students are unaccustomed to cooperative work and can more easily gain experience in cooperating skills when placed in the smallest social
unit (Joyce, Weil & Calhoun, 2000; Lou et al., 1996). Thus, optimal group size depends on the learning goals pertinent to the subject area and students’ existing levels of skill in cooperation.

3.1.5 Non-Academic Outcomes of Cooperative Learning

A very important aspect of the cooperative learning field is its interest in associated effects on non-academic domains. In particular, peer relations and self-esteem are usually considered to fare better in non-competitive, supportive environments. Schmuck and Schmuck (1988) describe, in more depth than the cognitive and behavioural perspectives would typically consider, how performing academic tasks in front of peers helps students to develop themselves intellectually and emotionally.

As ... informal peer relations increase in power and salience, the individual student’s definition and evaluation of self become more vulnerable to peer-group influence. Each student’s self-concept is on the line within the classroom setting, where the quality of informal relationships can either be threatening or debilitating, or supportive and enhancing to the development of self-esteem. ... Emotion-laden interpersonal relationships that occur informally can affect the student’s self-concept which, in turn, can influence his or her intellectual performance. (p. 33)

Whilst many proponents of cooperative learning are interested in its affective socio-emotional aspects, measures of these have not been as well developed as in the cognitive domain (Volet, 2001). However, there have been studies of friendships and peer relationships (see Rubin, Coplan, Nelson & Lagace-Seguin, 1999, for review) and self-concept (e.g., Marsh, 1990) that make an important contribution, and are relevant and thus surprisingly under-developed concerns for the field of psychology.
A relationship has been shown between the learning context and its particular goals and self-concept. For example, Marsh (1990) described the relationship between self-concept and intervention programmes, as measured by his Self-Description Questionnaires (SDQs) designed for several age groups. He theorized that there is a relationship between the focus of intervention programmes and changes in the participants’ specific, relevant domains of self-concept. He was involved in two studies in Australia during the early 1980’s which examined the effects of Outward Bound courses that have the goal of building participants’ confidence, typically by setting demanding physical challenges and supporting participants in knowing how to stay focused on goals and not give up. Later, he compared the two courses: the Outward Bound Standard Course that had no academic component (studied by Marsh, Richards & Barnes, 1996a, 1986b, cited in Marsh 1990), and the other, the Outward Bound Bridging Course that did have an academic component along with less of the outdoor physical components (studied by Marsh & Richards, in press at the time, cited in Marsh, 1990). Although the courses had not been run as direct comparisons and had substantial differences between them, Marsh’s intention in comparing them was to extrapolate issues related to the very rare occurrence of effective changes in self-concept.

For the Standard Course, 26 groups of 17-25 year-olds taking part in a 26-day, residential programme were administered the SDQ-III on four occasions to track changes in self-concept: one month before the start of the course, on the first and last days of the course, and 18 months after the course completion. For the Bridging Course, which was adapted as an academic intervention for high school under-achieving boys, 5 groups (one per year over 5 years from the same school) with 11-16 participants comprising low-achieving Year 9 (13-16 year-olds, average age 14 years) males taking part in a 6-week
residential programme were administered the simpler form, SDQ-I, on three occasions: six weeks prior to the course, and on the first and last days of the course.

Of particular interest in Marsh’s analysis of these two intervention studies was the finding that differently designed, (i.e., academic or non-academic), Outward Bound intervention courses enhanced those facets of participants’ self-concepts that were most specific to the aims of the respective courses, and that both of the courses were also found to have significantly less effect on other facets of self-concept that were not the focus. That is, Marsh found improvements in Maths and Reading in the Bridging course but not the Standard course. Furthermore, the Bridging course led to improvements in Home and Parent Relations scales of self-concept. Marsh attributed this outcome to the fact that a deliberate intention of the course was to foster family support and parents’ expectation of success. That is, ahead of the course, parents were told to expect positive changes in their sons, and additionally, the course involved parents by having participants write to them asking for their support at home in relation to the goals they had identified and in overcoming their typical “stoppers” to achievement. In the Standard Course, Marsh found improvements in Peer-self-concept in line with his conceptual analysis of it being a main goal of that programme. As such, Marsh’s juxtapositions of results from the two studies shows that self-concept is domain specific rather than global and that intervention studies can influence the aspects of self-concept related to the specific, targeted academic or social domain.

3.1.6 Shortcomings of Research in the Cooperative Learning Field Relevant to Study 1

The literature suggests that the field’s existing research has high levels of inconclusive results (Anderson et al., 1997; Bossert, 1988; CTEHP, 1994; Slavin, 1995). Three inter-
related causes typically contribute to such a situation (Anderson et al., 1997; Marsh, 1990; Slavin, 1995):

1. Ineffective intervention programmes may occur. For example, a faulty programme, inexperienced teachers or inexperienced students may prevent cooperation from occurring, and, therefore, any effects measured cannot be attributed to what was intended to be induced by the intervention (e.g., cooperation).

2. Ineffective experimental design may occur. For example, a lack of proper control groups, ill-defined outcome measurements, or too weak an intervention or too small a subject sample that might affect significance. These could make results false or unavailable.

3. Poor research reporting or interpretation, especially of findings of no difference or negative results.

In the field of Cooperative Learning, discrepancies in findings can be attributed to design aspects, such as programme duration (under or over 20 hrs, Bossert, 1988; Slavin, 1995); training periods or conceptual and resource support for teachers; training of children to cope with the cooperation (Cohen, 1994a; Susman, 1998); and the optimal group size relative to the curricular subject (Lou et al., 1996).

Some factors are debated as to whether or not they optimize cooperative learning or falsely boost the results. For example, programmes of short duration may appear successful due to a novelty effect or, arguably, rewarding that may not be effective in the longer term. Other problems are a lack of focus especially in the reporting that does not differentiate between studies with regard to adequacy of controls, random assignments, subject matter, task type, age of participants, ability-structure and other issues of heterogeneity. In particular, the Committee on Techniques for the Enhancement of Human Performance (CTEHP, 1994) described how the widely used Learning Together model is promising, but
there is a need for each of its elements to be tested more rigorously. All of the investigations for the present PhD thesis are influenced by that model and to some extent allow aspects of it to be tested. In this Study One, a focus on the key elements of cooperative learning has been informed by the Learning Together model and other literature, and so the research findings will also be of value in regard to that broad goal of the field for the influential model’s elements to be tested.

3.1.7 How Study 1 will Contribute to Aims of the PhD Research Project

A quasi-experimental design will be used to compare learning outcomes for Individual learning conditions and Cooperative dyadic learning conditions in a maths programme.

a) For the overall aim of understanding the mechanisms for improving academic and social-emotional outcomes in cooperative learning: Study One investigates dimensions of Positive Interdependence (PI), identified as the most important dimension for successful cooperative dyadic learning, as well as Group Goals and Individual Accountability. As such, a control condition with Individual learning and three different Cooperative conditions that all have differing amounts of the purportedly essential elements will be compared in a programme for Maths. The experiment will determine how the elements of cooperative learning can be applied to task-structures to optimise the learning outcomes of dyads.

b) For the overall aim of designing cooperative learning intervention approaches that are likely to be successful: Most of the perspectives of cooperative learning identified by Slavin are taken into account as follows: Cognitive, insofar as the programme is academic and will measure changes in learning. Motivational, insofar as school programmes always have reward systems for learning outcomes (whether they are tangible or not), and this experiment will test for effects of ‘reward
interdependence’. Social-cohesive in that cooperative dyads are social and the experiment will compare Peer–self-concept outcomes for cooperative and individual learning structures. Additionally, Peer–self-concept will be compared across conditions since task-structure is considered to be a facet affecting peer relations. Although there are no comparisons for the Developmental perspective, all students are within the age-group for concrete-operations and should thus be capable of benefiting from cooperative dyadic learning interventions.

c) For the overall aim of developing an integrated theory of the effects of cooperative learning on different domains – academic, emotional/attitudinal and social: The following outcomes will be measured and compared across conditions: Maths academic outcomes, and Maths–self-concept scores and Peer–self-concept scores from Marsh’s Self-Description Questionnaire.

3.1.8 Research Design for Study 1

Study One has three important research strengths– its use of dyadic pairs as its group size, its inclusion of Rasch Modelling Analyses, and its use of proper control groups and well-conceptualized variables to test how cooperation is induced. These will be discussed in turn.

3.1.8.1 Dyadic Pairs as Cooperative Group Size

The use of dyads as the smallest group size rather than groups of 3–5 students was chosen for two main reasons that prioritized pedagogical effectiveness. First, dyads’ small group size is beneficial to the intervention’s subject matter; that is, it is suitable for a maths revision programme where practice by each member is very important (Jacobs, 1998; Nastasi & Clements, 1991). Secondly, cooperative learning methods are not widely used in Singapore, and thus more opportunities for cooperation to be learned and effectively
implemented would occur with dyads rather than larger numbers of group members (Joyce, Weil & Calhoun, 2000). Furthermore, there are research-related advantages to using dyads rather than larger social units in that identifying and analyzing the essential elements of cooperative learning is more straightforward (O’Donnell & Dansereau, 1992; O’Donnell, Dansereau, Hythecker, Larson, Rocklin, Lambiotte & Young, 1986).

3.1.8.2 Strengthening Statistical Reliability with Rasch Modelling Analyses

The levels of reliability are improved through the use of Rasch modeling for the analyses of results for the pre- and post-tests of cognitive/academic outcomes (for Maths Word Problem-solving using a test referred to as MWPS) and affective, social-emotional outcomes of Peer–self-concept and Maths–self-concept (using aspects of Marsh’s test referred to as SDQ). The assessment of learning outcomes (gains) requires the use of a pre-post experimental design. The validity of the results of such designs is sometimes questioned because two types of confounds can occur: if the same test is administered twice, practice effects may confound results; if parallel forms are used, differences in test difficulties may confound results (Whitley, 1996). However, the use of Rasch modeling statistically minimises for these confounds. These potential confounds apply equally to tests that have standardized norms (e.g., the SDQ tests) as to non-standardised tests; however, it is important to be especially careful in researcher-constructed tests (i.e., in this case the MWPS tests) to ensure that the results accurately represent the ranking of students’ performances.

Rasch modeling assumes a unidimensional test construct and creates an equal-interval scale for interpreting the data (Andrich, 1988). The linear model is fitted to the data and various indices of complete-data and individual-item fit are produced (Wright & Stone,
Person-ability scores and item-difficulty scores are then estimated from the model. These scores for person-ability and item-difficulty are mutually orthogonal – the item-difficulty estimates are mathematically independent of the participants’ abilities, and the person-ability scores are mathematically independent of the tests’ difficulties (Andrich, 1988). The Rasch person-ability scores are more precise than raw scores since they lie on a genuine interval scale and this in turn renders the between-person differences more meaningful (Wright & Stone, 1979). Rasch modelling is particularly useful because a person-ability can be ascertained at pre-test with one set of items; another person-ability estimate can be ascertained at post-test with a new set of items; and these scores can be assumed to lie on the same interval scale, provided there are at least some identical items to allow for benchmarking difficulty levels between pre- and post- item-sets for use in scale calibration (Andrich, 1988; Ludlow & Haley, 1995). Once the item sets are calibrated, it is no longer necessary to use all item-sets to define the observed variable. That is, in the present study, because three item-sets have been calibrated, any two of the different item-sets used for pre- and post-tests will be comparable, thus addressing the common confound from testing more than once. The item-sets’ unique items increase the validity of the tests by limiting practice effects and the calibration of difficulty limits the effects of inconsistent test difficulty from using different test items.

The item logits should be interpreted as: the higher the item-difficulty score, the more difficult the item. For example, a relatively difficult item will have a large logit whereas a relatively easy item will have a smaller logit. The expected range of these scores is eight (-4 to +4). However, in order to use Rasch modeling, there must be some overlap of the items presented in each test form to allow item calibration between parallel forms of the tests (Andrich, 1988; Ludlow & Haley, 1995).
Rasch modeling provides person-ability scores in the following way. With a Guttman scale principle, a person will give correct answers to items at their estimated ability level and below, but not items above their estimated ability level, which they will not be able to answer correctly. That is, if the individual patterns of successful and unsuccessful scores fits the model of the pattern of item-difficulty, this indicates that these scores are continuous in nature and therefore can be manipulated in the same manner as any other continuous variable (e.g., time – measured in seconds). Person-ability scores are logarithmic transformations of an ‘odds of success’ estimate and, importantly, these scores are on an equal interval scale. The participant is placed on the scale where they have a chance of getting the item right 50% of the time (i.e., probability, $p = .5$). A positive logit and a negative logit, respectively indicate performance greater than and less than 50% for a medium difficulty item. That is, the higher the score, the greater the individual’s ability. As such, item-difficulty and person-ability lie on the same scale, although calculations of these estimates are mathematically independent of each other.

3.1.8.3 Proper Control Groups and Well-Conceptualized Variables to Test How Cooperation is Induced

The strengths of this study’s design include the improvements it makes on much of the previous research, the problems of which have been outlined in the previous sections. It takes into account contemporary requirements for high quality research standards in the cooperative learning field (e.g., Anderson et al., 1997). For example, it combines the intervention in a classroom-based setting with clearly-defined comparison groups in the experimental design that identify the mechanisms of cooperation being investigated.

Bossert argues that, “a fundamental issue for developers of cooperative learning methods always has been how to induce cooperation (Bossert, 1988, p. 227). Varied
cooperative learning structures are used in comparative conditions, which have been adapted in this study for use in dyads. Study One’s Jigsaw–Dyadic-Task-structure condition (referred to as “Jigsaw-DT”) is an adaptation of the original two Jigsaw approaches specifically trying to encapsulate task-interdependence; its “Mutual Agreement” condition is a dyadic adaptation of group processes in the Learning Together model, and its “Side-by-side” condition is a dyadic adaptation of Think/Pair Share. Each of these cooperative learning conditions has a different combination of the essential learning elements of Positive Interdependence, Group Goals and Individual Accountability. Therefore, they are conceptualized in the present study as having theoretically different, rank-ordered potential to realize optimal outcomes for learning maths. As such, the identified essential learning elements can be varied in the conditions and the importance and accuracy of the underlying theoretical constructs will be tested, alongside finding the optimal condition. These main concepts underlying Study One are all represented in the following table:
Table 3.1:1.

Conceptualisation of Essential Learning Elements in Optimal Order by Learning Condition,
Showing Implied Score as Basis of Hypothesised Ranking of Efficacy for Optimal Outcomes

<table>
<thead>
<tr>
<th>Learning condition</th>
<th>Essential learning elements in order of importance</th>
<th>Total number of essential learning elements present in condition *</th>
<th>Hypothesised ranking of optimal combination of essential elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1&lt;sup&gt;st&lt;/sup&gt;)</td>
<td>(2&lt;sup&gt;nd&lt;/sup&gt;)</td>
<td>(3&lt;sup&gt;rd&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Jigsaw-DT</td>
<td>Positive Interdependence</td>
<td>Individual Accountability</td>
<td>Group Goals</td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Side-by-side</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Individual</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

* Totals are based on assigned scores for each element that when present are scored as 1, and when absent are scored as 0.

** Mutual Agreement is ranked as having the higher score of 2, with it based on the 1<sup>st</sup> & 3<sup>rd</sup> elements, compared to Side-by-side that has a lower score of 2, based only on the 2<sup>nd</sup> & 3<sup>rd</sup> elements.

3.1.9 Hypotheses

Two hypotheses were proposed for the gains in academic Maths (MWPS), Maths–self-concept (SDQ-I Maths) and Peer–self-concept (SDQ-I Peer).

1. **Cooperative Learning vs Individual Learning**: “Combined Cooperative” outcomes will be significantly greater than for Individual learning. (Note that the first hypothesis takes into account the averages for the three cooperative dyadic learning conditions under the name “Combined Cooperative” in comparing it to the Individual condition.)

2. **Optimal Cooperative Learning Condition**: Each of the cooperative conditions will produce significantly better outcomes than the Individual condition. Furthermore,
there will be significant differences between the cooperative conditions’ outcomes that will rank order them as follows: Jigsaw-DT; then Mutual Agreement; then Side-by-side.
3.2 Method of Study 1

3.2.1 Participants

Participants were 285 children in Grade-5 (mean age = 10:7, SD = 0.39; age range = 10:1 – 10:12) from five government schools (totaling eight classes) in Singapore. The number of children in each allocated experimental condition from each class and school is shown in Table 3.2:1. Note that the nominated class numbers do not indicate any academic standard.

Table 3.2:1.

<table>
<thead>
<tr>
<th>School</th>
<th>Class</th>
<th>Experimental Learning Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Individual</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>75</td>
</tr>
</tbody>
</table>

Note: Schools A and B each have only 1 class.

The ethnic composition of the sample of children participating was 199 Chinese (69.8%), 50 Malay (17.5%), 20 Indian (7.0%) and 16 "Other" (5.6%). There were 149 males (52.3%) and 136 females (47.7%). Each ethnic and gender category was evenly
distributed across the schools and classes. Recruitment of participants is described in the forthcoming Procedures section.

3.2.2 Design

The between-groups factor was the experimental learning condition and the within-participants factor was time of testing. A 4 (experimental learning condition: Side-by-Side, Mutual Agreement, Jigsaw-DT and Individual) x 2 (time of testing: pre-, post-) mixed design was employed. The dependent variables were MWPS (maths performance), SDQ-I Maths (measure of Mathematics–self-concept) and SDQ-I Peer (measure of Peer–self-concept).

3.2.3 Materials

3.2.3.1 Software for Mathematical Computer-Based Activities

A tutorial-based piece of software, Zarc’s ‘Primary Mathematics Adventure’ 5A series (Times Multimedia, 1999), was used in all schools. This software was recommended to schools by the Singaporean Ministry of Education to be used for Computer-based–Instruction. The format of tutorial-based software is as follows: students are presented with information on the topic, asked to attempt a set of questions and are provided with feedback on the accuracy of their responses (Merrill et al., 1992; Roblyer, Edwards & Havriluk, 1997).

3.2.3.2 Cooperative Learning Intervention Video

Segments of the Sesame Street video “Kids’ Guide to Life: Learning to share” (Kanter & Shiel, 1996) were shown to children in all Cooperative learning conditions. The video segments illustrated what constitutes cooperative behaviours (e.g., turn-taking and sharing) to assist children in understanding what would be expected of them in the dyads.
This choice was based, on the one hand, on an absence of video materials dealing directly with cooperative learning targeting this age-group and, on the other hand, because of the familiarity with Sesame Street characters by children in Singapore as well as Sesame Street’s reputation for having ethical and educational content.

3.2.3.3 Mathematical Word-Problem Solving (MWPS) Tests

3.2.3.3.1 Requirements for Parallel Forms of MWPS Tests

In order to measure learning gains over time, a pre-post-experimental design was used. To avoid the problems of practice effects and item-difficulty variation on different test forms. Person-ability scores were also obtained using the Rasch model (see section 3.1.8.2), allowing assessment of the relative levels of performance by each student in relation to the others.

3.2.3.3.2 Preliminary Construction and Pilot Study of MWPS Tests

A preliminary MWPS test had previously been constructed as a measure of MWPS ability (Chan, 2000). Three topics were included: Whole Numbers, Fractions, and Area of Triangles and Ratio. The items on the test were formulated by consulting the respective sections of the Singapore Ministry of Education’s primary mathematical syllabus (Curriculum Planning & Development Division, 1998), school textbooks, previous school mathematical examination and test papers, and assessment workbooks. The format adopted was similar to that of the schools’ past examination papers. Table 3.2:2 provides an example item for each topic.
Table 3.2:2.

**Example Item for Each Topic of the Maths Word Problem Solving Tests**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Example item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Numbers</td>
<td><em>A farmer had 70 ducks and 80 hens. He sold 45 ducks and 36 hens. How many more hens than ducks had he left?</em></td>
</tr>
<tr>
<td>Fractions</td>
<td><em>In an examination 32 out of 40 pupils passed. What fraction of the pupils failed the examination? Express your answer in the simplest form.</em></td>
</tr>
<tr>
<td>Area of Triangle and Ratio</td>
<td><em>The ratio of the height of a triangle to the length of its base is 5:8. Find the area of the triangle if the length of its base is 24 cm.</em></td>
</tr>
</tbody>
</table>

The present study re-used evidence from the researcher’s pilot study in her Honours research (Chan, 2000) to establish the reliability of the test-construction methodology used in this PhD study. In the Honours study, to determine the suitability of the items and the time required for the test, 16 items were piloted on 70 Grade-5 children in three schools in Singapore (Chan, 2000). Item-difficulty indices (pi, Gregory, 2000 — NB: not Rasch logits) revealed that the items ranged from .13 to .99 indicating that there was a full range of item-difficulties (Chan, 2000).

The pilot study also demonstrated the reliability of teacher ratings (Chan, 2000). Five teachers with at least five years teaching experience in Grade-5 mathematics were asked to rate the difficulty of each of 150 MWPS pilot test items on a 10-point scale that ranged from 1 (extremely easy) to 10 (extremely difficult). The correlation between the mean teacher ratings and item-difficulty was .50 ($p = .48$, $n = 16$), suggesting that teacher ratings corresponded reasonably well with the objective difficulty levels of the items.
Table 3.2:3 provides a brief description of the items in each difficulty level group and the purpose of including the different levels in Grade-5 researcher constructed tests (for both previous Honours and the present PhD studies).

Table 3.2:3.

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Grade-4 standard.</td>
<td>‘Warm-up’ items</td>
</tr>
<tr>
<td></td>
<td>Grade-5 students can complete these with ease.</td>
<td></td>
</tr>
<tr>
<td>3-8</td>
<td>Grade-5 standard.</td>
<td>Assessing Grade-5 MWPS competence.</td>
</tr>
<tr>
<td></td>
<td>Difficulty level 3 items assess the children’s knowledge of the basic concept and usually involves only one step. Difficulty level 8 items comprise more complex multiple-step problems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>An average Grade-5 student is believed to be capable of competently answering items up to level 6 but may experience difficulty with items at level 7 and above.</td>
<td></td>
</tr>
<tr>
<td>9 - 10</td>
<td>Grade-6 standard. Only very competent (advanced) students may be able to answer these questions.</td>
<td>Assessing beyond Grade-5 competence.</td>
</tr>
</tbody>
</table>

### 3.2.3.3 Final MWPS Tests

The pilot testing was the only part of the researcher’s former Maths Word Problem Solving (MWPS) research that was re-used in the present study. Two hundred new items were constructed for the PhD research using similar sources to those used for the pilot items. A full range of item-difficulties (i.e., difficulty levels 1 to 10) was used, instead of
just the level 3-8 items optimal for Grade-5’s, for three reasons. First, the goal of the study was not to differentiate between pass and fail levels, but instead to obtain a fine-grained measure of participants’ scores. Second, both Study 1 and (later) Study 2 were conducted as holiday programmes, attracting ability groupings ranging from high- to low-achieving participants and requiring the full range of abilities to be catered for to prevent floor or ceiling effects. Third, having only difficult items would have been detrimental to the confidence of low-achieving participants.

Two parallel forms (A and B) of the MWPS test were constructed for the current study. These tests were presented to participants in the form of a "Revision Exercise". The word ‘test’ was not used with participants due to the association with school assessment. Since the intervention was part of a holiday programme rather than actual school assessment, this delineation was necessary. However, for discussion in the rest of this description, the term ‘test’ will be used.

The two final 60-items MWPS tests were constructed in the following manner:

1. Five teachers with at least five years teaching experience of Grade-5 were asked to rate the difficulty of each item on a 10-point scale ranging from 1 to 10 (refer to ratings from pilot study).

2. Items that displayed the higher inter-rater reliability (items for which the range of between-rater difficulty scores did not exceed 1) were retained.

3. Retained items were separated into 10 item-difficulty–banks for each topic so that items of similar difficulty and topic were grouped (e.g., difficulty level 1 items from Whole Numbers formed item-bank 1, Whole Numbers).

4. Three item-sets of 10 for each topic were created by randomly selecting one item from each item-difficulty–bank.
5. Within each item-set (per topic), the items were ordered according to level of difficulty from 1 (extremely easy) to 10 (extremely difficult).

6. Two forms were created by combining two of the three item-sets per topic. There was an overlap of one item-set (for all three topics) for both forms. The overlapped items formed the odd items in each form. The overlap is a Rasch modeling requirement to locate items from two different sets onto the same scale (Andrich, 1988).

Thus, each form contained 60-items, comprising 2 items from each of the ten difficulty levels for each of the three topics (see Accompanying Appendix A.1.1 for sample items; Electronic Appendices E.1 for full set of items). The mean teacher ratings and Rasch item-difficulty scores were found to be strongly positively correlated ($r = .89, p < .0001$). As had been previously demonstrated in the pilot study, this correlation demonstrated that the teacher ratings were a valid measure of the objective difficulty for a student to tackle the items.

### 3.2.3.3.4 Reliability

Split-half reliability, corrected for length using the Spearman-Brown method, was established by correlating the sum of the odd items with the sum of the even items for Form A and Form B for both the pre- and post-tests. Coefficients ranged from .86 to .91 (see Electronic Appendix E.1.2). Test-retest reliability was ascertained by correlating the odd items at pre-test with the odd items at post-test that followed after a period of ten days. The reliability coefficient, corrected for length using the Spearman-Brown method was .85 ($n = 223, p<.001$). Thus, there was evidence that the MWPS tests were reliable in terms of being internally consistent and stable over time.
3.2.3.5 Validity

Content validity of the MWPS tests was established through expert ratings (five teachers with a minimum of five years teaching experience). Criterion-related validity was established by correlating MWPS pre-test results with the combined mathematical assessments of each school. The school assessments were based on a combination of continual school assessment and mid-year examination results. Criterion-related evidence reached highly satisfactory levels, ranging from .54 to .95 (see Electronic Appendix E.1.3).

3.2.3.4 MWPS Worksheets

The use of the worksheets for Maths Word Problem Solving enabled consistency of the programme with regard to content and practice items. Furthermore, the instructions to students on how to use the worksheets could be adapted for each of the different conditions to support differences of task structures, allowing ease of implementation by the teachers. There were a total of six worksheets – two worksheets for each topic (See Accompanying Appendix A.1.1 for sample items; Electronic Appendix E.1.4). The item-difficulty of worksheet items corresponded to difficulty levels 3 to 8 (pitched for Grade-5 level) of the MWPS tests (refer Table 3.2:3). The items on the worksheets were constructed in the same manner as the items on the MWPS tests. For each worksheet, each level of difficulty was represented by two items. Hence there was a total of 12 items per worksheet. There were three parts to each item (Parts a, b and c). Part (a) and (b) are independent of each other, and Part (c) requires some combination of answers from Part (a) and Part (b). This was necessary for adjusting the task-structure across the various cooperative learning conditions.
3.2.3.5 Progress Card

The Progress Cards (see Accompanying Appendix A.1.2), for recording of children’s Target Score for each topic (see discussion on Target Score in the Procedure section below), were marked with empty spaces where a “good work” stamp could be placed to indicate meeting the target. The purpose of the progress card was threefold. Firstly, it provided feedback to participants on their MWPS pre-test (see Feedback Score in Progress card, Scoring). The pre-test was not returned to participants so as to minimize discussion and familiarity with items, which may have affected post-test results. Secondly, the progress card was used to set individual targets for participants to work towards when attempting the worksheets. Thirdly, the progress card was used to plot/chart the performance of participants. The intention was for the progress cards to also serve to encourage participants (through a Token economy, e.g., accumulating stamps) to achieve their individual targets and, in some of the conditions, to encourage participants to help their partners achieve their targets (refer to description of Rewarding System in Procedure section).

3.2.3.6 Self-Description Questionnaire I

The 76-item SDQ-I is a self-report measure of Shavelson’s hierarchical model of self-concept (Marsh, 1990). The SDQ-I assesses three areas of academic self-concept (Reading, Mathematics, and General School), four areas of non-academic self-concept (Physical Ability, Physical Appearance, Peer Relationships, and Parent Relationships), and General Self self-concept (Marsh, Craven & Debus, 1991). Each of the eight scales consists of eight items. Only the Mathematics Scale (SDQ-I Maths) and Peer Relations Scale (SDQ-I Peer) are of particular interest to the current study's hypotheses, and these were the only ones that were administered because Marsh (1990) found the scales to be
domain-specific, hence only they are described in the following section. For a description of the remaining scales, refer to Marsh (1990).

The SDQ-I Maths measures the participant’s self-concept regarding their ability, enjoyment and interest in mathematics. An example of an item on the SDQ-I Maths is, “I look forward to mathematics.” (Marsh, 1990). The SDQ-I Peer measures the participant’s self-concept regarding their popularity with peers, how easily the participant makes friends, and whether others want to befriend them. An example item is: “I have lots of friends.” (Marsh, 1990).

The SDQ-I was used in this study for three reasons. Firstly, it had relevant scales to measure mathematics and Peer–self-concept. Secondly, it has been widely used on Asian populations (Watkins & Cheung, 1995; Watkins, Dong & Xia, 1997) and is suitable for use with Grade-5 participants (being commonly used with Grade-4 to Grade-6 children; Marsh, 1990). Finally, it has desirable psychometric properties. The reported coefficient alpha estimates of reliability for SDQ-I Maths and SDQ-I Peer are .89 and .80 respectively (Marsh, 1990). Criterion-related validity for the SDQ-I Maths, demonstrated by correlating the SDQ-I Maths and mathematical academic achievement, ranged between $r = .17$ to $.55$. Criterion-related validity for SDQ-I Peer, demonstrated by correlating the SDQ-I Peer and the measure of perceived social competence in Harter’s Perceived Competence Scale (Harter, 1982), was $r = .74$.

### 3.2.3.7 Rasch Unidimensional Measurement Modeling Programme

A Rasch unidimensional measurement modeling programme, RUMM 2010 (Andrich, Lyne, Sheridan & Luo, 2001), was used to convert MWPS, SDQ-I Maths and SDQ-I Peer scores to Rasch logits (person-ability and item-difficulty scores).
3.2.4 Procedure

The researcher obtained written permission from the Ministry of Education in Singapore and the principals of the five government schools to conduct research in the form of a mathematics holiday revision programme to be held during the break for the school mid-year. The duration of the programme was ten days, with each day's session lasting two hours, totaling 20 hours for the whole programme. Approximately four hours was taken by test administration, so the learning programme was 16 hours, 20% short of the recommended 20 hour minimum time (Slavin, 1995).

Each class was randomly allocated to either the Individual condition or one of three Cooperative conditions: Side-by-Side, Mutual Agreement, and Jigsaw-DT (see Table 3.2:1). No two classes in the one school (where applicable) were assigned to identical experimental learning conditions so as to avoid confounding the school with the effects of the experimental learning condition.

Qualified teachers, who did not work in the schools used in the experiment, were hired to administer the intervention and tests. The teachers were blind to the different conditions and were randomly allocated to a class. The teachers were told that the purpose of the study was to scientifically determine the optimal learning condition for maths classrooms. Each teacher received a verbal briefing independently and an information sheet describing the experimental learning condition to which he or she had been assigned (see Electronic Appendix E.1.5).

On the first day of the programme, participants individually completed all eight scales of the SDQ-I self-concept test (untimed; administration time approximately 15 to 20 minutes). Standardized instructions from the manual (Marsh, 1990) were read out loud by the teacher. Participants responded to each of the items on a 5-point scale: 1 = False, 2 =
Mostly False, 3 = Sometimes False/Sometimes True, 4 = Mostly True, and 5 = True. Thus, total scores for each scale could range from 8 to 40.

Upon completion of the SDQ-I, children individually completed the Maths Word Problem Solving (MWPS) pre-test (timed: 1 hour 30 minutes). The time period may sound long to people outside of Singapore, but it is not an unusual occurrence in Singapore. Half of the children in each class completed Form A, while the other half completed Form B. Teachers informed participants that the MWPS pre-test (i.e., the Revision Exercise) was a quiz of their mathematical knowledge and they should give their best effort. Children were then instructed to work as quickly as possible, and to skip questions that they could not answer but to return to them later if time permitted. An item was scored 1 for a correct answer, and 0 for a non-attempt or incorrect answer. Thus, pre- and post-test scores for the MWPS tests could each range from 0 to 60.

Teachers, who had previously been shown how, then calculated “Feedback scores” of MWPS pre-test and set individual maths “Target scores” for use by students during the programme. To calculate the feedback score for each topic of the MWPS pre-test, only difficulty levels 3 to 8 (levels of Grade-5 standard) were considered. Regardless of form (i.e., Revision Exercise A and B were treated similarly), correctly answered items were given a score of 5 and items incorrectly answered or not attempted were given a score of 0. Thus, the feedback score for each topic (12 questions in total) could range from 0 to 60.

The target score for each topic was calculated by adding 10 points to the feedback score, and those 10 points represented a goal for children to reach one level of difficulty higher than the participant had achieved at pre-test. That is, the test included two items at each level, each worth 5 points. Thus it was assumed that children making progress would have answered questions up to a particular level but not beyond (i.e., the Guttmann scale assumption), and progress would allow them to achieve at a higher level. The maximum
target score was set at 60, the highest possible even when feedback scores were greater than 50.

On the second day of the programme, teachers gave each child a Progress Card detailing the participant’s feedback score and target score (calculated by the teacher). Teachers explained how the feedback and target scores were derived and how the reward system operated.

A target-scoring approach allows targets to be set based on individual performance. It is important to set such multiple criteria that allow for individual differences rather than using the same criterion for all children because they are less likely to make comparisons directly with their peers (Midgley & Urdan, 1992). Furthermore, recognition of accomplishment will be more genuine because, when there is only one set of criteria, it tends to be too low for high-achievers and too high for low-achievers. That is, the use of individual target scores may serve both to challenge (‘stretch’) the abilities of high-achieving students — who may too readily receive rewards if there is a uniform criterion at a moderate or low level (Midgley & Urdan, 1992) — and serve to motivate low-achieving students to make a reasonable effort through their having reason to believe they have a chance of being rewarded (Brophy, 1998; Stipek, 2002).

At the start of the intervention, children in Cooperative learning conditions were shown segments of the cooperative learning video. Participants were asked to identify the theme of the video (i.e., cooperation). The teacher explained that cooperative learning is about a willingness to take turns, share ideas, discuss concepts and help each other learn. The teacher then randomly placed participants into pairs (i.e., numbers recorded on the class register were put into a box and drawn). Participants were asked to introduce themselves to their partners and to discuss how they could work as a pair. Pairs were then
asked to share their ideas with the class. Participants in the Individual learning condition, on the other hand, were told to sit, listen quietly and not to talk to each other during class.

For Cooperative learning conditions, participants shared a computer terminal. For the Individual learning condition, participants worked individually on separate computer terminals. New topics all needed to be covered but were commenced at each teacher’s discretion to allow them to best judge any adjustment to explanation or revision needs for their class.

Figure 3.2:1 shows a diagrammatic sequence of the intervention for the three Maths Word Problem Solving (MWPS) topics.
Figure 3.2.1  Diagrammatic Sequence of the Maths Word Problem Solving Intervention for Whole Numbers, Fractions, and Area of Triangle and Ratio
All participants began with the computer-based presentation of the topic. Children then attempted the software’s maths problems on the topic (Computer-Based Instruction Worksheets). For Cooperative learning conditions, pairs were told to reach agreement on their answers prior to entering them into the computer. For Individual learning conditions, participants were told to enter their own answers without discussion.

Upon completion of the computer-based activity, participants completed the first MWPS worksheet (pencil and paper) for the respective topic. The worksheets were divided into three parts (total 12 items). The instructions for completion of the three-part worksheet (Parts a, b and c) varied according to the experimental learning condition.

In the Jigsaw-DT condition, the worksheets were the most complicated: Parts A and B had perforations between the questions and the answer, and Part C had more questions that relied on figures from the answers in the previous parts (see Electronic Appendix E.1.4.4). Participants were told to complete different set parts each of a shared worksheet. That is, Member A was instructed to complete all 12 items on Part (a) of the worksheet, whilst Member B was instructed to complete all 12 items on Part (b). During this stage, no discussion was permitted. Children then detached their answers from the question items, and used these answers to complete Part (c). When completing Part (c), participants were told to work with their partners and to reach agreement before moving to the next item. Participants were instructed to take turns in writing the answer. The time-limit for Part (c) was 20-minutes (total of 40-minutes for whole test). Both members were given the same mark for the worksheet.

Participants in the Side-by-Side and Mutual Agreement conditions were also given 40-minutes to complete the worksheets. In the Side-by-Side condition, participants worked on identical worksheets and were allowed to discuss items with their partner but had to hand in separate worksheets. They were assigned individual marks. In the Mutual
Agreement condition, participants were told to work together on one worksheet and to reach agreement on each answer before moving to the next item. Participants were instructed to take turns in writing the answer. Both members of a pair were assigned the same marks.

Participants in the Individual learning condition were not permitted to discuss their solutions or to ask for assistance from their classmates when completing the worksheets. Participants in the Individual learning condition were given 40-minutes to complete their worksheets.

For all experimental learning conditions, the assignment of scores was as follows: The marks for each worksheet could range from 0 to 60. Part (a) and Part (b) were worth 1 mark each and Part (c) was worth 3 marks. Part (c) had a greater weighting than Part (a) and Part (b) so as to facilitate a positive interdependence scenario in the Jigsaw-DT condition. Participants in the Jigsaw-DT condition could only meet their targets (see section: ‘Target Score in Progress Card, Scoring’) if each individual member completed their respective parts correctly and also if the pair completed the combined part correctly.

The completed worksheets were marked as a class. Participants exchanged papers with their classmates (but not with dyadic partners) and were required to mark their classmate’s paper. Participants were chosen at random to explain their solution to an item on the board (Slavin, 1995). This served to encourage individual accountability within pairs (i.e., to minimize copying and ‘free-riding’). As children did not know when or whether they would be called, they had an incentive to make sure that they understood the solution to each problem before writing answers down on the worksheet (Stipek, 2002). The teacher went through the solution for each question on the board after the child had explained his or her solution. Participants were told to add the scores for the worksheet they had marked. The teacher collected the worksheets and returned them to the respective
participants. Stamps were given to participants who had achieved their targets. The
teacher then collected the worksheets (so as to monitor the performance of the class). On
the following day, participants attempted the second worksheet. A similar sequence of
marking and rewarding as per Worksheet 1 was adopted for Worksheet 2, the completion of
which marked the end of the teaching/learning segment of the topic. The sequence was
repeated until all three maths word problem solving (MWPS) topics were completed.

On the last day of the intervention, the SDQ-I self-concept tests were re-
administered, followed by the MWPS post-test. For the MWPS post-test, participants were
told that the purpose of the Revision Exercise was to ascertain their progress in the maths
intervention and that it was not used to set targets. Other administrative instructions were
similar to those of the MWPS pre-test. Participants who completed Form A for the pre-test
completed Form B for the post-test and vice-versa. The teacher then gave prizes to
participants who met the criteria for rewards. The reward system was based on a token
economy paradigm. For the Side-by-Side and Individual learning conditions, participants
each received a stamp for each worksheet if target scores were achieved. For the Mutual
Agreement and Jigsaw-DT conditions, children each received a stamp if both they and their
partner met their respective target scores (i.e., positive interdependence). Children,
regardless of the condition, could receive a maximum of six stamps. Children could
exchange four, five and six stamps for a sticker, a pencil and a certificate, respectively.

At the close of the programme, the teacher thanked participants, advising them to
continue doing their best for their future progress in mathematics, and gave out to all
participants a small, tangible acknowledgment of participation in the form of plastic files
printed with the words, “Maths Holiday Programme”. The researcher met the teachers at
the end of the programme, and received verbal input about their experiences in the
programme, that mostly concerned their observations of student reactions and their recommendations for improvement of future programmes.
3.3 Results of Study 1

3.3.1 Overview of Section

This section is divided into three main sub-sections: preliminary analyses, main analyses and summary of findings. The preliminary analyses describe the raw score conversion of three dependent variables: Maths Word Problem Solving (MWPS), Maths–Self-concept (SDQ-I Maths) and Peer–Self-concept (SDQ-I Peer) using Rasch modeling methods. The outcomes of data screening procedures are also reported. The main analyses examine two hypotheses addressing each of the three dependent variables. The first hypothesis predicts that the “Combined Cooperative” conditions will have significantly greater gains than the Individual condition on all three dependent variables from pre- to post-test. (NB: The term “Combined Cooperative” conditions does not mean an actual condition but refers to results data composed from the three co-operative conditions). Following on, the second hypothesis predicts that there will be greater gains for each dependent variable in cooperative conditions in order of highest to lowest levels of the elements Positive Interdependence (PI), Group Goals, and Individual Accountability (IA). Hence, it was predicted that Jigsaw-DT would have the greatest gains, followed by Mutual Agreement, Side-by-Side and Individual conditions. Some additional relevant information from teachers is then described. The chapter concludes with a summary of the results.

3.3.2 Preliminary Analyses

3.3.2.1 Raw Score Conversion – Rasch Modeling Analyses

The data is well-suited to Rasch modeling analyses, having notably very high item separation indexes for MWPS ($r = .90$), SDQ-I Maths ($r = .94$) and SDQ-I Peer ($r = .87$). Item separation refers to “the ability of the test to define a distinction hierarchy of items along the measured value. The higher the number, the more confidence can be placed in the
replicability of item placement across other samples” (Bond & Fox, 2001, p. 46), and the maximum is 1. Therefore, for all three dependent variables, there is great certainty that item estimates can be replicated when given to other samples to whom it is suitable.

Rasch modeling analyses were performed on participants’ pre- and post-test scores for MWPS, SDQ-I Maths and SDQ-I Peer. A significant chi-square indicated that the data deviated significantly from the linear model for MWPS ($\chi^2 (267) = 633.35, p<.001$), SDQ-I Maths ($\chi^2 (24) = 54.54, p<.001$) and SDQ-I Peer ($\chi^2 (24) = 56.62, p<.001$). It is not surprising that there was a significant chi-square indicating a misfit to the linear model, given the large sample size. “[W]ith a large sample the parameters are estimated with great precision and any misfit is readily exposed. This does not mean that the model is not useful in capturing some of the essentials of the data” (Andrich, 1988, p. 64). Notably, there was only one individual item in the MWPS data that deviated significantly from the Rasch model and was subsequently removed. For SDQ-I Maths and SDQ-I Peer, no item deviate significantly from the model. The analyses to follow use Rasch scores, which transform the original ordinal scale raw scores onto an interval scale where negative scores are low and positive scores are high.

3.3.2.2 Data Screening Procedures: Children’s Data Excluded from Analyses

After the Rasch analyses, children with poor attendance (less than 70%), an incomplete data set (i.e., missing either pre- or post-test) or with extreme scores were excluded from further analyses (see Table 3.3:1). Exclusions were fairly evenly distributed across conditions. The approach to excluding extreme scores was chosen in preference to transformation procedures as the latter are difficult to interpret and may not represent natural phenomenon being studied (Tabachnick & Fidell, 1996). Univariate outliers were
defined as three or more standard deviations above or below the mean (Tabachnick & Fidell, 1996). Multivariate outliers were defined by a probability estimate for a Mahalanobis’ distance of less than .001 (Tabachnick & Fidell, 1996). To test for influential points, Cook’s distance was calculated. Pedhazur (1997) advises that data points with “unusual” Cook distance scores should be removed from the analysis. A score ± 3 standard deviations from the mean was used for the exclusion criterion.

The number of incomplete data sets was high for the following reasons: the holiday programme was not compulsory; it was run during the school holidays; and in some schools, it clashed with other optional activities. Due to time constraints and the need to avoid whole-class disruptions to the programme, tests could not be re-administered for absentees.
### Table: 3.3:1.

**Number of Children’s Data Excluded from MWPS, SDQ-I Maths and SDQ-I Peer Analyses**

<table>
<thead>
<tr>
<th></th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Poor Attendance</strong></td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>(7.72%)</td>
<td>(7.72%)</td>
<td>(7.72%)</td>
</tr>
<tr>
<td><strong>Incomplete Data Set</strong></td>
<td>42</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>(14.73%)</td>
<td>(18.94%)</td>
<td>(18.94%)</td>
</tr>
<tr>
<td><strong>Univariate Outliers</strong></td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(1.05%)</td>
<td>(0.35%)</td>
<td>(2.10%)</td>
</tr>
<tr>
<td><strong>Multivariate Outliers</strong></td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(0.35%)</td>
<td>(1.05%)</td>
<td>(2.10%)</td>
</tr>
<tr>
<td><strong>Influential Points</strong></td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(1.75%)</td>
<td>(2.10%)</td>
<td>(2.45%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>73</td>
<td>86</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>(25.61%)</td>
<td>(30.17%)</td>
<td>(33.33%)</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are a percentage of the total sample.

### 3.3.3 Main Analyses: MWPS, SDQ-I Maths and SDQ-I Peer

The mean Maths Word Problem Solving (MWPS), Maths–Self-Concept (SDQ-I Maths) and Peer-Self-Concept (SDQ-I Peer) pre- and post-test scores for each experimental learning condition and the combined data for cooperative conditions are shown in Table 3.3:2. To investigate whether the experimental conditions were matched at pre-test, one-way Analysis of Variance (ANOVA) was conducted on all dependent variables’ pre-test scores. Equivalence is important to establish the extent to which there is reasonable basis for comparison of experimental effects alone.
Table 3.3:2.

Mean (and Standard Deviation) Pre- and Post-Test Scores for MWPS, SDQ-I Maths and SDQ-I Peer
for Each Experimental Learning Condition with Additional “Combined Cooperative” Data

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>Individual</td>
<td>64</td>
<td>-0.21</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.11)</td>
<td>(1.08)</td>
</tr>
<tr>
<td>“Combined Cooperative” data</td>
<td>148</td>
<td>-0.82</td>
<td>-0.48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.01)</td>
<td>(1.15)</td>
</tr>
<tr>
<td>Side-by-Side</td>
<td>47</td>
<td>-0.39</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.16)</td>
<td>(1.26)</td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>48</td>
<td>-1.19</td>
<td>-0.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.98)</td>
<td>(1.17)</td>
</tr>
<tr>
<td>Jigsaw-DT</td>
<td>53</td>
<td>-0.86</td>
<td>-0.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.74)</td>
<td>(0.88)</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>-0.64</td>
<td>-0.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.08)</td>
<td>(1.20)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent standard deviation.

The one-way ANOVA indicated that the experimental conditions were not matched at pre-test for MWPS ($F(3, 208) = 10.21, p <.001$) and SDQ-I Maths ($F(3, 195) = 4.36, p =.005$). To identify which experimental conditions were not equivalent at pre-test, Slavin’s (1995) criterion for cooperative learning studies was used: that is, differences between pre-test scores for conditions should be within 50 percent of a standard deviation of one another. From Table 3.3:2, it is noted that for MWPS, the Individual learning condition had
greater MWPS pre-test scores than the Mutual Agreement and Jigsaw conditions. In addition, the Side-by-Side condition also had greater mean pre-test score than the Mutual condition. For SDQ-I Maths, it is noted that Individual and Side-by-Side conditions had greater means at pre-test than the Mutual Agreement condition. These differ from each other by Slavin’s (1995) criteria.

By using the gain scores (for the difference between post- and pre-test), the Rasch analysis can help to address the statistical difference in equivalence between conditions, as the gains would be on a linear equal-interval scale and therefore would be comparable. Slavin suggests that such checks need to be used when it is not possible to use random assignment to condition. However, despite conditions being randomly assigned to the available groups in schools, it was not possible to randomly assign the participants to the groups. Thus, it will be necessary to exercise care in interpreting pairwise comparisons for the unmatched conditions due to the possibility of psychological differences.

The one-way ANOVA indicated that the experimental condition were matched at pre-test for SDQ-I Peer ($F(3, 186) = 1.84, p = .140$). Therefore, there is a basis for assuming equivalence in comparisons.

For each of the three dependent variables, 2 (times of test: pre-, post-) x 4 (experimental conditions: Individual, Side-by-Side, Mutual Agreement and Jigsaw-DT) Split-Plot Analyses of Variance (SPANOVA) were conducted to test whether changes from pre- to post-test varied across conditions in regard to the two hypotheses (see Table 3.3:3).
Table 3.3:3.

Split-Plot Analysis of Variance for MWPS, SDQ-I Maths and SDQ-I Peer

<table>
<thead>
<tr>
<th>Source</th>
<th>$df$</th>
<th>$F$</th>
<th>$\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 208</td>
<td>83.02</td>
<td>.28</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Condition</td>
<td>3, 208</td>
<td>12.94</td>
<td>.15</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>3, 208</td>
<td>7.33</td>
<td>.09</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 195</td>
<td>4.70</td>
<td>.02</td>
<td>.031</td>
</tr>
<tr>
<td>Condition</td>
<td>3, 195</td>
<td>4.45</td>
<td>.06</td>
<td>.005</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>3, 195</td>
<td>0.71</td>
<td>.01</td>
<td>.540</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 186</td>
<td>0.03</td>
<td>.00</td>
<td>.853</td>
</tr>
<tr>
<td>Condition</td>
<td>3, 186</td>
<td>2.99</td>
<td>.04</td>
<td>.032</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>3, 186</td>
<td>1.82</td>
<td>.02</td>
<td>.144</td>
</tr>
</tbody>
</table>

The results from SPANOVA analyses revealed significant main effects for pre-/post- and condition for MWPS and SDQ-I Maths only (see also Figure 3.3:2). Generally, the MWPS showed improvements by children in all conditions but this was less certain in the Jigsaw-DT condition, which showed the smallest mean gain and had a confidence interval that contained zero (see Figure 3.3:2).

For Maths–self-concept, generally children in the Side-by-side co-operative condition improved but to a lesser extent than children in the other co-operative conditions who showed gains, although their confidence intervals included zero (see Figure 3.3:2). There was no change in the Individual condition.
For Peer–self-concept, only the main effect of condition was significant indicating peer self-concept varied across conditions. A pre-/post- x condition interaction was only observed for MWPS indicating that MWPS gains were influenced by the learning condition in which children followed the maths programme, but for SDQ-I Maths and SDQ-I Peer, the gains were not influenced by the learning condition.

The gain scores for all dependent variables comparing the Individual condition with “Combined Cooperative” conditions are shown in Figure 3.3:1; and the comparisons amongst all conditions are shown in Figure 3.3:2.

**Figure 3.3:1** Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores for Individual and “Combined Cooperative” Conditions (error bars represent 95% confidence intervals).
To investigate the nature of the pre-post- X condition interaction, one-way Analysis of Variance (ANOVA) with planned comparisons on difference scores (i.e., between pre- and post-test) were conducted on each of the three dependent variables to identify which conditions, if any, differed significantly from the other conditions (see Tables 3.3:4-6).

There was a statistically significant main effect for MWPS pre-post \((F(3, 208) = 7.37, p<.001)\). The difference score was not statistically significant for either of SDQ-I Maths \((F(3, 195) = 0.71, p=.543)\) or SDQ-I Peer \((F(3, 186)=1.82, p=.144)\). Thus, the difference scores were consistent with the results from the SPANOVA analyses and, therefore, useful for subsequent analysis.

Using the Modified Bonferroni test (Keppel, 1991), a conservative alpha coefficient of .021 was adopted for each of the planned comparisons. In addition, Cohen’s \(d\) (measure
of effect) was calculated by finding the difference between the means of the two conditions and dividing by the pooled standard deviation (Cohen, 1988). An effect size greater than 0.2 (which corresponds to 85% overlap between conditions) is considered to be educationally significant (Slavin, 1995). Hence, the planned comparisons were evaluated against two criteria: an alpha coefficient of .021 and an effect size of 0.2, and these are reported in Table 3.3:4:

Table 3.3:4.

F-Values in Planned Comparisons of Experimental Conditions and “Combined Cooperative” Conditions’ Data for MWPS Gain Scores

<table>
<thead>
<tr>
<th>“Combined Cooperative”</th>
<th>Side-by-Side Mutual Agreement</th>
<th>Jigsaw-DT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>7.44&lt;sup&gt;a&lt;/sup&gt; 0.24</td>
<td>19.37***</td>
</tr>
<tr>
<td></td>
<td>(0.21&lt;sup&gt;es&lt;/sup&gt;) (0.04)</td>
<td>(0.43&lt;sup&gt;es&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Side-by-Side</td>
<td>- 1.15</td>
<td>6.32&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>- (0.10)</td>
<td>(0.24&lt;sup&gt;es&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>- 13.20***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.34&lt;sup&gt;es&lt;/sup&gt;)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s d (index of effect size).

***p < .001.  <sup>a</sup>p < .021.  <sup>es</sup>d > 0.2.

For MWPS (Table 3.3:4, & Figure 3.2:1), the first hypothesis was not supported. The Individual condition had significantly greater gains than the “Combined Cooperative” conditions. The effect size indicates that this is educationally significant. The second hypothesis that MWPS gains would be in the following order, from greatest to least: — Jigsaw-DT, Mutual Agreement, Side-by-Side, and Individual — was also not supported.

---

Even though Cohen (1988) considers an effect size of 0.2 to be small, researchers (Newton & Rudestam, 1999; Zwick, 1997) have cautioned that Cohen’s definition of small, medium and large effect sizes should not be rigidly adopted but instead should be interpreted within the context of an area of inquiry.
(see also Figure 3.3:2). On the contrary, the Mutual Agreement, Side-by-Side and Individual conditions had statistically and educationally significantly greater gains than the Jigsaw-DT condition. There were no statistically or educationally significant differences in MWPS gains amongst the Mutual Agreement, Side-by-Side and Individual conditions.

Table 3.3:5.
F-Values in Planned Comparisons of Experimental Conditions and “Combined Cooperative” Conditions’ Data for SDQ-I Maths Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>“Combined Cooperative”</th>
<th>Side-by-Side</th>
<th>Mutual Agreement</th>
<th>Jigsaw-DT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>1.64</td>
<td>2.06</td>
<td>0.84</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.14)</td>
<td>(0.08)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Side-by-Side</td>
<td>-</td>
<td>-</td>
<td>0.25</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>-</td>
<td>-</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.02)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s $d$ (index of effect size).

For SDQ-I Maths (Table 3.3:5), there were no statistically or educationally significant differences between the “Combined Cooperative” conditions and the Individual condition; hence Hypothesis 1 was not supported. However, inspection of means and standard error bars at 95% confidence intervals (see Figure 3.3:1) indicates a trend\(^3\). The trend observed suggests that children in the “Combined Cooperative” conditions had gains in Maths–self-concept (i.e., the interval does not include the value of zero), whereas some

\(^3\) Interpreting graphs is a well-developed and recommended statistical approach not widely used in the field’s research papers. Dunlap and May (1989) and Newton and Rudestam (1999) explain the technique clearly.
children in the Individual condition appear not to have made any gains in Maths–self-concept (i.e., the confidence interval contains zero).

Hypothesis 2 on SDQ-I Maths was also not supported. There were no statistically or educationally significant differences amongst the four experimental conditions. Two trends are observed through the inspection of means and standard error bars of Figure 3.3:2. First, consistent with the earlier trend noted in Figure 3.3:1, there appear to be no mean gains (or mean losses) in Maths–self-concept in the Individual condition, (and the confidence interval contains zero); while trends point towards all the cooperative conditions having overall mean gains. Second, there appear to be clear gains for the Side-by-Side condition only (i.e., its confidence interval does not include the value of zero). However, for Jigsaw-DT and Mutual Agreement, although there were overall mean gains shown, the confidence interval includes zero.
Table 3.3:6.

$F$-Values in Planned Comparisons of Experimental Conditions and “Combined Cooperative” Conditions’ Data for SDQ-I Peer Gain Scores

<table>
<thead>
<tr>
<th>Condition</th>
<th>“Combined Cooperative”</th>
<th>Side-by-Side</th>
<th>Mutual Agreement</th>
<th>Jigsaw-DT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>2.21</td>
<td>4.93&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.83</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.22&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>(0.08)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Side-by-Side</td>
<td>–</td>
<td>1.65</td>
<td>3.31&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.13)</td>
<td>(0.19)</td>
<td></td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>–</td>
<td>–</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s $d$ (index of effect size).

$^b p = 0.028. \ ^c p = 0.070. \ ^{es} d > 0.2.$

For SDQ-I Peer, there were no statistically or educationally significant differences between the Individual condition and the “Combined Cooperative” conditions. Thus, Hypothesis 1 was not supported. A trend was noted in Figure 3.3:1, however; where there were mean gains for “Combined Cooperative” SDQ-I Peer scores as compared with the Individual condition, where the mean change was negative. For both conditions, the confidence interval contained zero.

The second hypothesis was also not supported. There were no statistically significant differences between conditions. However, two planned comparisons were approaching statistical significance. The first suggests that children in the Side-by-Side condition had greater Peer–self-concept gains than children in the Individual condition ($p = .028$). The second planned comparison result is weaker, but given the difficulty of detecting significance and effect size in the field of cooperative learning (Slavin, 1995), it will be reported as a contribution to theory development. The result suggests that Side-by-
Side had greater gains than Jigsaw-DT ($p = .070$). Similar findings were noted with effect size – the effect size of the difference between Individual and Side-by-Side was educationally significant; while an effect size only approaching educational significance between Side-by-Side and Jigsaw-DT was noted.

The inspection of Peer–self-concept means and error bars also reveals a similar pattern. There are overall mean losses for Individual and Jigsaw-DT conditions. The Side-by-Side condition has an overall mean gain with a confidence interval that only just includes zero; while Peer–self-concept for the Mutual Agreement appears to be almost unchanged.

3.3.4 Additional Relevant Information from Teachers

Feedback from teachers during Study One highlighted some issues that had not been fully “imagined” in theorizing and planning the co-operative intervention’s design. Some of the teachers reported that: it was difficult for them to keep each child of a dyad focused on their own role, some of the children were complaining that the rewarding systems were unfair, especially amongst the most competitive children who were high-achieving at pre-test; and that in dyads the mistakes of one peer could lead to frustrated outbursts by the other peer, for example asking “Why are you so stupid?!”. Teachers understand about setting limits to prevent interpersonal aggression but they voiced concern that the cooperative conditions made it more prevalent. Although the teachers’ comments were not collected systematically, and the number of comments seemed to be related more to how spontaneously talkative each teacher was rather than to different cooperative conditions, the comments will be taken into account in seeking to interpret the study’s findings. That is, as these results have shown, cooperative learning is not simply a panacea.
(Anderson et al., 1997), and various difficulties as well as possible advantages need to be clearly understood.

### 3.3.5 Summary of Results

In summary, the results of Study One indicate that for Maths Word Problem Solving (MWPS), cooperative conditions do not lead to significantly greater gains than the Individual condition. On the contrary, the Individual condition had significantly and educationally greater gains than the “Combined Cooperative” conditions. However, further analyses making comparisons amongst the four experimental conditions indicated that it was the Jigsaw-DT condition only that was responsible for the averages of the combined gains for all of the cooperative conditions being significantly lower than for the Individual condition. There were no statistically or educationally significant differences in MWPS gain scores amongst the Individual, Side-by-Side and Mutual Agreement condition; and all three of those conditions had statistically and educationally significantly greater MWPS gains than the Jigsaw-DT condition.

For Maths–Self-concept (SDQ-I Maths), whilst there were no statistically or educationally significant differences amongst the four experimental conditions, trends from observing the graphs indicate that the cooperative conditions had greater gains, or smaller losses, in comparison to the Individual condition. Only children in the Side-by-Side condition appear to have had clear gains on Maths–self-concept.

For Peer–Self-concept (SDQ-I Peer), there were no statistically or educationally significant differences between the Individual condition and the “Combined Cooperative” conditions; although a trend suggests that the “Combined Cooperative” conditions had greater gains than losses when compared with the Individual condition where gains and losses were even. Exploration of this trend in Hypothesis 2 led to the observation of two
consistent patterns. First, the Side-by-Side condition had greater gains in Peer–self-concept as compared to the Individual condition. This was statistically only approaching significance but was educationally significant. Second, children in the Side-by-Side condition had greater gains in Peer–self-concept than children in the Jigsaw-DT condition. This was approaching statistical and educational significance. This finding was further substantiated with the exploration of means and error bars indicating losses of Peer–self-concept for the Individual and Jigsaw-DT conditions; no change for the Mutual Agreement condition and gains for the Side-by-Side condition.
3.4 Discussion of Study 1

3.4.1 Overview of Discussion Section

The purpose of Study One was to investigate the efficacy of and optimal conditions for cooperative dyadic learning in terms of outcomes for academic and affective socio-emotional outcomes. This discussion is divided into five main sections. The first section examines Hypothesis 1 which makes a broad comparison between the Individual learning condition with cooperative learning in general (three conditions are treated as “Combined Cooperative”); predicting significantly greater gains for the latter from pre- to post-test on variables of Maths Word-Problem Solving (MWPS), and SDQ-I Maths and SDQ-I Peer self-concept measures. The second section examines Hypothesis 2, which predicted a rank order of gains for the four separate conditions: each of the three cooperative conditions (Jigsaw-DT, Mutual Agreement and Side-by-Side) and the Individual condition. The predicted rank ordering was based on which of the task-structures was considered to have the most of the essential elements: Positive Interdependence, Group Goals and Individual Accountability. The third section will re-examine Johnson and Johnson et al’s model of “Learning Together” in the light of the study’s findings. The fourth section revises the underlying conceptualization of Study One. The fifth section discusses the limitations of Study One and addresses the implications for Study Two.

3.4.2 Examination of Hypotheses

In addressing Study One’s hypotheses, all statistically significant results as well as some other relevant results that only approach statistical significance or indicate trends will be discussed. For those latter results, because levels for “educational significance” are based on effect size (Slavin, 1995), it will be pointed out whether the relevance is for educational significance or only in terms of sign-posting future theory development.
3.4.2.1 Examination of Hypothesis 1: Cooperative Learning vs Individual Learning

The hypothesis that the “Combined Cooperative” conditions compared to the Individual condition would have significantly greater gains in the MWPS, SDQ-I Maths and SDQ-I Peer outcomes was not supported. As the patterns of results differ for the three dependent variables, they will be discussed separately.

3.4.2.1.1 MWPS

For Maths Word Problem Solving (MWPS), a significant difference, converse to the hypothesis, was found: Individual gains were higher than gains for the “Combined Cooperative” conditions.

Although taken in isolation this might suggest that Individual learning is superior to cooperative learning, the result is more likely to be an effect of what is termed “over-synthesis” (Damon & Phelps, 1989, p. 14). That is, as will be further explored in the discussion of Hypothesis 2, the finding is likely to be a statistical interpretation of three disparate cooperative conditions’ effects canceling each other out.

Nevertheless, this finding from the “Combined Cooperative” conditions demonstrates that cooperative learning does not necessarily lead to significantly greater academic gains than the Individual condition and, furthermore, cooperative learning may be comparatively more vulnerable to poor academic outcomes.

3.4.2.1.2 SDQ-I Maths–Self-Concept

For SDQ-I Maths-self-concept, no significant differences were found. A trend suggesting that there were gains in the “Combined cooperative” conditions but not the Individual condition is puzzling in its contradictory pattern to that of gains for MWPS
because Marsh (1990) argues that gains in specific domains of academic self-concept are related to gains in competence in the relevant skills.

### 3.4.2.1.3 SDQ-I Peer–Self-Concept

For SDQ-I Peer–self-concept, no significant differences were found. A trend suggests that there were gains in the means of the “Combined cooperative” conditions and a loss in means of the Individual condition.

Whilst the trend of higher Peer self-concept in the cooperative conditions points towards agreement with the hypothesis, a loss rather than no changes in the Individual condition is puzzling, except that it supports arguments that Individual classrooms are perceived by students as competitive which is detrimental to peer relationships (Deutsch, 1962; Johnson et. al., 1994).

For the findings of no significant differences for both of SDQ-I Maths- and Peer–self-concept results, one possible consideration is that there may have been differences for particular comparison groups; however, because there is the category that combines the data for all cooperative conditions, it may be that disparate effects of specific cooperative conditions might be counteracting the effects of the other cooperative conditions.

The findings of Hypothesis 1 need to be treated tentatively as they are based on a generalized statistical grouping of three different structures of cooperative learning that are compared with the Individual learning condition. This grouping does not reflect an actual condition, but several grouped together. The advantage of combining the conditions for making observations is that it allows the possibility of identifying differences in the broad conceptualization of cooperative learning in comparison to individual learning. The disadvantage, however, is that it may be too heterogeneous a grouping. Examination of
Hypothesis 2 will therefore be useful for further investigation of the separate conditions, and will allow greater focus and clarity of explanation (Damon & Phelps, 1989).

3.4.2.2 Examination of Hypothesis 2: Optimal Cooperative Learning Condition

It was hypothesized that Jigsaw-DT would lead to the highest significant differences in gains, followed by Mutual Agreement, then Side-by-side and lastly Individual. There was no support for the hypothesised rank ordering of conditions. The general pattern of results points towards a different rank order, as well as unevenness in the findings for the three dependent variables pointing towards a more complex situation than hypothesized. Each of the three dependent variables will be discussed in turn.

3.4.2.2.1 MWPS

The results were quite contradictory to the hypothesis and showed a pattern of Mutual Agreement, Side-by-side and Individual conditions having equivalent gains that were significantly greater than for the Jigsaw-DT condition.

Note that there were differences in equivalence at pre-test, with Individuals having the highest pre-test score. This ability difference may in part explain why they appeared to gain the most from the programme. However, the programme allowed each student an equal opportunity to improve, and the use of Rasch analysis of gain scores statistically allows for students (and experimental conditions) with differences in ability to be comparable.

Regarding Hypothesis 1, the different MWPS outcomes for the varied cooperative learning conditions refute any inference that Individual Learning is superior to all cooperative conditions. Two of the cooperative conditions, Mutual Agreement and Side-by-side, have equivalent outcomes to the Individual condition. Neither Individual learning
nor either of those two cooperative conditions stands out as significantly better than the others.

The finding that two cooperative conditions and the Individual condition had equivalent gains, superior to the gains of the Jigsaw-DT cooperative condition, highlights the importance of recognizing that some of the effective cooperative conditions may have more in common with individual learning than is usually recognized in the field. Thus, it underlines the importance of having a very specific focus for terms such as ‘learning’, ‘cooperative structures’, ‘individual structures’, as well as which of the particular cooperative approaches is used to represent ‘cooperative learning’.

Furthermore, the finding that the Jigsaw-DT condition’s gains were significantly lower than the other learning conditions’ gains raises another issue. The underlying theoretical framework of Study One about the relative importance of contributing factors of Positive Interdependence, Group Goals and Individual Accountability, needs reconsideration (see later section 3.4.3).

**3.4.2.2 SDQ-I Maths Self-Concept**

There was a lack of significant differences, both statistically and educationally, for SDQ-I Maths. However, at a statistically non-significant level, observation of Figure 3.3: indicates a trend in the means for Maths-self-concept gains: the Individual condition showed no change; whereas all three co-operative conditions showed mean gains; and this effect is greatest in the Side-by-side condition.

All three indications of that trend require discussion.

(a) **Stability in self-concept in individual condition**

In the academic performance realm, Marsh (1990) contended from findings in his comparison of two types of intervention courses, that an improved self-concept was related
to an improvement in the “reality” of improved competence. However, this relationship between levels of improvement in academic Maths learning gain and in Maths-self-concept claimed by Marsh does not seem to be the case in the present study for the Individual condition where Maths-self-concept remained stable despite comparatively robust performance gains.

Contrasting with Marsh’s optimism about self-concept gains, Tennen and Affleck suggest that self-concept is generally very slow to change, and indeed “traditional [psychological] clinical theories … assume that the most adaptive appraisals are those that remain true to reality” (Tennen & Affleck, 1993, p. 254). Regarding Individuals gaining in MWPS, the stability in Maths-self-concept might be understood as the students’ understanding that in any learning programme, especially a revision programme, they would learn more in the academic domain of the intervention without necessarily having dramatic changes in how they feel about their competence in and liking for the academic subject.

The relevance of Marsh’s findings of gains in academic self-concept in group situations compared to Tennen and Affleck’s cautions about changes of self-concept will be explored further in relation to the following discussion of cooperative conditions.

(b) Changes in cooperative conditions only

The trend of gains for Maths-self-concept in each of the cooperative conditions but no change for Individuals is not consistent with the pattern of MWPS Maths gains that were equal for Individual, Side-by-side and Mutual Agreement, all of which were greater than for Jigsaw-DT.

Study One’s results for Maths-self-concept (albeit at the non-significant level, being read from Figure 3.3:2), point to a hitherto untested issue in the field about the relationship between changing academic self-concept and academic intervention studies. Rather than
the change in the academic self-concept being accounted for solely in terms of a successful intervention affecting a corresponding academic domain—interestingly and somewhat disconcertingly—the change appears to take place only where there is a cooperative component.

Marsh (1990) argued that the two Outward Bound interventions he studied, and one other intervention by Brookover and Erikson (1975), which made up the few known studies to have successfully intervened to improve either or both of academic outcomes and self-concept, had done so by capturing specific effects in their cooperative interventions.

Marsh’s analysis found improvements in the highly supportive groups. However, unlike Study One, none of the studies reported by Marsh employed a control group and so changes were not compared to non-cooperative settings. The academic Outward Bound course employed a target sample that was too specific to viably set up a comparable control sample (Marsh, 1990), that is, it selected students from a particular school who appeared to be underperforming academically and to not have behavioural problems. Another difference is that there was direct intervention in the academic Outward Bound course to work on participants’ academic self-concept by advising the boys participating and their families to expect improvements following the course. Whereas, in Study One, there was no particular effort made to intervene on Maths-self-concept, since it was anticipated that any improvements in Maths-self-concept would happen in relation to “reality” by reflecting any changes in Maths performance.

The discrepancy in the present study’s patterns of results for Maths-self-concept outcomes and MWPS outcomes, as well as for differences across each of the cooperative conditions and the Individual condition, might be explained as effects of within-group dynamics (e.g., cooperation or competition, as described in Sherif’s 1950s studies). That is, it can be speculated from the patterns of results, that being included in a cooperative group
or dyad increases the self-concept in the related academic domain with some relevance to
the level of academic gain, whereas being in an Individual learning structure leads to a
comparatively more stable self-concept or inhibits change.

(c) Changes greatest in the Side-by-side condition

The differences between the four conditions in Study One may be explained as
different outcomes of social comparisons that interact dynamically with the learning
environment. For example, Festinger (1954) theorized that people compare themselves to
others to test their own self-concepts, and studies by Stendler et al (1951) have shown that
social comparisons are damaging in competitive environments, especially in reducing the
motivation to participate by less confident group members. Social comparisons have been
shown to be relevant to self-concept (Cheung & Lau, 2001) whereby there is validity to
how students rank themselves against their classmates or some other comparison group.
Self-concept has also been found to have effects on learning outcomes (Levine, 1983, cited
in Monteil & Huguet, 1999), including the advantage of having high density and
accessibility to compare oneself with others who are reasonably similar.

The different learning conditions might alter the nature of social comparisons, and
this might account for the varying outcomes for Maths-self-concept. For example, Monteil
and Huguet (1999) referring to studies by Willerman, Lewit and Telegen (1960), state
about collective work in cooperative learning, “By concealing individual performance, [it]
… may constitute an attractive situation for students experiencing problems in such-and-
such a dimension of social comparison”. Therefore, from the present study, it could be
speculated that, in dyads, the focus of social comparison might be restricted more to the
other partner, whereas students working individually will necessarily compare their
performance against the whole class. As such, increased opportunities for cooperation
might allow one student to become more strongly aware of their own competence
benchmarked in comparison to a less competent partner. Additionally it could allow for a less competent peer, whose outcomes are improved whilst in a group or dyad, to internalize the better dyadic performance as their own standard. Each of these alterations to the comparative structure could lead to increases in Maths-self-concept that are unrealistically positive (e.g., Monteil & Huguet, 1999).

Furthermore, taking into account the comments by teachers of destructive conflict, it would seem that Mutual Agreement and Jigsaw-DT, with their higher levels of Positive Interdependence, might lead to higher levels of arguments and “put downs” when agreement is not reached, in comparison to the Side-by-side cooperative condition. If this were so, it would seem that the Side-by-side condition’s relatively higher gain may be explained in that it was not necessary for one dyadic partner to be tied to the answer of the other partner.

Concluding this subsection, the findings of Maths-self-concept highlight a problem with assuming that increases in self-concept are simply related to increases in competence in the domain in which interventions occur (e.g., Marsh, 1993). Moreover, the assumption that increases in self-concept results are necessarily desirable is contentious (Tennen & Affleck, 1993, p. 254). “Positive illusions” are typically defended for low self-esteem individuals at risk of suicidal ideation (e.g., Harter, 1993) although evidence shows that low-self esteem individuals are highly resistant to interventions intended to improve their self-concept (Tennen & Affleck, 1993). For example, Harter, from a clinical psychologist’s perspective, discusses ways of assisting people to increase self-esteem by decreasing the difference between their goals and their aspirations, either through attempting increased competence or attempting lowering of aspirations. However, for some people, an overly high self-esteem is maladaptive because it can make them insensitive to environmental cues of poor or inadequate performance, for example, in relation to social sensitivity (Tennen &
Affleck, 1993). This implies that for the research concerns of Study One, changes in Maths-self-concept would be “adaptive” only if they are linked to relative changes in performance of Maths, and this appears not to be the case as per discrepant findings of gains in MWPS and SDQ-I Maths-self-concept.

These Maths-self-concept results indicate that the differences between individual and cooperative learning are more complex than anticipated and more complex than Study One is capable of fully explaining. Nevertheless, they serve as some preliminary evidence that educational programmes have effects in various domains besides cognitive academic outcomes, in this case Maths-self-concept as an emotional, attitudinal measure. Furthermore, it provides evidence that outcomes of other domains will differ according to environmental learning structures – Individual or Cooperative – and that the effects differ even amongst different cooperative structures.

3.4.2.2.3 SDQ-I Peer-Self-Concept

One difference that was educationally significant (by Slavin’s criteria), but not statistically significant was: the Side-by-side condition had greater gains than the Individual condition. Also, approaching statistical and educational significance was the greater gains in Peer-self-concept by the Side-by-side condition over the Jigsaw-DT condition.

These findings of differences in Peer self-concept outcome suggest that the varied learning structures including those with similar MWPS outcomes may produce different effects in the social domains. That is, theorists have critiqued some studies for creating comparison groups that have only nominal (labeling) differences rather than operationalising relevant and specific differences across conditions (Anderson et al., 1997; CTEHP, 1994). Thus, it would appear that Individual’s loss compared to Side-by-side’s gain in Peer-self-concept is evidence that the two groups’ structures were different enough
to effect changes in this domain. The loss for Individuals can be explained in comparative terms in that, unlike in dyadic learning conditions, peer interaction is not encouraged and thus it is unlikely that there would be peer-self-concept improvements. This would also explain Side-by-side leading to greater gains in Peer-self-concept in comparison to Individual. However, the difference between Side-by-side and Jigsaw-DT requires a more complex explanation.

It may be the case that if dyadic learning structures limit control by individuals over their own academic outcomes, then seen in that light, and consistent with the study’s findings, greater amounts of positive interdependence in situations of “sinking together” would invite frustration and threaten interpersonal cohesion. It seems relevant to refer to the teachers’ comments, which contradict Study One’s hypothesis about positive interdependence in cooperative conditions. The teachers pointed towards consideration that there can be a downside of cooperative learning, which is rarely addressed in the literature. For example, Monteil and Huguet (1999) state:

Collective work does not only present good points. It can both encourage the good student to loaf, because of its anonymous nature, and incite the poor achiever to take advantage of the competences and efforts exerted by the good student, which in turn represents a good reason for the latter to loaf. (p. 136)

Thus, from the findings of the present study, therefore, it may be speculated that positive interdependence increases the likelihood of a dyad member encountering negative effects of “sinking” due to the other partner’s lack of competency or lack of performance which would not only have had an impact on peer relations that was less than optimal, but it would likely also have reduced each member’s individual motivation to perform during the programme; notably, Side-by-Side is the condition that had the lowest levels of positive
interdependence in the task-structure and rewarding systems compared to Jigsaw-DT, which had the highest levels.

To conclude, one aim of the present research project is to identify optimal conditions for cooperative learning. From Study One, Side-by-side appears to be the optimal condition for producing what appear to be desirable outcomes in all of the dependent variables, for the following reasons:

- From MWPS results, Side-by-Side and Mutual Agreement had equivalent learning gains (that were equivalent to Individual), all of which had greater gains than Jigsaw-DT so Jigsaw-DT is excluded from being the best cooperative condition, especially since it is not optimal in other dependent variable measures.

- From Peer self-concept results, Side-by-side appeared optimal having the greatest gains in comparison to Mutual Agreement’s slight gain, and in comparison to Jigsaw-DT’s slight loss. Note that Peer-self-concept was nearer than Maths-self-concept to attaining statistical significance and thus has the greatest potential for theory development in Study Two, and also it apparently captures the notion of “social” in the psychology of learning.

- Maths-self-concept gains were clear in Side-by-side compared to the other cooperative conditions. Nevertheless, as discussed, it is unclear whether or not a gain is beneficial in its own right. Although on statistical grounds for theory development, Side-by-side is optimal in this dependent variable, after reconsideration of the literature on self-concept gains, it is the findings of the other dependent variables that are considered more useful to educational outcomes in this analysis.
Overall, for both educational and future research purposes, Study One’s finding is that Side-by-side is the optimal cooperative learning condition.

3.4.3 Implications for Theory

Study One has demonstrated that differences in task-structures and rewarding structures do appear to have varied influences on outcomes in academic and various social-emotional domains. However, even though firm conclusions cannot yet be reached, it is notable that the differences are more complex than is typically reflected in the field’s literature. Pertinent issues raised by the present study will be described.

(1) The finding in Study One of similarities in the Individual condition compared to some of the cooperative conditions has relevance for theory development (e.g., there were equivalent maths (MWPS) outcomes for Individual, Side-by-side and Mutual Agreement that were greater than for Jigsaw-DT).

It appears that several key concepts have been conflated (Damon & Phelps, 1989). The concept of “learning” has been conflated with other distinct concepts—“cooperative” and “individual”.

Karmiloff-Smith (1995) criticizes psychology for its typical conceptual blurring of individual processes and social processes in learning. Development within an individual does not take place outside of social environments and thus “individual learning” should not be considered as a ‘pure’ category, nor the polar opposite of cooperation (cf., May & Doob, 1937). Individual learning is not pure since classroom environments have the effects of the teacher and a curriculum and books with other people’s ideas. So too does cooperative learning include many of the same individual effects on learning along with its cooperative elements and so neither is this a pure category. Indeed, one highly relevant example of this comes from D.W Johnson and R. T. Johnson’s (1990) discussion of
Individual Accountability in cooperative classrooms where they state: “students are not only accountable to the teacher in cooperative situations, they are also accountable to their peers” (p. 31). In addition to their intended point that there are complex dynamics in the cooperative learning structure, Johnson and Johnson implicitly acknowledge that Individual Accountability happens in both broad types of learning structure, not just cooperative structures.

Therefore, the learning conditions, “Individual” and “Cooperative”, should not be understood as pure constructs (Anderson et al., 1997; Rogoff, 1990) but, more correctly, the categories of Individual learning and Cooperative learning should be understood as representing different points on a continuum of shared elements. Nevertheless, differences between learning conditions (e.g., dyadic or individual learning, each embedded within whole classes!); task-structures; rewarding structures; and grouping structures (e.g., of ability) would still be expected to have specific effects on the outcomes in the various academic and social-emotional domains.

(2) The study’s informing concepts of three co-operative elements, Positive Interdependence, Group Goals and Individual Accountability, and how they are considered to influence learning in dyads, needs major revision and reconceptualisation.

Hypothesis 2, which was not supported, was based upon a conceptualization that the most important element of cooperative learning was Positive Interdependence (operationalised as joint rewarding to structure “sinking or swimming” together), followed by Individual Accountability (operationalised as each member of the dyad having an opportunity to separately write the answer on a separate worksheet or part of a worksheet), and then by Group Goals (operationalised as the children being assigned to dyads and the

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4 Johnson and Johnson’s Learning Together model was criticized by CTEHP (1994) in that each of the elements of their model had not been tested separately.
programme encouraging the children to help each other). Such concepts influenced the hypothesized rank ordering of learning outcomes that incorrectly predicted Jigsaw-DT to be the optimal condition (see Table 3.1:1). Therefore, in light of the present study’s unexpected findings, all of those elements and their relative importance to cooperative (and individual) learning need to be re-theorised:

Group Goals do not appear to have discriminated for Individual or Cooperative outcomes for MWPS since it was mainly only one but not all of the cooperative conditions that differed from the individual condition. Bossert (1988), in relation to the debate about cooperation and competition, draws similarities between different learning structures, questioning the utility of the Group Goals element:

“[P]ure cooperation” remains merely a theoretical construct. Many observers write that pure cooperation entails “promotively interdependent” goal structures, implying that cooperative interaction and its benefits result from an individual’s awareness that collective actions are necessary for individual goal attainment (Deutsch, 1994a; Johnson & Johnson, 1975). Yet Pepitone (1985) points out that “[j]ust how, theoretically, individual goals may be transformed into a group goal is still an unsolved conceptual issue. (Bossert, 1988, p. 21)

For the conditions of Study One, it appears that the Group Goals concept was not clearly delineated but instead was conceptually differentiated as absent for Individuals in comparison to being present in each of the cooperative conditions. This now needs to be re-theorised.

A re-conceptualised perspective of Group Goals is that they are a learning structure defined by the teacher including directions about learning behaviours, specifically for students to interact with other class members. However, it seems that the extent to which a
given learning structure is nominated as a ‘Cooperative’ (learning as a group) or as “Individual” (learning alone) is more complex than initially recognized.

That is, in relation to conceptual issues such as those raised by Bossert, it is difficult to ascertain much more than the teacher’s nomination of learning goals in a classroom. Note that to some extent, either of these broad learning categories requires cooperation in a classroom context – even individual tasks require students to study without distracting other classmates – therefore, cooperation itself may not be exclusive to what the literature refers to as cooperative conditions. Furthermore, reconsideration of the literature on the efficacy of cooperative learning interventions reveals that many of the more successful ones, such as Slavin’s Jigsaw II, incorporated ‘improvements’ such that aspects of individual specialization were modified to include all group members needing to learn all aspects but having to develop expertise in separate aspects.

Thus, at this point, Group Goals are re-conceptualised as not being a separate element that of itself discriminates for academic outcomes across individual or cooperative learning conditions and, furthermore, both Cooperative and Individual learning conditions have in common classroom Group Goals and across-the-board Individual goals, although they vary in their salience and impact on the specific directions for task-structures. However, typical operationalisations, such as through the use of reward, role or task-structures, are integral to the other elements, which can have differential effects across conditions: Positive Interdependence and Individual Accountability. Therefore, the reconceptualised impact of Group Goals is not an element that is completely present or completely absent, and it does not appear to be completely separable from the remaining two essential elements which will be examined next.

The conceptualisation of Positive Interdependence, particularly given the poorer academic outcomes of the Jigsaw-DT condition, needs to be reconsidered in terms of how it
might be detrimental to MWPS and Peer–self-concept because its design increases the likelihood of a group or dyad “sinking together”. Problems with task-related positive interdependence have been recognized in the literature, for example, by Bossert (1988, p.232) who states that, “Cooperative learning methods that rely solely on task interdependence generally do not produce robust achievement gains.” (NB: The present study was not based on a conceptualization that the Jigsaw-DT condition would have positive interdependence solely in terms of task-structure, but task-structure was a substantially important aspect.)

The Positively Interdependent task-structure appears to have inflated the effects of earlier mistakes by one or both members of the dyad, which may be speculated as having invited destructive conflict rather than constructive conflict as evidenced in Jigsaw-DT having the lowest MWPS outcomes, and arguably the lowest outcomes of the cooperative conditions in self-concept measures. Positive Interdependence (PI) will now be reconceptualised as occurring in all learning structures to different degrees, rather than being conceptualized as either present or absent.

The conceptualization of Individual Accountability (IA) amongst dyadic peers in relation to PI is also important. Although many influential constructs of cooperative learning include both PI and IA, the patterns of results in the present study suggest that they have oppositional effects. That is, a high amount of PI can lead to one person being forced to follow another’s lead in terms of approaching the problem (process) and presenting an answer (product), whereas a high amount of IA leads to each dyadic member making an individual effort over the process and the product in relation to the set task. When this can happen without it affecting the other’s outcomes (i.e., low positive interdependence), this is another side of IA that in the reconceptualised version shall be called “Individual Accountability control” (IAc).
IAC can notionally be conceptualized as present in different levels for different learning conditions. In regard to Jigsaw-DT and Side-by-side conditions, IAc differs for the process (i.e., during the working out stage) and for the product (i.e., level of control over the submitted answer). Furthermore, levels of PI appear to be inversely related to levels of IAc: During the Process – IAc, such as individual involvement in working out an answer is the reverse of what PI is structured to make happen, such as turn-taking, or task specialization; and the Product of IAc, such as individual freedom to decide which answer to submit, is also the reverse of PI’s structuring to require a shared worksheet that implies a shared final decision. It is notable that Johnson and Johnson, (1989, p.61) compare “goal interdependence” (which in this case would mean a shared answer) and “resource interdependence” (which in this case is the level of interdependence demanded by the task-structure), stating that the latter is problematic in mixed-ability situations causing lowering of motivation by “group members … because their actions cannot substitute for the actions of the less capable member”. This seems very pertinent to the present study’s findings – although the present study did not measure the effects of different ability in cooperative mixed-ability dyads. Thus it seems important to be specific about the type of learning demanded, since in a very cognitively based academic activity such as mathematics, too much task specialization and opportunities for partner substitution may have detrimental learning outcomes for at least one member of the dyad.

In the final re-conceptualisation of essential elements, each of the two elements, PI and IAc, is necessary to some degree in learning environments, and the overall balance for each particular learning structure is unique, affecting outcomes based in three domains: cognitive (academic maths learning), and social-emotional affective (maths–self-concept) and social-emotional interpersonal (peer–self-concept).
In Table 3.4:1, a number of adjustments have taken place. The essential learning elements are now more clearly recognized as occurring in both cooperative and individual learning conditions and, rather than being conceptualized as present or absent, they are re-conceptualized on a continuum as High (H), Medium (M), Low (L) and Extra Low (XL), allowing for hypothetical ranking.

Table 3.4:1.
Re-theorised Cooperative Elements, with Re-Quantified Presence and Comparative Hypothetical Rankings of Positive Interdependence and Individual Accountability

Hypothetical Ranking by Learning Condition

<table>
<thead>
<tr>
<th>Learning conditions</th>
<th>Essential Cooperative &amp; Individual Learning Elements</th>
<th>Implied rankings of PI &amp; IAc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1st) Positive Interdependence (PI)</td>
<td></td>
</tr>
<tr>
<td>Jigsaw-DT</td>
<td>H</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(H&amp;L=) M L</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(2nd) Individual Accountability (IA) → Control (IAc)</td>
<td></td>
</tr>
<tr>
<td>Mutual Agreement</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M M M M L</td>
<td>3</td>
</tr>
<tr>
<td>Side-by-Side</td>
<td>L H M</td>
<td>3</td>
</tr>
<tr>
<td>Individual</td>
<td>(XL) H H L</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: Strike-through indicates that original conceptualization does not apply.

The levels of Positive Interdependence (PI) are now seen to be more complex, although the originally hypothesized rank order remains the same. PI does exist for Individuals, in that disruptive class members will adversely affect others’ ability to make
progress, but typically this would be an element with very low levels relative to the cooperative conditions. PI is present in low levels in Side-by-side – although each person can independently attempt each question and put their own answer, but compared to Individuals, they must be prepared to listen to another person which may be beneficial, but it leaves them more exposed to distraction and opportunities to “loaf”. PI in Mutual Agreement is at a medium level in that only one answer can be put down, structuring possible effects of disagreement over the choice of answer as well as distraction or social loafing. Jigsaw-DT has the highest levels of PI, and the highest possibility for reduced levels of IAc, which can have a negative impact. Inadvertently, Jigsaw-DT carried over any errors made by individual members of a dyad in Part A to the jointly undertaken Part C. Since previous mistakes could not be rectified, the IAc was reduced to a low level during the joint part of the task.

Individual Accountability is now regarded less in terms of individual contribution – as IA (which may reflect a theoretician’s/observer’s perspective), and more in terms of individual control - as IAc (which may more closely reflect a student perspective); and as different for the ‘process’ and the ‘product’. What is noticeable is that their ranking goes in the opposite order to Positive Interdependence. That is, it supports the new re-theorisation about the elements PI and IAc as creating for each learning condition a different balance, whereby high amounts of Positive Interdependence will reduce IAc and vice-versa.

(3) The effects on Maths-self-concept (in the form of a trend, and thus requiring further investigation), point towards evidence that changes may occur in this domain. Marsh contends that for changes to occur in academic self-concept it is necessary that the intervention is relevant to the particular academic concern (Marsh, 1993). However, this trend points towards a relevant academic intervention being “necessary but not sufficient” for change in self-concept concerning the relevant academic subject, because the findings
of the present study suggest that the change in self-concept is related more to the learning condition being “cooperative” than to the success of the academic intervention.

The patterns of complexity in the results, in terms of an integrated theory of learning, appear to be related to the extent of the PI of the cooperative conditions, and therefore social comparison theories can be drawn upon in a speculation that PI can lead to relative differences in the levels of scrutiny and criticism of each partner’s Maths performance. That is, it may be that children compared their Maths ability to that of their dyadic peer, either in positive or negative ways according to their assigned condition. Individuals may have compared themselves to the full range of the classroom and accurately ranked themselves. Then side-by-side would have seen a boost in confidence. There was a high chance of the dyads comprising students of mixed ability, whereby those helping might increase their confidence about their Maths ability in comparison to someone with lower ability, and those being successfully helped would see an improvement in their Maths and hence improve their self-concept.

(4) The findings for peer-self-concept had educational significance and approached statistical significance. They suggest that changes in Peer-self-concept are related less to the level of academic gains than to being assigned to a dyadic cooperative learning condition. Nevertheless, academic outcomes do appear to make a difference, since the gains and losses of peer self-concept in the cooperative conditions appear to be related to levels of MWPS gains. Therefore, this supports the viability of an integrated theory that cognitive engagement with academic Maths and social-emotional attitudes towards Maths and towards peer relations are interactive domains. That is, each of the domains is separate, being affected in unique ways by individual- or cooperative-learning structures and, additionally, they are interactive because each domain impacts upon the other domains.
The literature typically emphasizes the benefits of collective work to low achievers, especially if they are “confronted by success” and motivated to learn useful strategies to cope with learning individually (Dweck, 1975; Monteil & Huguet, 1999). Nevertheless, certain learning structures might cause frustrating outcomes which could be damaging if not resolved properly, especially where levels of confidence and ability to articulate one’s perspective within dyads are disparate (Tudge, 1989, 1990, 1992), or if the experience serves to reinforce the self-defeating attitudes and self-beliefs (Bandura, 1997; Dweck, 1975). Thus, it may be that low achievers stand potentially to lose as much as they might potentially gain, depending on the specific effects of comparison in cooperative learning structures.

3.4.4 Limitations of Study 1 and Implications for Study 2

(1) The study’s overall findings point towards needing a more moderate or revised perspective about any assumed superiority of Cooperative learning in comparison to Individual learning. In particular, no differences were found in the MWPS outcomes for Individual, Side-by-side and Mutual Agreement conditions that all had equivalent academic maths outcomes, and for which Jigsaw-DT had significantly lower gains.

It is possible that, where no differences are found, this reflects problems in the research design. For example, in Hypothesis 1, the combining of cooperative conditions was too general (Damon & Phelps, 1989), which was partially addressed by analysing differences between some conditions for Hypothesis 2. Another possibility is failure in programme implementation. Programmes are sometimes unsuccessful, and in particular implementing cooperative classrooms can be difficult especially when new to either teachers or students (Johnson et. al., 1994). Programmes can also make the research fail due to the design producing unintentional and different qualities from
those intended and measured. Marsh (1990), for example, describes the way there has been criticism of the way cooperative interventions measure heightened parental or student expectations in anticipation of special programmes. In regard to the MWPS findings of Hypothesis 2, that Side-by-side, Mutual Agreement and Individual had no statistically significant differences, Study One’s finding of “no differences” has been taken at “face value” that it can mean, in fact, there are no differences. Nevertheless, Study Two will aim to further investigate the differences between cooperative and individual learning structures. This will leave open the possibility that an optimal cooperative learning condition might academically outperform Individual learning.

Study One compared a number of cooperative conditions to the Individual condition. A limitation was that inadvertently the Side-by-side condition included differences that could not be completely separated for analysis. That is, for the Side-by-side condition, both its task-structure and rewarding-structure had comparatively less Positive Interdependence when compared to the other cooperative conditions. As such, it is impossible to separate those two factors in Study One to pinpoint how task-structure, or rewarding structure, or the combination of both factors, influenced Side-by-side’s outcomes. Therefore, in Study Two, each learning structure, whether it has Individual or Cooperative tasks, will also allow comparisons of each variable in the rewards structures.

(2) The elements of cooperative learning have been re-theorised. When Positive Interdependence is too extreme, or when Individual Accountability Control (IAc) is too limited, the effects are counterproductive to the intended effects of enhancing learning outcomes. Therefore, Side-by-side would now appear to be the optimal cooperative condition. That is, each student in a dyad retains ultimate control over deciding which answer to write and hand in, with academic rewards still contingent upon individual
mastery goals. Furthermore, since academic rewards (tangible or otherwise) are implicit in grading of work, the rewarding of academic outcomes will not vary for any of the learning conditions in Study Two. Notably, two problems in the existing research are, firstly, usually even if the target behaviours are cooperative behaviours, it is academic outcomes that are rewarded and, secondly, rewarding is still contentious (CTEHP, 1994; Slavin, 1995). However, Study Two will test the impact on learning outcomes of rewarding specific Cooperative and Individual learning behaviours as well as the impact of not rewarding those behaviours.

(3) Some aspects of Study One’s findings for varying patterns in academic maths, Maths self-concept and Peer self-concept are still unclear. The literature suggests that grouping children with homogeneous or heterogeneous ability may have an impact (Kulik & Kulik, 1982; Webb, 1982a, 1982b). Most of the research focuses on the impact on academic outcomes, and less is known about the impact on social and emotional outcomes, such as self-concept. Unfortunately Study One was unable to undertake an exploration of the impact of ability grouping in relation to its focus on different task and rewarding structures because categorizing the data into different high, medium and low ability combinations led to too few students (average < 7) in the 12 categories, which would not allow statistically meaningful comparisons.

Therefore, there are several implications for the continuation of this research. Study Two will include comparison groups of homogeneous (equal-ability) peers and heterogeneous (mixed-ability) peers to allow investigation of this aspect. Furthermore, larger sample sizes in the comparison groups might lead to better detection of effects of ability structure in relation to rewarding or not rewarding, and in relation to cooperative structures or individual structures.
In addition, Study One’s has investigated the different domains of academic maths, and social-emotional attitudes towards Maths and towards peer relations. The findings suggest that each domain is affected in its own way by individual or cooperative learning structures and that each of the domains impacts upon the other domains. This may be the first step towards developing an integrated theory of the multiple domains affected by cooperative learning.

3.4.5 Summary

In summary, Study One has made a number of research contributions that deserve further investigation. First, the study has conceptually and empirically advanced understandings of positive interdependence in cooperative learning. The study identified that, at least for Maths Word Problem Solving (MWPS), in order to broadly structure optimal conditions for learning, it seems likely that low levels of Positive Interdependence (PI) for a learning condition and high levels of Individual Control in relation to Accountability (IAc) are needed. In particular, for cooperative learning, a dyadic structure similar to the Side-by-side condition seems optimal. Second, the present study investigated known elements of cooperative learning - group-goals, positive interdependence and individual accountability - and has conceptually refined those elements and developed understanding of their role in cooperative and individual learning conditions. Third, the study provides evidence that different domains, whether social-emotional domains (peer–self-concept and maths–self-concept) or the cognitive domain (maths word problem-solving) are all aspects that are affected by the learning conditions as evidenced by the unique results for each domain; and furthermore the pattern of results suggests that the effects on the domains are integrated. Fourthly, it has brought to light problems in the
research design and suggested improvements for follow-up studies in accordance with the goals of the present research that will be addressed in Study Two.
CHAPTER 4

STUDY 2 (A): LEARNING-BEHAVIOUR (LB) REWARDS & ABILITY-STRUCTURES - EFFECTS ON MATHEMATICS ACADEMIC ACHIEVEMENT AND PEER-SELF-CONCEPT

4.1 Introduction

Study Two (a) continues from the findings of Study One, which primarily compared Individual-learning and various types of Cooperative-learning by investigating aspects of task-structure in order to find the optimal learning conditions for maths– and peer–self-concept outcomes. Because of conceptual advances made in response to Study One’s findings, the present study has made some modifications to strengthen the research design, and in addition, it includes some new research directions.

4.1.1 Background and Contribution to Goals of PhD Research Project

Following on from the findings of Study 1’s investigation of optimal cooperative conditions, one modification made to the present study is that it will compare individual learning with only one form of cooperative learning (similar to Study 1’s Side-by-side condition). From these cooperative- and individual-learning comparisons, Study 2a will investigate the effects of a number of influences on learning outcomes in cognitive, social and affective domains using the same dependent variable outcomes as in the previous study: Maths Word Problem Solving (MWPS) and Peer- and Maths–Self-concept (SDQ-I Peer & SDQ-I Maths). Notably, for the present study, Maths–Self-concept is treated as exploratory and not included in the hypotheses as will be discussed later (see Section 4.1.4). There are several foci of the present study’s investigations. One main focus will be on the effects of ‘learning-behaviour rewards (LB-Rewards)’ – so named to distinguish
them from ‘academic-mastery rewards’. Another main focus will be on the effects of three different ability-structures, comparing pairings in the cooperative conditions that are either homogeneous (Equals) or heterogeneous (Mixed) plus the individual ability in the non-paired conditions (Individuals). Additionally, exploratory dimensions of the study will include the effects of initial Low-, Medium- and High-ability on the measured outcomes.

The following section will develop the statement of the hypotheses respectively for LB-Rewards and Individual-, Equals- and Mixed-ability structures. The section after that will explain the study’s proposed exploratory dimension.

4.1.2 Rationale and Hypotheses for Investigations in Study 2a

4.1.2.1 Investigation of LB-Rewards

Study 2a modified and extended the rewarding approach used in the previous study. Instead of rewards being based on positive-interdependence between partners and targeting academic achievement, rewards in the present study target two different goals, (1) academic achievement, in all conditions with no comparison between groups and (2) learning-behaviour (LB), with the latter being manipulated (LB-Rewards vs no-LB-Rewards) within each type of learning: individual and cooperative. In both the individual- and cooperative-learning conditions, rewarding of academic outcomes will be based on individual attainment of target mastery scores, and rewarding of learning-behaviours (LB) will be based on teachers’ observations of individual children helping themselves to learn (as individual LB) or children in dyads helping their partners or each other to learn (as cooperative LB).

There are several possible approaches to group rewards. They can be given just on shared academic outcomes (as in Study 1); to all members of the group or dyad, or as will be the case here, to any individual in the group or dyad who exhibits the target behaviour.
Webb (1992) suggests on the basis of a meta-analysis of research that “group rewards promote helping behaviour among group members” (p. 383) but points out that some researchers are concerned about possible detrimental effects of extrinsic rewarding. She recommends that “students working in small groups should be encouraged to give explanations to each other and to be sensitive to students’ need for help” (p. 382). In the present study, in order to elicit appropriate learning-behaviours rather than merely instructing students to work together (Cohen, 1994b; Jacobs, 1998; King, 1992; Webb, 1992), a programme showing Individuals how to help oneself and Cooperative partners how to help each other in maths problem-solving was developed for use during Study 2.

The rationale for rewarding academic outcomes and learning-behaviours separately was based on conceptual and methodological issues: School programmes always recognize academic achievement and so opportunities to be rewarded for this should be applied consistently to all conditions and not be the basis for comparison. However, in this second study, now that the academic rewards were not tied to eliciting positive-interdependence, recognition was given to the other aspect of the programme that was expected to elicit either cooperative learning or individual learning. Given that there are different specific learning-behaviours required for cooperative learning and individual learning, it seemed conceptually preferable to target these behaviours to compare the effects of rewarding or not rewarding. The behavioural principle is that reinforcing a target behaviour leads to its recurrence predicts that, rewards should lead to an increase in the target behaviours for both individual and cooperative conditions to the extent that the LB’s influence performance. As such, given that cooperative behaviours are more complex and more difficult to learn, there is uncertainty as to whether or not there is likely to be a greater reward-related improvement for cooperative groups in comparison to individual-learners. The complexity of cooperative behaviours may make improvements less likely, but the reality that students
have less exposure to studying cooperatively than individually leaves more scope for improvement in cooperative conditions.

4.1.2.1 Hypothesis 1: LB-Rewards Effects on Maths

1. For MWPS, LB–Rewards conditions will lead to significantly greater gains than No-LB-Rewards conditions.

In relation to Peer–Self-concept, learning behaviour rewards would be expected encourage students in cooperative conditions to behave in ways that potentially make them more likeable, without being tied to interdependence in academic performance, which in some situations may cause resentment by partners. It is less obvious how LB rewarding in individual conditions may affect Peer–Self-concept, but nevertheless there would appear to be potential to generally improve levels of positive recognition at the whole class level, which may enhance the regard peers have for one another.

4.1.2.1.2 Hypothesis 2: LB-Rewards Effects on Peer-Self-Concept

2. For SDQ-I Peer, LB–Rewards conditions will lead to significantly greater gains than No-LB-Rewards conditions.

4.1.2.2 Investigation of Individual, Equals and Mixed Ability-Structures

There are competing hypotheses for mathematics (MWPS) outcomes for the learning conditions (cooperative: mixed and equal, or individual). Note that the Side-by-side condition of Study 1 – which had equivalent academic Maths outcomes to the Individual condition – was adopted as the model for Cooperative conditions in the present
study. However, whilst that finding suggests there should once again be no significant differences between the cooperative and individual conditions, the greater part of the literature in the field suggests that good cooperative-learning programmes have superior outcomes to individual-learning programmes. Thus, it is possible that minor modifications in this second study intended to improve the outcomes of both learning programmes might have a stronger effect in cooperative conditions (e.g., structuring experiences to reflect on learning-behaviours and structuring experiences to improve individual- or cooperative–problem-solving). Additionally, since cooperative conditions are more complex and rare than individual conditions, it is likely that this study’s intervention of rewarding learning behaviours could have a greater impact on the cooperative condition than the individual condition. Furthermore, although not conclusive and although results vary according to ability-structure (Chan, 2000; Doise & Mugny, 1984; Lake, 1988; Mugny & Doise, 1978), much of the previous research has shown that heterogeneous ability-groupings have superior outcomes to homogeneous ability-groupings in cooperative learning (e.g., Chan, 2000; Cohen, Kulik & Kulik, 1982; Lake, 1988), and this is relevant for predicting outcomes for the present study’s Mixed and Equals conditions.

4.1.2.2.1 Hypothesis 3: Competing - Ability-Structures

Effects on Maths

3. For MWPS, there are three competing parts: (3a) There will be significant gains for all conditions with no significant differences across combined- Individual or combined-Cooperative conditions; (3b) There will be no significant differences between Individual and Mixed; Individual and Equal (for: combined LB-Rewards and No-LB-Rewards together; LB-Rewards; and LB-No-Rewards
categories), and (3c) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for combined LB-Rewards and No-LB-Rewards together; LB-Rewards; and LB-No-Rewards categories).

The overall advantages of heterogeneous ability-groupings over homogeneous ability-groupings also apply to social relationship outcomes. Much of the literature argues that cooperative-learning opens more opportunities for social acceptance especially for those students whose status may be lower (Cohen, Kulik & Kulik, 1982). Furthermore, this is indicated in the findings of Study 1. That is, the Side-by-side condition, adopted in Study 2, was optimal for improving Peer-self-concept and it contrasted particularly with the Jigsaw-DT condition, which was argued to have allowed dyads to “sink-together”. Reducing the likelihood of sinking together, which is most likely to be a problem for mixed-ability dyads, opens the possibility that in the particular rewards conditions of Study 2 (i.e., no positive interdependence for academic rewards, and availability of learning-behaviour rewards), it will be Mixed rather than Equals who have the most to gain in social relationships as measured by the SDQ-I Peer.

4.1.2.2.2 Hypothesis 4: Ability-Structures Effects on Peer-Self-Concept

4. For SDQ-I Peer (a) Combined-Cooperative conditions will have significantly greater gains than for Combined-Individual conditions; and (b) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for combined-: LB-Rewards and No-LB-Rewards; LB-Rewards; and LB-No-Rewards categories).

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5 Although it is unusual to predict findings of ‘no difference’, it is necessary in the present study since it is following on from some unexpected findings of Study 1. Cohen (1990) points out that where a study has sufficient power to detect an effect 91% of the time, and if there is not an effect shown, then the chances are there is not one there to detect.
4.1.3 Rationale for Exploratory Investigation Focusing on High-, Medium- and Low-Ability-Levels

An exploratory analysis for each ability-level will be undertaken to investigate the effects of ability on both individual- and cooperative-learning outcomes. In particular, the aim is to ascertain optimal learning structures in cooperative dyads, and to gain insight into whether or not children’s different abilities might affect whether a cooperative or an individual approach to learning is optimal.

Table 4.1:1.
Exploratory Analysis for Each Ability-Level: High, Medium, and Low

<table>
<thead>
<tr>
<th>Partner’s ability level</th>
<th>High-ability</th>
<th>Medium-ability</th>
<th>Low-ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-ability</td>
<td>HI</td>
<td>H(H-H)</td>
<td>H(H-L)</td>
</tr>
<tr>
<td>High-ability</td>
<td>MI</td>
<td>M(H-M)</td>
<td>M(M-L)</td>
</tr>
<tr>
<td>Low-ability</td>
<td>LI</td>
<td>L(H-L)</td>
<td>L(L-L)</td>
</tr>
</tbody>
</table>

Table 4.1:1 shows the possible combinations of ability-structures as well as the notation used. Children will learn alone (individually) or cooperatively (in dyads) with a High-, Medium- or Low-ability partner. The comparisons will be made within each ability-level. For example, for High-ability structures: comparisons will be made between High-ability individuals learning alone (HI), dyads comprising a High-ability child learning with another High-ability child H(H-H), dyads comprising a High-ability child learning with a Medium-ability child H(H-M), and dyads comprising a High-ability child learning with a Low-ability child.
What needs to be pointed out to avoid later confusion is that these categories of high, medium and low ability were derived statistically, not from comparison with other children within the conditions, but from using the whole cohort of students divided into thirds according to their MWPS pre-test scores. This is a useful methodology for overcoming skewing of ability in particular classes or schools (Noreen Webb, personal communication, 2 Sept 2001). The abilities of individual children in this study do not correspond to the ability levels based on a single class population that were used for the class-based pairings into Equals and Mixed conditions (for discussion of the latter procedure used, see Section 4.2.4). Therefore, one of the reasons this ‘ability’ investigation in Study 2 is exploratory is that the ability-structures to be analysed are derived statistically without an absolute match to the assigned conditions. Another reason is there were small numbers in many of the categories. Some pairings, such as high-ability students with low-ability students were less common than pairing that included a medium-ability student, and this affected the power of statistical analyses.

4.1.4 Justification and Purpose of Continuing SDQ-I Maths in Study 2

Study 1 encountered a number of problems in analyzing the results for maths–self-concept using Marsh’s (1990) SDQ-I Maths as a measure. In particular, gains in this measure were more strongly related to being in a cooperative condition than to mathematical performance (MWPS) gains. Since the outcome is difficult to explain (see discussion of Study 1, section 3.1.5), no hypothesis can be developed for the measure. Nevertheless, the SDQ-I Maths is included in this study to ascertain whether or not it replicates the previous results, and to evaluate the extent to which maths–self-concept is a useful construct. Failure to replicate the results might highlight important issues about the differences in design of Study 1 in comparison to Study 2.
Having discussed Study 2a’s approach to investigating the effects of LB-Rewards, ability-structures and exploration of ability levels on Maths (MWPS), Peer-Self-concept and an exploration of Maths–Self-concept, the strengths in the study’s design will be listed. As with Study 1, it combines a classroom-based setting with clearly-defined comparison groups in the experimental design that identify the mechanisms of cooperation being investigated; the combination of MWPS, SDQ-I Maths and SDQ-I Peer outcome measures allow the inter-relationships between cognitive, affective and social-emotional domains to be examined; and the results have high reliability due to applying Rasch Analysis to the outcome measures. Study 2a’s design has made several advancements following Study 1 by which it more closely meets a primary goal of social-psychology research “to begin with the social” (Ross, 1908; Thibaut & Kelley, 1959) – a goal which is frequently lost as a main research focus in the field (Anderson et al., 1997; Hogg & Vaughan, 1998). That is, in Study 2a’s cooperative conditions, learning-behaviour rewards have a more social focus than the previous academic-mastery rewards; and the comparison of Equals and Mixed ability-structures which could not be undertaken due to low numbers in Study 1 will provide insight into the social dynamics of dyadic learning.

The additional dimension of the exploratory analyses of outcomes for High-, Medium- and Low-ability will move the research in the direction of more specific results that can be useful for theorising the nature of interaction between-dyadic members. Furthermore, in the overall set of investigations for Study 2, the present Study 2a’s findings will be strengthened by its connected studies 2b and 2c which will provide further insight into the within-dyadic effects. Study 2b makes several methodological advances in its own right, using factor analysis to develop an original measure to investigate outcomes for self-efficacy beliefs that combines ‘learning maths’ and ‘cooperation with a partner’, and applying findings from using that measure in developing an original social-psychological
theory of classroom learning; and Study 2c is a qualitative dimension that will illustrate the proposed theory by drawing on children’s descriptions about their affective responses to dyadic learning experiences.
4.2 Method of Study 2

4.2.1 Participants

Participants were 451 children in Grade-5 (mean age: 10.7, SD = 0.30; age range: 10:0 – 10:11) from six government schools (totaling twelve classes) in Singapore. Each class was randomly allocated to one of the six experimental conditions and no school’s classes were allocated any condition more than once. The number of children in each experimental condition from each class and school is shown in Table 4.2:1. Note that the nominated class numbers do not indicate any academic standard. Participants in Study 1 were not included in Study 2.

Table 4.2:1.

Number of Grade-5 Children in each Experimental Condition from each School and Class

<table>
<thead>
<tr>
<th>School</th>
<th>Class</th>
<th>Individual LB-Rewards</th>
<th>Individual No LB-Rewards</th>
<th>Cooperative LB-Rewards</th>
<th>Cooperative No LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>-</td>
<td>28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>29</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>-</td>
<td>42</td>
<td>-</td>
<td>-</td>
</tr>
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<td></td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>43</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>40</td>
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<tr>
<td>D</td>
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<td>-</td>
<td>39</td>
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<td>38</td>
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<tr>
<td>F</td>
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<td>N=451</td>
<td></td>
<td></td>
<td></td>
<td>72</td>
<td>77</td>
</tr>
</tbody>
</table>
The ethnic composition of the sample was 317 Chinese (70.3%), 97 Malay (21.5%), 32 Indian (7.1%) and 5 “Other” (1.1%). There were 235 males (52.1%) and 216 females (47.9%). Each ethnic and gender category was fairly evenly distributed across the schools and classes.

4.2.2 Design

The between-groups factors related to experimental learning condition and the within-participant factor was the time of testing. A 3 (experimental learning condition: Individual, Equal, and Mixed) x 2 (experimental reward conditions: LB-Rewards and No-LB-Rewards) x 2 (time of testing: pre-, post-) mixed design was employed. The dependent variables were MWPS (measure of maths performance), SDQ-I Maths and SDQ-I Peer (measures of Maths- and Peer-self-concept), and SLQ-Individual and SLQ-Cooperative (measures of self-efficacy to learn maths individually and cooperatively).

4.2.3 Materials

4.2.3.1 Software for Maths Computer-Based Activities

Zarc’s ‘Primary Mathematics Adventure’ 5A series (Times Multimedia, 1999) was used in all schools (see Study 1 for description).

4.2.3.2 Broken Squares Activity

The objective of the ‘Broken square’ activity was to introduce concepts of cooperation and, more specifically, to promote awareness that a participant’s own behaviours may help or hinder the pair effort. The ‘Broken squares’ activity consists of 12 variously shaped and sized puzzle pieces from which four equally-sized squares can be made up (Kagan, 1992; see Electronic Appendix E.2.1). For cooperative conditions, the twelve puzzle pieces were randomly divided and six pieces contained in each of Envelope
A and Envelope B. For individual conditions, all 12 puzzle pieces were contained in one envelope.

### 4.2.3.3 Mathematical Word-Problem Solving (MWPS) Tests

Two parallel, 30-item short-form MWPS tests were constructed as MWPS pre-test and post-test measures: Short Form Revision Exercise A and Exercise B (See Electronic Appendix E.2.2). The short forms were based on a refinement of the 60-item long forms used in Study 1. The refinement was possible because it could draw on relevant data and analyses from Study 1. The short form was useful, not only in allowing for time-saving in test administration, but more importantly for improving the reliability of the MWPS tests by reducing measurement errors which can be caused by fatigue or waning motivation (Whitley, 1996).

The tests, Short Form Revision Exercises A and B, were constructed in the following manner:

1. Data from Study 1’s Revision Exercises A and B were analysed to guide selection of items that best differentiated between the performances of high- and low-ability children. Positive item-characteristic curves, which resemble cumulative, normal orgives are evidence of high discrimination (Gregory, 2000) and were used as the basis of item selection.

2. The test items were then rated for difficulty by referring to the teacher ratings in Study 1 of each item’s difficulty. One item per level of difficulty (from levels 1 to 10) for each topic was selected for each of Short Form Revision Exercises A and B.
4.2.3.4 MWPS Worksheets

A total of six MWPS worksheets that were developed and used in Study 1, were used again for the current study. There were two worksheets for each of the topics: Whole Numbers; Fractions; Area of a Triangle and Ratio (see Electronic Appendix E.1.4). The same worksheets as previously used in Study 1 for Individuals and the Side-by-Side condition were used respectively for Study 2a’s Individual and Cooperative conditions.

4.2.3.5 Mathematics Activities

Eight mathematics activities were used to stimulate interest and motivation in mathematical problem solving (Milton, 1986): Two each of matchstick exploration, magic square, division, and arrangement activities (see Electronic Appendix E.2.3).

4.2.3.6 Progress Card

The Progress Card used in Study 1 (– see Rewarding System in Procedure) was re-used in the current study with one modification for the three LB-Rewards conditions only: Additional empty spaces were added to record the student’s displaying of learning strategies (see Accompanying Appendix A.2.1). This served to encourage children by reminding them of the need to display learning strategies through the use of LB-Rewards in these conditions. For the remaining (non-LB-Rewards) conditions, the Progress Card was identical to that used in Study 1 (see Accompanying Appendix A.1.2).

4.2.3.7 Learning Strategies

Materials to aid learning of effective strategies for the academic programme’s maths problem-solving, based on guidelines by Polya (1957), were developed for use in all conditions, with different versions for the Individual conditions and the cooperative
It is not standard practice to develop parallel forms of learning materials in cooperative learning studies, however, doing so addresses criticisms, (for example, by CTEHP, 1994), that often control groups have comparatively less well-structured programmes. Furthermore, it clearly pinpointed what was meant by “learning” in the programme regardless of conditions, and delineated what specific learning-related behaviours were expected for either individual learning or for cooperative learning.

Polya (1957) originally devised a four-phase approach to problem-solving, as follows: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan and (4) checking the results. Thus, it seemed viable to have parallel instructions whereby, when tackling a problem, Individuals learn the strategies and check for having done them, and, alternatively, members of Cooperative dyads help each other learn the strategies and help each other check that they have applied them.

4.2.3.8 Learning Strategies: Self-Evaluation Sheets

Four self-evaluation sheets were constructed, with a separate set for “Learning alone” or “Learning together” for the Individual and Cooperative conditions respectively (see Accompanying Appendices A.2.2 and A.2.3). The evaluation exercises were intended to encourage reflection by students in terms of the extent to which they applied each of Polya’s problem-solving steps in each of the four phases taught. The number of items in each sheet varied and was in accordance with the number of steps taught for each learning phase (generally between 3 to 6 items). A free-response section eliciting the children’s thoughts on any improvements needed and how they might “do better next time” was also included.
Samples of these sheets were also used in Study 2c to illustrate the theory developed in the research project.

4.2.3.9 Pair Evaluation Sheets

A 6-item Pair Evaluation form was constructed to support group processing in cooperative conditions (see Accompanying Appendix A.2.4). Johnson et al. (1994) advocated raising awareness on how well the group is functioning since it allows members to make decisions about what behaviours to continue with or what needs to be changed. Hence, Pair Evaluation items were constructed to promote reflection, discussion and feedback (in pairs) on how well members were achieving the target behaviours, and in addition, a free response section was incorporated for members to decide how to improve the effectiveness of their working relationship or raise any other concerns that may not have been already addressed by the items.

This form was the only one in Study 2 that was used for the Cooperative conditions only without the same or an equivalent form administered to the Individual conditions. That was because cooperating is an additional behaviour and there was not any apparent equivalent behaviour to reflect upon for the students in individual conditions.

4.2.3.10 Reflection Sheets: “My Thoughts – Today I Learned Maths on My Own/ With a Partner”

Two free-response reflection sheets were constructed, respectively for the individual learning conditions and the cooperative learning conditions. The objective of the reflection sheets was to encourage children to reflect upon their learning processes. Reflection is recognized as an integral process of successful learning. For example, Bransford and Stein (1993) include reflection as a last phase in their learning model: “IDEAL: Identify problems and opportunities, Define goals and represent the problem, Explore possible

In order to guide children in their reflections, six areas for reflection were identified. Children were to write their thoughts and feelings towards what they: (1) found most useful, (2) found least useful, (3) enjoyed most, (4) enjoyed least, (5) found most easy and (6) found most difficult; while learning on their own (individual learning conditions; see Accompanying Appendix A.2.5) or while learning with a partner (cooperative learning conditions; see Accompanying Appendix A.2.6).

The free-response format allowed for the recognition that children are individuals and may have thoughts and feelings that differ from other children. This is in contrast to the use of questionnaires where children’s general thoughts and feelings are preempted and children are asked to rate the degree to which they agree with a certain statement.

The response sheet was also intended to gather important qualitative information, such as: the strengths, weaknesses, issues and concerns faced by each individual participant when individual or cooperative learning techniques are used.

4.2.3.11 Self-Description Questionnaire I

The SDQ-I Maths– and SDQ-I Peer–self-concept scales were administered as in Study 1.

4.2.3.12 Student Learning Questionnaire

Developed for Study 2, the 40-item Student Learning Questionnaire (SLQ) comprised two scales: SLQ-Individual and SLQ-Cooperative; each with 20-items (See Accompanying Appendix A.2.7). The SLQ Individual and SLQ Cooperative are measures of self-efficacy to learn maths individually (i.e., ‘alone’) and cooperatively (i.e., partnered),
respectively. For details of scale construction and psychometric properties of the SLQ, refer to Chapter 5. Note that some parts of the thesis refer to this measure as ‘SLQ-Alone-&-Partnered’ in an attempt to avert possible acronym confusion by readers.

4.2.4 Procedure

The researcher obtained written permission from the Singapore Ministry of Education and the principals of six government schools to conduct research in the form of a mathematics holiday revision programme during the mid-year holiday (June 2002). The duration of the programme was ten days, with each day’s session lasting two hours (totaling 20 hours for the whole programme, but only 16 hours for the intervention after allowing 4 hours for test administration).

Each class was randomly allocated to one of the six experimental conditions (see Table 4.2:1). Note that where there were two or three classes in the one school, the classes were assigned to different experimental learning conditions (see Study 1 for justification).

Qualified teachers were hired to administer the intervention and tests. The teachers were blind to the different conditions and were randomly allocated to a class. The teachers were told that the purpose of the study was to determine scientifically the optimal learning condition for maths classrooms. Each teacher received a verbal briefing, and an information sheet describing the experimental learning condition to which he or she was assigned (See Electronic Appendix E.2.6).

The programme consisted of three phases: an introductory phase which included administration of pre-tests, the cooperative and individual maths problem-solving phase, and a completion phase that included post-tests and administering of rewards.
4.2.4.1 Introductory Phase

On the first day of the programme, children individually completed the SLQ-Alone-&-Partnered (untimed; administration time, approximately 20 minutes). Teachers informed children that the questionnaire was about how they think they learn. Teachers emphasized that the SLQ was not a test and that there were no right or wrong answers. Children were also told to be honest in their responses. Teachers then read out the instructions for completing the questionnaire from the front page of the questionnaire (see Accompanying Appendix A.2.7). Children responded to each of the items on a six point scale, 1 = Strongly Disagree, 2 = Moderately Disagree, 3 = Disagree Slightly More than Agree, 4 = Agree Slightly More than Disagree, 5 = Moderately Agree and 6 = Strongly Agree. The range of total scores possible for each scale is 20 to 120.

The MWPS pre-test was administered and timed at 45 minutes. Half the children in each class were allocated Short Form A while the other half were allocated Short Form B. Teachers informed children that the MWPS pre-test was a quiz of their mathematical knowledge and they should give their best effort. Children were instructed to work as quickly as possible, and to skip questions that they could not answer but return to them later if time permitted. An item was scored 1 for a correct answer, and 0 for a non-attempt or incorrect answer. Thus, these test scores could range from 0 to 30.

Later, from these tests, Person-ability estimates had to be established. The procedure differed from Study 1 because it was possible to determine the Person-ability estimates without having overlapping items. This was done by anchoring the two short forms to the original Revision Exercises A and B and the children’s data from Study 1 which provided the links that otherwise would depend upon overlap items in the short form test.
Day 1 ended with the ‘Broken squares’ activity, which was administered differently between the Individual and Cooperative conditions. Children in the Individual–No-LB-Rewards and Individual–LB-Rewards conditions were each given an envelope containing 12 puzzle pieces and were told to form four perfect squares of equal sizes from the pieces. Children were told to do the activity on their own and not to talk or show their solution to their classmates. Children were told to raise their hand when they had formed all four squares so that the teacher could check their performance.

In the cooperative conditions teachers paired up children for this activity by picking out names from a box. Teachers gave each child an envelope so that each pair had between them both Envelopes A and B. Children were told that each envelope contained six puzzle pieces; and that the task of each participant was to form two perfect squares of equal sizes. Children were told that in order to complete the task, members had to take turns, exchanging puzzle pieces one at a time, giving their partner pieces that they thought may help their partner complete the squares. Children were not allowed to speak or signal for pieces. Upon completion, they could raise their hand so the teacher could check their performance.

At the end of the ‘Broken square activity’, children in all conditions were asked as a class to share how they managed to complete the task successfully (e.g., turning the pieces around, trial and error, giving and sharing in cooperative groups etc). Children in cooperative conditions were asked, in addition, to describe ways that their partner was or was not helpful and how that made them feel (for example, when their partner finished their own squares and sat back without helping them solve their puzzles, and when their partners held back a puzzle piece and did not know that they needed it or did not see the solution).
On the second day of the programme, children individually completed the SDQ-I (Maths- and Peer–self-concept scales only; untimed; administration time, approximately 10 minutes). Teachers read the standardized instructions from the manual (Marsh, 1990).

Teachers gave each participant a Progress Card, containing the participant’s MWPS Feedback Score and Target Score. The techniques teachers used to compute the Feedback score in the current study remained unchanged from Study 1, but each correct answer in Study 2 was allocated 10 marks, rather than 5, to keep the total scores consistent for both studies. Teachers explained to children how their maths Feedback and Target scores were derived and how the Reward Systems would operate.

For the cooperative conditions, the teacher assigned children to pairs. Children in each class were first rank ordered (from the highest scoring participant to the lowest scoring participant) according to their mathematics pre-test score. Where more than two students shared the same rank, children were ordered alphabetically (by their surnames). For the Equals conditions, children were then paired top down. Hence, the first two children on the list became the first pair; and the third and fourth ranked ordered participant became the second pair, and so on. For the Mixed conditions, the ranked ordered list was median-split. Children in each half of the split were paired, for example, in a class of 30 children, a participant rank ordered 1 was paired with a participant ranked ordered 16, 2 with 17 and so on. Classes with an odd number had to include a group of three from which the data set was not used. For inclusion in the data set, children needed to have stayed in their allocated pairing for at least 80% of the time (sometimes moving at the discretion of the teacher due to a partner’s absence).

Before the start of the intervention (Day 2), children in Individual conditions were told to sit, listen quietly and not to talk to each other during class. In contrast, children in the cooperative conditions were asked to introduce themselves to their partners and to
discuss how they could work as a pair. Pairs were then asked to share their ideas with the class.

4.2.4.2 Problem-Solving Strategy Phase

Three Maths (MWPS) topics were covered in the programme together with the problem-solving strategies for the individual or cooperative learning approaches. For each MWPS topic, which took approximately 2 days, the teacher introduced the learning strategy (for that day) introducing one of the four Polya phases successively and illustrating with examples how it could be applied to MWPS. The teacher projected a computer based presentation segment of the MWPS topic onto the board. Following this, the children completed the paper-and-pencil MWPS worksheets for that topic as individuals or in dyads, marked their classmates’ work, and then received their stamps in relation to their maths targets. In the applicable “learning behaviour” Rewards groups, stamps were also given at the end of each topic by the teacher. All students completed a Learning Strategy Self-evaluation sheet, and in addition, students in cooperative conditions completed the Pair Evaluation sheet. These steps are described in more detail in the following paragraphs.

The computer presentation taught basic concepts of the topic (e.g., going through a specific formula). After the computer-based presentation of each MWPS item, the teacher re-explained how the learning strategy could be applied to solve the question. Upon completion of the computer-based presentation, each MWPS question from the computer-based exercises was projected onto the board and children were asked to work out the problem either on their own (individual condition) or as a pair (cooperative condition) on a sheet of paper. For all conditions, teachers then randomly asked one participant to key-in their answer to the computer. If a correct answer was entered, the software would automatically move onto the next question. If the answer was incorrect, the software would
break the problem down into small steps, asking the participant for a response to each step. After each item, the teacher asked if the class needed any further clarification on how the solution was derived. NB: In Study 1 it was possible for each child or dyad to follow the MWPS goals from the software; however the whole class method of using the computer-based instruction was necessary because it was not possible to borrow sufficient copies of the software for Study 2’s larger sample size.

Upon completion of the computer-based activity, children attempted to do the first MWPS worksheet for the same topic. Children in the individual condition were not permitted to discuss their solution or ask for assistance from their classmates (or teacher) when completing the worksheets. Children in the cooperative conditions were allowed to discuss their solution only with their assigned partner. Children in both conditions were required to hand in their worksheet at the end of the activity. For all conditions, there was no time limit for completion of the worksheets; the experimenter told teachers to use their discretion as to when to move to the next activity, although it was expected that all three maths topics would be covered. A fixed time limit, similar to testing conditions, was avoided so as not to place emphasis on the product (i.e., completing the worksheet) but rather on the learning process. In addition, having a fixed time limit may influence the extent to which cooperation occurs. For example, high-ability children in mixed-ability pairs may be less willing to discuss their solutions with their partners if they perceive that the allocated time is insufficient.

The completed worksheets were marked as a class (see Study 1). Similar scoring methods were also adopted for the current study. Stamps were given to children who had achieved their targets and those who had displayed the learning strategy (LB-Rewards condition only).
For rewards, there were two possible categories: (1) When MWPS targets were met in worksheets and (2) When learning strategies were displayed. The former applies to all conditions while the latter only applies to Individual–LB-Rewards, Equal–LB-Rewards and Mixed–LB-Rewards conditions. The rewarding system adopted for meeting of targets in worksheets in Study 2, followed that of the Side-by-Side and Individual learning conditions in Study 1 (i.e., the cooperative learning conditions in Study 2 are essentially Side-by-Side conditions; and the Individual learning condition structures were the same in Studies 1 and 2). For MWPS, children each received a stamp for each worksheet if targeted scores were achieved (see Target Scores, Study 1).

For the rewarding of displaying of learning strategies, in the Individual–LB-Rewards, Equal–LB-Rewards and Mixed–LB-Rewards conditions (LB-Rewards Conditions), for each topic the children each received a ‘stamp’ (at the teacher’s discretion) when exhibiting the targeted behaviour (i.e., independent learning behaviours for the Individual–LB-Rewards condition; and cooperative learning behaviours for Equal–LB-Rewards and Mixed–LB-Rewards conditions).

For each rewarding category, across-the-board for Maths (MWPS) targets and, only in the experimental LB-Rewards conditions for learning behaviours, a maximum of six stamps could be awarded. Applicable only to the LB-Rewards conditions, the stamps collected from the learning behaviour category could not be added to the stamps collected from the maths achievement category. That is, as the targeted behaviours in each category were distinct from each other, the rewards for each category were kept separate.

For both rewarding categories, the stamps could be exchanged for prizes at the end of the programme. As with Study 1, for four stamps children received a sticker; for five stamps, a pencil; and for six stamps, a certificate. The type of prize (sticker, pencil and certificate) was kept similar for both rewarding categories so as not to show preference for
one target behaviour (i.e., both target behaviours have equal importance). Hence, in order to distinguish between the two rewarding categories, the stickers, pencils and stickers used had distinctive designs.

All conditions completed a Learning Strategy: Self-Evaluation sheet. Children responded to each item on a 4-point scale: ‘Always’, ‘Sometimes’ and ‘Never’, or on applicable items, ‘Does not apply to me’. In addition, all cooperative conditions completed a Pair Evaluation Sheet. Children responded to each of the items on a 3-point scale: Always, Sometimes and Never. The day ended with the Mathematics Activity.

On the following day, the teacher recapitulated the learning strategy and children attempted the second worksheet on the same topic. A similar sequence of marking and rewarding as per worksheet 1 was adopted for worksheet 2. This concluded the teaching/learning segment of the topic. This sequence was repeated until all three topics were completed.

During this sequence, at the end of Day 5 and 7, in addition to the worksheet activities, children completed the reflection sheet, “My Thoughts - Today I learned Maths on My Own” or “My Thoughts - Today I learned Maths with a Partner”, with an approximate time of 10 minutes.

### 4.2.4.3 Completion Phase

On Day 9, the SDQ-I self-concept measures were re-administered; and on Day 10, the SLQ-Alone-&-Partnered; and following that the maths (MWPS) post-test was administered. For the MWPS post-test, children were told that the purpose of the ‘Revision Exercise’ was to ascertain their progress in the intervention and that it would not be used to set targets. Other administration instructions were similar to that of the pre-test. The teacher then gave prizes to children who had met the criteria for rewards (see Rewarding
system). The teacher thanked the children, offered verbal encouragement for them to continue doing their best for their future progress in mathematics and gave out token pens to all children.

The researcher then met with the teachers and sought their feedback. In particular, teachers were asked for their thoughts about the intervention and the children’s reaction to the mode of instruction. Notes were taken on this feedback.
4.3 Results of Study 2a

4.3.1 Overview of Section

This section is divided into four main sub-sections: Preliminary analyses, main analyses, exploratory analyses and summary of findings. The preliminary analyses report the outcomes of raw score conversions of three dependent variables: Maths Word Problem-Solving (MWPS); Maths–Self-concept (SDQ-I Maths); and Peer–Self-concept (SDQ-I Peer) using Rasch modeling methods and the outcomes of data screening procedures.

The main analyses, which each encompassed comparisons of Individual and Cooperative learning, are grouped according to two broad categories: Learning Behaviour (LB)-Rewards (combined-Individual-LB-Rewards vs combined-Individual-no-LB-Rewards; and combined-Cooperative-LB-Rewards vs combined-Cooperative-no-LB-Rewards) and Ability-Structures (comparing combined-Individual, combined-Equal and Combined-Mixed, with each of those three conditions compared pairwise for LB-Rewards and No-LB-Rewards; that is, the hypotheses did not require the 6 conditions to be statistically compared beyond the pairwise constructions). These broad categories were used to generate 2 sets of 3 hypotheses addressing two of the dependent variables, MWPS and SDQ-I Peer.

Hypotheses 1 and 2 pertain to the use of Learning Behaviour (LB)-rewards’ effects on MWPS and SDQ-I Peer respectively, and predict that: LB-Rewards conditions will lead to significantly greater gains than No-LB-rewards.

Hypotheses 3 and 4 pertain to Ability-Structures on Maths (MWPS) and Peer–self-concept (SDQ-I Peer) outcomes. Hypothesis 3 for MWPS comprises three parts: (3a) there will be significant gains for all conditions with no significant differences across combined-Individual or combined-Cooperative conditions; (3b) there will be no significant differences between Individual and Mixed; or between Individual and Equal (for combined
LB-Rewards and No-LB-Rewards together; LB-Rewards; and LB-No-Rewards categories\(^6\), and (3c) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for combined LB-Rewards and No-LB-Rewards together; LB-Rewards; and LB-No-Rewards categories).

Finally, Hypothesis 4 for SDQ-I Peer predicts that: (a) Combined-Cooperative conditions will have significantly greater gains than for Combined-Individual conditions; and (b) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for combined: LB-Rewards and No-LB-Rewards; LB-Rewards; LB-No-Rewards categories).

Additional to the above experimental dimensions of the study in the main analyses is SDQ-I Maths for which there is no hypothesis, but analytic methods for all three dependent variables are similar. (NB – the exploratory status of the SDQ-I Maths measure is due to theoretical problems raised by Study 1 in relation to its operationalisation as a construct that will be explained in more detail in the discussion section of the present study.)

The exploratory study of SDQ-I Maths will consider the patterns of gains and losses in the experimental conditions. An important consideration will be the extent to which any differences appear to be due to the learning conditions (i.e., rewarding and ability-structure) or whether, consistent with Study 1, any differences appear to be due to assignment to Individual and Cooperative conditions.

The exploratory study of more refined ability categories (High, Medium and Low) will consider the extent to which ability level makes a difference in Individuals and Equals

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\(^6\) Cohen (1990) points out that where a study has sufficient power to detect an effect 91% of the time, and if there is not an effect shown, then the chances are there is not one there to detect.
conditions, and especially the effects of status within a dyad of being a more competent partner or a less competent partner.

The main analyses (totaling 14 planned comparisons) are presented in two parts. The first part, comprising 5 planned comparisons, makes comparisons between broad combined categories to address issues on Learning structure (comparing combined-Individual vs combined-Cooperative conditions), Reward structure (comparing combined-LB-Rewards vs combined-No–LB-Rewards) and Ability groupings (comparing combined-Individual vs combined-Equal, combined-Individual vs combined-Mixed, and combined-Equal vs combined-Mixed).

The second part, comprising nine comparisons examines the effects of specific experimental conditions and addresses the effects of Learning Behaviour (LB) reward structures and ability-structures in the dyadic pairings. To address the effects of LB-Reward structure, No-LB-Rewards conditions are compared with LB-Rewards conditions for Individual-, Equal- and Mixed-ability dyads (e.g., Individual–No-LB-Rewards vs Individual–LB-Rewards). To address the effects of ability-structure, comparisons between Individual vs Equal, Individual vs Mixed and Equal vs Mixed are made for No-Rewards and Rewards categories (e.g., Individual No-Rewards vs Equal-No-Rewards, Individual-Rewards vs Equal-Rewards).

The exploratory analysis uses post-hoc comparisons (Tukey’s HSD) for each ability grouping: High-, Medium- and Low-ability children, to explore the effects of more refined ability-groupings i.e., those that further break down the Equal and Mixed categories. For each ability-structure, comparisons are made between working alone, with an equal, and in a mixed condition with a more competent peer (for Medium- and Low-ability children only) and with a less competent peer (for High- and Medium-ability children only). The chapter concludes with a summary of the results.
4.3.2 Preliminary Analyses

4.3.2.1 Raw Score Conversion – Rasch Modeling Analyses

Rasch modeling analyses were performed on participants’ pre- and post-test scores for MWPS, SDQ-I Maths and SDQ-I Peer. Given the large sample size, a significant chi-square was noted indicating that the data had a significant deviation from the linear model for MWPS ($\chi^2 (267) = 846.59, p<.001$), SDQ-I Maths ($\chi^2 (72) = 162.01, p<.001$) and SDQ-I Peer ($\chi^2 (72) = 153.59, p<.001$). However, the model can be still used for capturing the essentials of the data (see Study 1). Notably, there was only one individual item in the MWPS data that deviated significantly from the Rasch model and was subsequently removed. For SDQ-I Maths and SDQ-I Peer, no items deviated significantly from the model. There are also very high item separation indices for MWPS ($r = .88$), SDQ-I Maths ($r = .93$) and SDQ-I Peer ($r = .88$) indicating great certainty that item estimates can be replicated when applied to other population samples if they have shared sample characteristics (e.g., age; country/system of education and so on). Remaining analyses use Rasch scores which transform the original ordinal scale raw scores onto an interval scale, where negative scores are low and positive scores are high.

4.3.2.2 Data Screening Procedures: Children’s Data Excluded from Analyses

The criteria used for exclusion of children’s data sets are as per Study 1 (see section 3.3.2.2). The number of data sets excluded from each of the three main measures (MWPS, SDQ-I Maths and SDQ-I Peer): poor attendance (less than 70%), incomplete data set (i.e., missing either pre- or post-test) or extreme scores are shown in Table 4.3:1.
Table 4.3:1.

**Number of Children’s Data Excluded from MWPS, SDQ-I Maths and SDQ-I Peer Analyses**

<table>
<thead>
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<th></th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
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</thead>
<tbody>
<tr>
<td>Poor Attendance</td>
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<td>54</td>
<td>54</td>
</tr>
<tr>
<td>(11.97%)</td>
<td>(11.97%)</td>
<td>(11.97%)</td>
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</tr>
<tr>
<td>Incomplete Data Set</td>
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<td>53</td>
</tr>
<tr>
<td>(7.76%)</td>
<td>(13.53%)</td>
<td>(11.75%)</td>
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</tr>
<tr>
<td>Univariate Outliers</td>
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<td>(0.44%)</td>
<td>(0.89%)</td>
<td>(2.66%)</td>
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</tr>
<tr>
<td>Multivariate Outliers</td>
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<td>9</td>
</tr>
<tr>
<td>(0.22%)</td>
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<td>(2.00%)</td>
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<tr>
<td>Influential Points</td>
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<td>5</td>
<td>9</td>
</tr>
<tr>
<td>(1.55%)</td>
<td>(1.11%)</td>
<td>(2.00%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>129</td>
<td>137</td>
</tr>
<tr>
<td>(21.95%)</td>
<td>(28.60%)</td>
<td>(30.38%)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are a percentage of the total sample.

### 4.3.3 Main Analyses

The mean MWPS, SDQ-I Maths and SDQ-I Peer pre- and post-test scores for the combined data for Individual, Cooperative, Equals, Mixed, No-LB-Rewards and LB-Rewards are shown in Table 4.3:2; and for each experimental learning condition in Table 4.3:3.
Table 4.3:2.

Mean Pre- and Post-Test Scores for MWPS, SDQ-I Maths and SDQ-I Peer for “Combined” Individual and Cooperative; Equal and Mixed, and No–LB-Rewards and LB-Rewards Data

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>Individual</td>
<td>107</td>
<td>-0.49</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(1.33)</td>
<td>(1.68)</td>
<td>(1.49)</td>
</tr>
<tr>
<td>Cooperative</td>
<td>245</td>
<td>-1.05</td>
<td>-0.66</td>
</tr>
<tr>
<td></td>
<td>(1.38)</td>
<td>(1.49)</td>
<td>(1.37)</td>
</tr>
<tr>
<td>Equal</td>
<td>128</td>
<td>-0.69</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td>(1.29)</td>
<td>(1.33)</td>
<td>(1.40)</td>
</tr>
<tr>
<td>Mixed</td>
<td>117</td>
<td>-1.45</td>
<td>-1.09</td>
</tr>
<tr>
<td></td>
<td>(1.38)</td>
<td>(1.54)</td>
<td>(1.32)</td>
</tr>
<tr>
<td>No–LB-Rewards</td>
<td>178</td>
<td>-0.50</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(1.36)</td>
<td>(1.61)</td>
<td>(1.54)</td>
</tr>
<tr>
<td>LB-Rewards</td>
<td>174</td>
<td>-1.27</td>
<td>-0.86</td>
</tr>
<tr>
<td></td>
<td>(1.31)</td>
<td>(1.44)</td>
<td>(1.23)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent standard deviation
### Table 4.3: Mean Pre- and Post-Test scores for MWPS, SDQ-I Maths and SDQ-I Peer for each Experimental Learning Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td><strong>Individual No–LB-Rewards</strong></td>
<td>52</td>
<td>0.11</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.12)</td>
<td>(1.35)</td>
</tr>
<tr>
<td><strong>Individual LB-Rewards</strong></td>
<td>55</td>
<td>-1.05</td>
<td>-0.82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.26)</td>
<td>(1.56)</td>
</tr>
<tr>
<td><strong>Equal No–LB-Rewards</strong></td>
<td>64</td>
<td>-0.47</td>
<td>-0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.24)</td>
<td>(1.36)</td>
</tr>
<tr>
<td><strong>Equal LB-Rewards</strong></td>
<td>64</td>
<td>-0.91</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.31)</td>
<td>(1.30)</td>
</tr>
<tr>
<td><strong>Mixed No–LB-Rewards</strong></td>
<td>62</td>
<td>-1.05</td>
<td>-0.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.45)</td>
<td>(1.71)</td>
</tr>
<tr>
<td><strong>Mixed LB-Rewards</strong></td>
<td>55</td>
<td>-1.90</td>
<td>-1.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.14)</td>
<td>(1.17)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>352</td>
<td>-0.88</td>
<td>-0.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.39)</td>
<td>(1.57)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent standard deviation

The participating classes were randomly assigned to conditions in the study, however, it was not possible to randomly assign all participants to groups. To investigate whether the experimental conditions were matched at pre-test, one-way Analyses of Variance (ANOVA) were conducted on all dependent variables’ pre-test scores.
Equivalence is important to establish the extent to which there is reasonable basis for comparison – as without it, there may be pre-existing psychological differences between conditions.

The one-way ANOVA indicated that the experimental conditions were not matched at pre-test for MWPS ($F(5, 346) = 15.24, p < .001$) and SDQ-I Maths ($F(5, 316) = 3.54, p = .004$). To identify which experimental conditions were not equivalent at pre-test, Slavin’s (1995) criterion that differences between pre-test scores for conditions should be within 50 percent of a standard deviation of one another was used. From Table 4.3:3, of importance to this study’s pairwise comparisons, it is noted that for MWPS, Individual-No-LB-Rewards had greater mean pretest scores than Individual-LB-Rewards and Mixed-No-LB-Rewards. In addition, Mixed-LB-Rewards had lower mean pretest scores than Individual-LB-Rewards and Equal-LB-Rewards. For SDQ-I Maths, Individual-No-LB-Rewards had greater mean pretest scores than Mixed-No-LB-Rewards.

As discussed previously, because Rasch analysis uses gain scores (the difference between post- and pre-test), it overcomes the problems of statistical difference in equivalence between conditions, since it places the gain scores on a linear equal-interval scale. Nevertheless, it will be necessary to exercise care in interpreting further comparisons between the latter pairwise comparisons due to the possibility of psychological differences.

The one-way ANOVA indicated that the experimental conditions were matched at pre-test for SDQ-I Peer ($F(5, 308) = 1.92, p = .090$). Therefore, there is a basis for assuming equivalence in making comparisons.

For each of the three dependent variables, 6 (Individual No-LB-Rewards, Individual LB-Rewards, Equal No-LB-Rewards, Equal LB-Rewards, Mixed No-LB-Rewards, Mixed LB-Rewards) x 2 (times of test: pre-, post) Split-Plot Analyses of Variance (SPANOVA)
were conducted to test whether changes from pre- to post-test varied across conditions (see Table 4.3:4).

Table 4.3:4.

**Split-Plot Analysis of Variance for MWPS, SDQ-I Maths and SDQ-I Peer**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>η²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 346</td>
<td>77.29</td>
<td>.18</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Condition</td>
<td>5, 346</td>
<td>17.53</td>
<td>.20</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>5, 346</td>
<td>3.45</td>
<td>.05</td>
<td>.005</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 316</td>
<td>12.64</td>
<td>.04</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Condition</td>
<td>5, 316</td>
<td>2.57</td>
<td>.04</td>
<td>.027</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>5, 316</td>
<td>1.68</td>
<td>.03</td>
<td>.139</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 308</td>
<td>5.81</td>
<td>.02</td>
<td>.017</td>
</tr>
<tr>
<td>Condition</td>
<td>5, 308</td>
<td>1.31</td>
<td>.02</td>
<td>.260</td>
</tr>
<tr>
<td>Pre-/post- x Condition</td>
<td>5, 308</td>
<td>1.87</td>
<td>.03</td>
<td>.100</td>
</tr>
</tbody>
</table>

The results from SPANOVA analyses revealed statistically significant main effects for pre-/post-test for MWPS, SDQ-I Maths and SDQ-I Peer. The main effect for condition was only statistically significant for MWPS and SDQ-I Maths. Generally, children across all conditions improved on MWPS and SDQ-I Maths. For SDQ-I Maths, children in all conditions except for Individual-No-LB-Rewards had mean gains. Children in Individual-No-LB-Rewards had mean losses for SDQ-I Maths, but had slight gains for SDQ-I Peer. All other conditions appeared to have losses in SDQ-I Peer. A pre-/post- x condition
interaction was only observed for MWPS indicating that MWPS gains were influenced by the learning condition to which children were assigned for the maths programme.

To investigate the nature of the pre-post- x condition interaction, one-way Analyses of Variance (ANOVA) with planned comparisons on difference scores (i.e., between pre- and post-test) were conducted on each of the three dependent variables to identify which conditions differed significantly from all other conditions.

Consistent with the results from the SPANOVA analyses, the between-groups effect for MWPS was statistically significant \( (F(5, 346) = 3.45, p = .005) \). The between-groups effect was not statistically significant for either SDQ-I Maths \( (F(5, 316) = 1.68, p = .139) \) or SDQ-I Peer \( (F(5, 308) = 1.87, p = .100) \).

A total of 14 planned comparisons were made for each dependent variable. The first five planned comparisons address issues of Learning/ Ability groupings (comparing Combined Individual and Combined Cooperative conditions; Combined Individual and Combined Equal; Combined Individual and Combined Mixed; and Combined Equal and Combined Mixed) and Reward structure (comparing Combined LB-Rewards and No-LB-Rewards together; and LB-Rewards and No-LB- Rewards categories). The nine comparisons following those compare the effects of specific experimental conditions to address the effects of Reward Structure and Ability groupings.

To address the effects of Reward structure, No-LB-Rewards conditions are compared with LB-Rewards conditions pairwise for Individual, Equal and Mixed (i.e., Individual-No-LB-Rewards vs Individual-LB-Rewards, and so on ).

To address the effects of Ability grouping, comparisons between Individual vs Equal, Individual vs Mixed, and Equal vs Mixed are made pairwise for No-LB-Rewards and LB-Rewards categories (e.g., Individual No-LB-Rewards vs Equal-No-LB-Rewards; Individual-LB-Rewards vs Equal-LB-Rewards).
Each of the 14 planned comparisons is evaluated against two criteria: (1) a conservative alpha coefficient of 0.018, corrected using Modified Bonferroni test and (2) an effect size of 0.2 (as in Study 1). It should be also noted the observed power of .91 in the pre-post-x condition interaction enables the detection of an effect; and also in the absence of an effect, there is great certainty (91%) that there is not one (Cohen, 1990). Tables 4.3:5 and 4.3:6 show the MWPS planned comparisons for “combined” conditions and for experimental conditions, respectively.

The following Figures 4.3:1-3, show the gains scores for all dependent variables, comparing combined-Individual and Combined-Cooperative, No-Rewards vs Rewards, and comparing Combined-Individual, Combined-Equal and Combined-Mixed respectively. There appear to be no differences between these comparison categories.

![Gain Scores (Rasch Logits) with 95% Confidence Interval](image)

**Figure 4.3:1** Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores for “Combined Individual” and “Combined Cooperative” Conditions (error bars represent 95% confidence intervals).
Figure 4.3:2 Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores for “Combined No-LB-Rewards” and “Combined LB-Rewards” Conditions (error bars represent 95% confidence intervals).

Figure 4.3:3 Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores for “Combined Individual”, “Combined Equal” and “Combined Mixed” Conditions (error bars represent 95% confidence intervals).
Planned comparisons for MWPS gains scores (Table 4.3:5) indicate that there were no statistically or educationally significant differences amongst the combined conditions (see also Figure 4.3:1, 4.3:2 and 4.3:3), which was consistent with Study 1. This indicates that similar outcomes are attained for Cooperative and Individual; LB-Rewards and No-LB-Rewards, and different ability pairings considered in isolation.

Table 4.3:5.

*F*-Values in Planned Comparisons for “Combined” Conditions’ Data for MWPS Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>Cooperative</th>
<th>Equal</th>
<th>Mixed</th>
<th>LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>0.81</td>
<td>0.32</td>
<td>1.02</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.03)</td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>Equal</td>
<td>-</td>
<td>-</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
</tr>
<tr>
<td>No–LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.14</td>
</tr>
<tr>
<td>Rewards</td>
<td></td>
<td></td>
<td></td>
<td>(0.00)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s *d* (index of effect size).
Table 4.3:6.

*F*-Values in Planned Comparisons of Experimental Condition for MWPS Gain Scores

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual-No-LB-Rewards</td>
<td>8.60* (0.27&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>10.43* (0.31&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>- (0.19)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Individual-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>6.11* (0.22&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>- (0.07)</td>
<td>0.44</td>
</tr>
<tr>
<td>Equal-No-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>7.69* (0.25&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>1.34 (0.11)</td>
<td>-</td>
</tr>
<tr>
<td>Equal-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.18 (0.16)</td>
</tr>
<tr>
<td>Mixed-No-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.06 (0.02)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s *d* (index of effect size).

* *p < .018.  es*d* > 0.2.

Although there were no significant differences indicated in the previous planned comparisons for MWPS gain scores in “combined” conditions, when comparisons were made amongst actual experimental conditions, both statistically and educationally significant differences were noted. These differences were for comparisons involving the Individual-No-LB-Rewards, Individual-LB-Rewards, Equal-No-LB-Rewards and Equal-LB-Rewards conditions only (see Table 4.3:6; see Figure 4.3:4). Individual-No-LB-Rewards had statistically and educationally significantly greater gains than Individual-LB-Rewards.
While rewarding appeared less beneficial for MWPS gains in the Individual condition, rewarding appeared to be more beneficial for the Equals condition. Equal-LB-Rewards had statistically and educationally significantly greater MWPS gains than Equal-No-LB-Rewards.

Significant differences were also noted in comparisons between the Individual and Equal conditions. Individual-No-LB-Rewards had statistically and educationally significantly greater gains than Equal-No-LB-Rewards. In comparing the LB-Rewards structures, Equal-LB-Rewards had statistically and educationally significantly greater gains than Individual-LB-Rewards.
There were no other statistically or educationally significant differences between conditions comparing Individual and Mixed; and Equal and Mixed conditions, in either No-LB-Rewards or LB-Rewards structures. There is, however, some suggestion that Individual-No-LB-Rewards had greater MWPS gains than Mixed-No-LB-Rewards only approaching statistical ($p = .036$) and educational significance ($d = 0.19$) levels.

Tables 4.4:7 and 4.3:8 show the planned comparisons for the combined conditions and for each experimental condition respectively for SDQ-I Maths.

Table 4.3:7.

$F$-Values in Planned Comparisons for “Combined” Conditions’ Data for SDQ-I Maths

<table>
<thead>
<tr>
<th>Gain Scores</th>
<th>Cooperative</th>
<th>Equal</th>
<th>Mixed</th>
<th>LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>1.56</td>
<td>0.73</td>
<td>1.78</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.07)</td>
<td>(0.11)</td>
<td></td>
</tr>
<tr>
<td>Equal</td>
<td>-</td>
<td>-</td>
<td>0.27</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>No–LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.11</td>
</tr>
<tr>
<td>Rewards</td>
<td></td>
<td></td>
<td>-</td>
<td>(0.02)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s $d$ (index of effect size).
Table 4.3:8.

*F*-Values in Planned Comparisons of Experimental Conditions for SDQ-I Maths Gain Scores

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual-No-LB-Rewards</td>
<td>2.35 (0.20&lt;sup&gt;*&lt;/sup&gt;)</td>
<td>2.42 (0.18)</td>
<td>-</td>
<td>7.62* (0.33&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>-</td>
</tr>
<tr>
<td>Individual-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>0.10 (0.03)</td>
<td>-</td>
<td>0.59 (0.08)</td>
</tr>
<tr>
<td>Equal-No-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>0.06 (0.02)</td>
<td>1.55 (0.11)</td>
<td>-</td>
</tr>
<tr>
<td>Equal-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.25 (0.05)</td>
</tr>
<tr>
<td>Mixed-No-LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.77 (0.19)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s *d* (index of effect size).

<sup>*</sup>*p* < 0.018.  <sup>es</sup>*d* > 0.2.

For SDQ-I Maths (Table 4.3:7, Figures 4.3:1, 4.3:2 and 4.3:3), there were no statistically or educationally significant differences amongst combined conditions. However, when comparing specific experimental conditions (Table 4.3:8; Figure 4.3:4), Mixed-No-LB-Rewards had statistically and educationally significantly greater gains than Individual-No-LB-Rewards. In addition, Individual LB-Rewards had educationally significantly greater gains than Individual-No-LB-Rewards. There were no statistically or educationally significant differences between the remaining pairs of comparisons across conditions.
Tables 4.3:9 and 4.3:10 show the planned comparisons for combined conditions and for each experimental condition respectively for SDQ-I Peer.

Table 4.3:9.

**F-Values in Planned Comparisons for “Combined” Conditions’ Data for SDQ-I Peer Gain Scores**

<table>
<thead>
<tr>
<th></th>
<th>Cooperative</th>
<th>Equal</th>
<th>Mixed</th>
<th>LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>1.64</td>
<td>2.98</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.12)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>Equal</td>
<td>-</td>
<td>-</td>
<td>1.38</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.08)</td>
</tr>
<tr>
<td>No–LB-Rewards</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s $d$ (index of effect size).
For SDQ-I Peer (Table 4.3:9, Figures 4.3:1, 4.3:2 and 4.3:3), there were no statistically or educationally significant differences amongst combined conditions. However, comparisons between conditions (Table 4.3:10, Figure 4.3:4) indicated that there were both statistically and educationally significant differences between Individual-No-LB-Rewards and Equal-No-LB-Rewards; with Individual-No-LB-Rewards having slightly greater gains on SDQ-I Peer and Equal-No-LB-Rewards having losses on SDQ-I Peer. Equal-LB-Rewards had also educationally lesser losses than Equal-No-LB-Rewards. This was however only approaching statistical significance ($p = .019$).
Comparisons between Equal-No-LB-Rewards and Mixed-No-LB-Rewards indicated that Mixed-No-LB-Rewards had educationally significantly lesser losses than Equal-No-LB-Rewards on SDQ-I Peer. However, this was only approaching statistical significance \((p=.023)\). There were no statistically or educationally significant differences between the remaining pairs of comparisons between conditions.

4.3.4 Exploratory Analyses

To explore the effects of more refined ability-categories, the sample was first rank ordered according to MWPS pre-test scores and divided into three “relative ability” categories (Webb, 1991). The first one-third was regarded as “High-ability”, the second third as “Medium-ability” and the bottom third as “Low-ability” (Good & Brophy, 2000; Good, Mulryan & McCaslin, 1992; Webb, 1991, 1992; Yager, Johnson & Johnson, 1985). It is notable that this was a different method for assigning ability-pairings than used for experimental conditions, which had to be done within the constraints of class-sized samples, and where the “Mixed” conditions were divided using only two relative ability categories. Within each ability category, the sample was further categorized according to whether children learned alone, were paired with an equal, were paired with a more competent peer (for Medium- and Low-ability children only) or were paired with a less competent peer (for High- and Medium-ability children only).

The mean MWPS, SDQ-I Maths and SDQ-I Peer pre- and post-test scores for High-, Medium- and Low-ability groupings are shown in Tables 4.3:11, 4.3:12 and 4.3:13 respectively.
Table 4.3:11.

Mean Pre- and Post-Test Scores for MWPS, SDQ-I Maths and SDQ-I Peer for High-AILITY Categories

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>HI</td>
<td>45</td>
<td>0.77</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.76)</td>
<td>(1.12)</td>
</tr>
<tr>
<td>H(H-H)</td>
<td>38</td>
<td>0.48</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.45)</td>
<td>(0.92)</td>
</tr>
<tr>
<td>H(H-M)</td>
<td>20</td>
<td>0.50</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.71)</td>
<td>(1.27)</td>
</tr>
<tr>
<td>H(H-L)</td>
<td>15</td>
<td>0.69</td>
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<tr>
<td></td>
<td></td>
<td>(0.81)</td>
<td>(0.92)</td>
</tr>
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</table>

Note: Parentheses represent standard deviation
Table 4.3:12.

Mean Pre- and Post-Test Scores for MWPS, SDQ-I Maths and SDQ-I Peer for Medium-Ability Categories

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>MI</td>
<td>44</td>
<td>-1.00</td>
<td>-0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.48)</td>
<td>(1.21)</td>
</tr>
<tr>
<td>M(M-M)</td>
<td>42</td>
<td>-0.96</td>
<td>-0.52</td>
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<tr>
<td></td>
<td></td>
<td>(0.45)</td>
<td>(0.94)</td>
</tr>
<tr>
<td>M(H-M)</td>
<td>24</td>
<td>-1.12</td>
<td>-0.68</td>
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<tr>
<td></td>
<td></td>
<td>(0.39)</td>
<td>(0.70)</td>
</tr>
<tr>
<td>M(M-L)</td>
<td>28</td>
<td>-0.99</td>
<td>-0.69</td>
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<tr>
<td></td>
<td></td>
<td>(0.49)</td>
<td>(1.04)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent standard deviation
### Table 4.3:13.

**Mean Pre- and Post-Test Scores for MWPS, SDQ-I Maths and SDQ-I Peer for Low-Ability Categories**

<table>
<thead>
<tr>
<th>Condition</th>
<th>MWPS</th>
<th>SDQ-I Maths</th>
<th>SDQ-I Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>LI</td>
<td>18</td>
<td>-2.38</td>
<td>-2.13</td>
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<tr>
<td></td>
<td></td>
<td>(0.43)</td>
<td>(0.75)</td>
</tr>
<tr>
<td>L(L-L)</td>
<td>27</td>
<td>-2.72</td>
<td>-2.10</td>
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<td></td>
<td></td>
<td>(0.87)</td>
<td>(1.41)</td>
</tr>
<tr>
<td>L(H-L)</td>
<td>11</td>
<td>-2.35</td>
<td>-1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.41)</td>
<td>(0.85)</td>
</tr>
<tr>
<td>L(M-L)</td>
<td>23</td>
<td>-2.72</td>
<td>-2.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.48)</td>
<td>(0.80)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent standard deviation

For High-ability groupings a 4 (ability categories: Individuals working alone (HI), with another High-ability peer - H(H-H), with a Medium-ability peer - H(H-M), with a Low-ability peer – H(H-L)) x 2 (times of test: pre-, post-) SPANOVA was conducted to test whether changes from pre- to post-test varied across High-ability categories (see Table 4.3:14).
Table 4.3:14.

Split-Plot Analysis of Variance for MWPS, SDQ-I Maths and SDQ-I Peer for High-Ability Groupings

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 114</td>
<td>10.46</td>
<td>.08</td>
<td>.002</td>
</tr>
<tr>
<td>High-Ability Groupings</td>
<td>3, 114</td>
<td>3.44</td>
<td>.08</td>
<td>.019</td>
</tr>
<tr>
<td>Pre-/post- x High-Ability Groupings</td>
<td>3, 114</td>
<td>1.52</td>
<td>.04</td>
<td>.214</td>
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<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 109</td>
<td>5.48</td>
<td>.05</td>
<td>.021</td>
</tr>
<tr>
<td>High-Ability Groupings</td>
<td>3, 109</td>
<td>0.50</td>
<td>.01</td>
<td>.682</td>
</tr>
<tr>
<td>Pre-/post- x High-Ability Groupings</td>
<td>3, 109</td>
<td>0.38</td>
<td>.01</td>
<td>.766</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 108</td>
<td>2.45</td>
<td>.02</td>
<td>.121</td>
</tr>
<tr>
<td>High-Ability Groupings</td>
<td>3, 108</td>
<td>1.59</td>
<td>.04</td>
<td>.195</td>
</tr>
<tr>
<td>Pre-/post- x High-Ability Groupings</td>
<td>3, 108</td>
<td>1.68</td>
<td>.04</td>
<td>.176</td>
</tr>
</tbody>
</table>
The results from SPANOVA analyses revealed statistically significant main effects for pre-/post- and High-ability groupings for MWPS. There were also statistically significant main effects for pre-/post- for SDQ-I Maths. Generally, high-ability children in all categories showed improvements on MWPS and SDQ-I Maths. There were however losses for SDQ-I Peer across categories except for HI. The pre-post- x High-ability groupings interactions for all categories and dependent variables were not statistically significant, indicating that the gains or losses on all three dependent variables were not influenced by the ability groupings in which children followed the maths programme.

To explore the nature of pre-/post- x High-ability groupings, one-way Analysis of Variance (ANOVA) with post-hoc comparisons (using Tukey’s honest significant difference test, henceforth referred to as Tukey’s HSD) on difference scores were conducted on each of the three dependent variables to identify which, if any, categories differed significantly from all other categories. Tukey’s HSD was used because it is considered one of the most conservative pairwise comparison procedures in terms of control of Type 1 error (e.g., in comparison to Fisher’s least significant difference) (Newton & Rudestam, 1999). It is robust with large numbers of comparison groups and has good power for pairwise contrast (e.g., in comparison to Scheffe’s test) (Newton & Rudestam, 1999). Each post-hoc comparison is evaluated against two criteria: an alpha of .05 and an effect size of 0.2 (see Study 1).

Consistent with the results from SPANOVA, the between-groups effect was not statistically significant for MWPS ($F(3, 114) = 1.52, p=.214$), SDQ-I Maths ($F(3, 109) = 0.38, p=.766$) or SDQ-I Peer ($F(5, 108) = 1.68, p=.176$).

Table 4.3:15 shows the post-hoc comparisons for MWPS, SDQ-I Maths and SDQ-I Peer for High-ability children.
Table 4.3:15.

**Post-Hoc Comparisons using Tukey’s Honest Significance Difference Test for MWPS, SDQ-I Maths and SDQ-I Peer for High-Ability Categories**

<table>
<thead>
<tr>
<th></th>
<th>H(H-H)</th>
<th>H(H-M)</th>
<th>H(H-L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI</td>
<td>.159</td>
<td>.671</td>
<td>.868</td>
</tr>
<tr>
<td></td>
<td>(0.24&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>(0.14)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>H(H-H)</td>
<td>-</td>
<td>.939</td>
<td>.869</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.08)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>H(H-M)</td>
<td>-</td>
<td>-</td>
<td>.996</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI</td>
<td>.999</td>
<td>.874</td>
<td>.823</td>
</tr>
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<td>(0.02)</td>
<td>(0.12)</td>
<td>(0.11)</td>
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<tr>
<td>H(H-H)</td>
<td>-</td>
<td>.929</td>
<td>.885</td>
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<tr>
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<td></td>
<td>(0.09)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>H(H-M)</td>
<td>-</td>
<td>-</td>
<td>.999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.02)</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI</td>
<td>.145</td>
<td>.983</td>
<td>.720</td>
</tr>
<tr>
<td></td>
<td>(0.25&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>(0.05)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>H(H-H)</td>
<td>-</td>
<td>.510</td>
<td>.952</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.23&lt;sup&gt;es&lt;/sup&gt;)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>H(H-M)</td>
<td>-</td>
<td>-</td>
<td>.918</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.11)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s <i>d</i> (index of effect size).

<sup>es</sup><i>d > 0.2</i>.

Not surprisingly, there were no statistically significant differences amongst the High-ability categories (Table 4.3:15, see also Figure 4.3:5). However, it is noted that HI had educationally significantly greater gains than H(H-H) for MWPS. In addition, HI had educationally significantly greater gains than H(H-H) on SDQ-I Peer; with H(H-H) having losses on SDQ-I Peer. H(H-M) also had educationally significantly lesser losses on SDQ-I Peer than H(H-H). No other post-hoc comparisons were found to be educationally significant.
Figure 4.3:5 Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores High-Ability Categories (error bars represent 95% confidence intervals).

For Medium-ability groupings a 4 (ability categories: Individuals working alone (MI), with another Medium-ability peer - M(M-M), with a High-ability peer - M(H-M), with a Low-ability peer – M(H-L)) x 2 (times of test: pre-, post-) SPANOVA was conducted (see Table 4.3:16).
Table 4.3:16.

Split-Plot Analysis of Variance for MWPS, SDQ-I Maths and SDQ-I Peer for Medium-Ability Groupings

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>η²</th>
<th>p</th>
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</thead>
<tbody>
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<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 134</td>
<td>30.83</td>
<td>.19</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medium-Ability Groupings</td>
<td>3, 134</td>
<td>0.39</td>
<td>.01</td>
<td>.763</td>
</tr>
<tr>
<td>Pre-/post- x Medium-Ability Groupings</td>
<td>3, 134</td>
<td>.29</td>
<td>.01</td>
<td>.835</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 114</td>
<td>0.35</td>
<td>.00</td>
<td>.557</td>
</tr>
<tr>
<td>Medium-Ability Groupings</td>
<td>3, 114</td>
<td>0.61</td>
<td>.02</td>
<td>.612</td>
</tr>
<tr>
<td>Pre-/post- x Medium-Ability Groupings</td>
<td>3, 114</td>
<td>0.63</td>
<td>.02</td>
<td>.597</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 111</td>
<td>9.96</td>
<td>.08</td>
<td>.002</td>
</tr>
<tr>
<td>Medium-Ability Groupings</td>
<td>3, 111</td>
<td>0.26</td>
<td>.01</td>
<td>.858</td>
</tr>
<tr>
<td>Pre-/post- x Medium-Ability Groupings</td>
<td>3, 111</td>
<td>2.91</td>
<td>.07</td>
<td>.038</td>
</tr>
</tbody>
</table>

The results from the SPANOVA analyses revealed statistically significant main effects for pre-/post- in MWPS and SDQ-I Peer only. Generally, children in all medium-ability categories had gains on MWPS. Children in M(M-L) and M(H-M) generally gain on SDQ-I Maths. Children in M(M-M) categories generally stayed the same (i.e., remained stable), having no gains or losses, while children in MI categories generally had losses on
SDQ-I Maths. For SDQ-I Peer, children in M(M-L) categories generally stayed the same, while children in remaining categories: MI, M(M-M) and M(H-M) had losses in SDQ-I Peer.

The pre-/post-x Medium-ability grouping interaction was found to be statistically significant for SDQ-I Peer only, indicating that the losses and gains (if any) noted for SDQ-I Peer were influenced by the category in which children followed the maths programme.

Consistent with the results from SPANOVA, the between-groups effect from the one-way ANOVA was statistically significant for SDQ-I Peer ($F(5, 111) = 2.91, p=.038$). The between-groups effect was not statistically significant for MWPS ($F(3, 134) = 0.29, p=.835$) and for SDQ-I Maths ($F(3, 114) = 0.63, p=.597$).
Table 4.3:17.

Post-Hoc Comparisons using Tukey’s Honest Significance Difference Test for MWPS, SDQ-I Maths and SDQ-I Peer for Medium-Ability Categories

<table>
<thead>
<tr>
<th></th>
<th>M(M-M)</th>
<th>M(H-M)</th>
<th>M(M-L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MWPS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>.988</td>
<td>.995</td>
<td>.795</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>M(M-M)</td>
<td>-</td>
<td>1.000</td>
<td>.924</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.00)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>M(H-M)</td>
<td>-</td>
<td>-</td>
<td>.940</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MI</td>
<td>.985</td>
<td>.967</td>
<td>.539</td>
</tr>
<tr>
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<td>(0.04)</td>
<td>(0.06)</td>
<td>(0.20)</td>
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<tr>
<td>M(M-M)</td>
<td>-</td>
<td>.999</td>
<td>.760</td>
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<td>(0.02)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>M(H-M)</td>
<td>-</td>
<td>-</td>
<td>.869</td>
</tr>
<tr>
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<td>(0.11)</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>.987</td>
<td>.072</td>
<td>.941</td>
</tr>
<tr>
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<td>(0.05)</td>
<td>(0.32)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>M(M-M)</td>
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<td>.157</td>
<td>.825</td>
</tr>
<tr>
<td></td>
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<td>(0.27)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>M(H-M)</td>
<td>-</td>
<td>-</td>
<td>.031</td>
</tr>
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<td>(0.36)</td>
</tr>
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Note: Parentheses represent Cohen’s $d$ (index of effect size).

$\geq d \geq 0.2$; $*p<.05$
Figure 4.3:6 Mean MWPS, SDQ-I Maths and SDQ-I Peer Gain Scores Medium-Ability Categories (error bars represent 95% confidence intervals).

Post-hoc comparisons (see Table 4.3:17, see also Figure 4.3:6) revealed that there was a statistically significant difference between M(M-L) and M(H-M) on SDQ-I Peer. M(M-L) had no change in SDQ-I–Peer while M(H-M) had losses on SDQ-I Peer. In addition, there was an educationally significant difference between M(M-L) and MI with the latter having losses on SDQ-I Peer. M(M-M) had also educationally significant lesser losses than M(H-M). No other comparisons were noted to be statistically or educationally significant.

For Low-ability groupings a 4 (ability categories: Individuals working alone (LI), with another Low-ability peer - L(L-L), with a High-ability peer - L(H-L), with a Medium-ability peer – L(M-L)) x 2 (times of test: pre-, post-) SPANOVA was conducted.
Table 4.3:18.

Split-Plot Analysis of Variance for MWPS, SDQ-I Maths and SDQ-I Peer for Low-Ability Groupings

<table>
<thead>
<tr>
<th>Source</th>
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<th>$\eta^2$</th>
<th>$p$</th>
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<td><strong>MWPS</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 75</td>
<td>14.75</td>
<td>.16</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Low-Ability Groupings</td>
<td>3, 75</td>
<td>0.70</td>
<td>.03</td>
<td>.558</td>
</tr>
<tr>
<td>Pre-/post- x Low-Ability Groupings</td>
<td>3, 75</td>
<td>0.61</td>
<td>.02</td>
<td>.612</td>
</tr>
<tr>
<td><strong>SDQ-I Maths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 72</td>
<td>7.14</td>
<td>.09</td>
<td>.009</td>
</tr>
<tr>
<td>Low-Ability Groupings</td>
<td>3, 72</td>
<td>1.20</td>
<td>.05</td>
<td>.318</td>
</tr>
<tr>
<td>Pre-/post- x Low-Ability Groupings</td>
<td>3, 72</td>
<td>0.24</td>
<td>.01</td>
<td>.868</td>
</tr>
<tr>
<td><strong>SDQ-I Peer</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pre-/post-</td>
<td>1, 69</td>
<td>0.01</td>
<td>.00</td>
<td>.907</td>
</tr>
<tr>
<td>Low-Ability Groupings</td>
<td>3, 69</td>
<td>1.73</td>
<td>.07</td>
<td>.169</td>
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<td>Pre-/post- x Low-Ability Groupings</td>
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<td>.11</td>
<td>.050</td>
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</tbody>
</table>
The results from the SPANOVA analyses (Table 4.3:18) revealed statistically significant main effects for pre-/post- for MWPS and SDQ-I Maths. Generally, Low-ability children across all categories had gains from pre- to post- test for MWPS and SDQ-I Maths. For SDQ-I Peer, it appeared that gains were only noted for L(L-L) and L(H-L) categories. For both LI and L(M-L), there appeared to be losses for SDQ-Peer.

Consistent with SPANOVA, the between-groups analysis from the one-way ANOVA, showed no statistically significant effects for MWPS ($F(3, 75) = 0.61, p=.612$) and SDQ-I–Maths ($F(3, 72) = 0.24, p=.868$). The between-groups effect was approaching statistical significance for SDQ-I Peer ($F(3, 69) = 2.74, p=.050$).
Table 4.3:19.

Post-Hoc Comparisons Using Tukey’s Honest Significance Difference Test for MWPS, SDQ-I Maths and SDQ-I Peer for Low-Ability Categories

<table>
<thead>
<tr>
<th></th>
<th>L(L-L)</th>
<th>L(H-L)</th>
<th>L(M-L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LI</td>
<td>.566</td>
<td>.991</td>
<td>.899</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.07)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>L(L-L)</td>
<td>-</td>
<td>.859</td>
<td>.924</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.13)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>L(H-L)</td>
<td>-</td>
<td>-</td>
<td>.992</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>SDQ-I Maths</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LI</td>
<td>1.000</td>
<td>.997</td>
<td>.936</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>L(L-L)</td>
<td>-</td>
<td>.992</td>
<td>.946</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>L(H-L)</td>
<td>-</td>
<td>-</td>
<td>.870</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>SDQ-I Peer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LI</td>
<td>.828</td>
<td>.711</td>
<td>.539</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.20)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>L(L-L)</td>
<td>-</td>
<td>.989</td>
<td>.091</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.05)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>L(H-L)</td>
<td>-</td>
<td>-</td>
<td>.084</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.41)</td>
</tr>
</tbody>
</table>

Note: Parentheses represent Cohen’s $d$ (index of effect size).

$^{cs}d > 0.2.$
Figure 4.3:7 Mean MWPS, SDQ-I Maths and SDQ-I Peer gain scores Low-Ability Categories (error bars represent 95% confidence intervals)

As seen from Table 4.3:19 (see also Figure 4.3:7), no statistically significant differences were noted across categories for MWPS, SDQ-I Maths and SDQ-I Peer. However, there were educationally significant differences for SDQ-I Peer between categories. L(H-L) had educationally significantly greater gains than LI, which had losses for SDQ-I Peer. LI in turn had educationally significantly lesser losses than L(M-L). L(L-L) and L(H-L) categories also had educationally significantly greater gains than L(M-L). L(L-L) had greater MWPS gains than LI (LI had losses), although this was only approaching educational significance ($d = 0.19$). In addition, L(L-L) had greater SDQ-I Peer gains than LI, again this was only approaching educational significance ($d = 0.15$).
4.3.4 Levels of Support for the Hypotheses

It can be seen from the above results that there are highly complex effects of the multiple conditions of: cooperative or individual learning-approach, ability-grouping and rewarding-structure targeting learning behaviours, as well as the experimental dimensions of low, medium and high-ability, and that the interactions between the independent variables (e.g., rewards together with ability) are very difficult to interpret with normal statistical methods (Keppel, 1991). In the present study, the interaction of all these measures is inferred – for example by inferring across pairwise findings which make some patterns more discernable than from just reading graphs. Certainly, what seems to be most pertinent in the patterns of findings across the independent variables goes beyond the more unidimensional predictions of any of the hypotheses. This complexity was anticipated by the inclusion of all of the measures, but its incompatibility with answering more simple hypotheses was not envisioned: for example, that it is not adequately analytic to approach the task of evaluating the hypotheses by reporting at levels of 14 planned-comparisons for MWPS, SDQ-I Peer and so on. Thus, despite the use of experimental method in the present study, some aspects of the analysis move more towards an exploratory level. In the discussion section to follow, it will be necessary to explicate which of the results is given the most importance and which will be addressed in more general terms of overall patterns. In other words, the answer to any of Study 2a’s hypotheses is complex, and could only be answered at such a generalized level as, “It depends …”.
4.3.5 Summary of Findings

In summary, the results of Study 2a suggest that differences for Maths Word Problem-Solving (MWPS), Maths–Self-Concept (SDQ-I Maths) and Peer–Self-Concept (SDQ-I Peer) outcomes in dyads can be explained overall less as effects of either of the experimental conditions: learning-behaviour rewards or ability-structure; but more as the effects of the interactions of both conditions regarding whether or not children are rewarded for learning behaviours within particular ability-structures (i.e., comparing between LB-Rewards and No–LB-Rewards for Individual, Equal and Mixed). The results indicate that a variety of effects which are not unidimensional occur for each experimental condition and dependent variable.

NB: Academic mastery rewards based on worksheet results were used in all conditions, and distinct from this were problem-solving strategies for which LB-Rewards were offered in only some of the conditions.

The results for MWPS suggest that the optimal experimental learning conditions are Individual-No-LB-Rewards and Equal-LB-Rewards conditions (i.e., both conditions have similar mean gains). The use of LB-Rewards seems to de-motivate or distract Individuals – that is, Individuals perform better when rewards for displaying learning behaviours are not used, compared to when learning behaviour rewards are used. By contrast, for cooperative conditions, Equals perform better when LB-Rewards are used than when LB-Rewards are withheld; and rewarding for learning-behaviour (or not) appears to make little difference for Mixed-ability dyads.

The Maths-Self-concept (SDQ-I Maths) in Study 2 was undertaken as an exploratory investigation. The results highlight the need to problematise whether gains in this dimension should be interpreted as a ‘positive’ outcome or whether the gains should be
interpreted with less optimism (see discussion for details). Therefore, this present analysis should not be used directly in interpretations about which condition is the ‘best’ without a clearer understanding of the implications of a maths–self-concept loss or gain. Nevertheless, the results will be summarised here to maintain consistency with Study 1. It appears that the experimental learning condition that leads to the greatest gains is that of Mixed-No-LB-Rewards. Individual-No-LB-Rewards is the only condition with mean losses; hence suggesting that rewarding may promote SDQ-I Maths gains. The use of LB-Rewards seems to have no effect for Equals. For Mixed, no LB-rewarding appears to induce the greatest SDQ-I Maths gains. It is possible that SDQ-I Maths results in Study 2 are due more to the assigned Individual- or Cooperative-learning condition than to the experimental conditions of rewarding learning behaviours or ability-structure.

For Peer-Self-concept (SDQ-I Peer), it is noted that all conditions had losses except Individual-No-LB-Rewards; which had no change. The use of LB-Rewards appears to contribute to only slight effects on SDQ-I Peer gains for the Individual condition. However, for Equals and Mixed, LB-rewards induce lesser losses than No-LB-rewards.

From the exploratory analysis of ability as well as ability-structures, that is, whether children have High, Low or Medium ability and work alone, with an equal or with a more- or less-competent partner, it appears to be an important consideration for Peer-self-concept (SDQ-I Peer) outcomes only. In summary: for High-ability groupings, HI (i.e., learning alone) appears to promote the highest gains; for Medium-ability groupings, M(M-L) (i.e., learning in a Mixed dyad with a less-competent peer) appears to promote the highest gains; and for Low-ability groupings, L(L-L) (i.e., learning in an Equal dyad) appears to promote the highest Peer-self-concept gains.
4.4 Discussion of Results (Study 2a)

4.4.1 Overview of Section

The purpose of Study 2a was to investigate differences in learning-conditions (Individual vs Cooperative), and the efficacy of rewarding learning-behaviours (LB-Rewards vs No-LB-Rewards) and the effects of ability-structure composition for studying alone or in homogeneous or heterogeneous cooperative dyads (Individual vs Equals vs Mixed). The study included an exploratory investigation of the effects of High, Medium and Low ability. Study 2a investigated the same dependent variables as in Study 1: Maths Word Problem Solving (MWPS), Peer–Self-Concept (SDQ-I Peer) and Maths–Self-Concept (SDQ-I Maths), but the latter variable was included here as an exploratory measure without specific hypotheses (see Study 1 conclusions).

LB-rewards are considered in the present study from a conceptual proposition that incentives to encourage appropriate learning behaviour may overcome some of the problems that students experience from cooperating with a peer, and in particular avoid conflict and resentment that may arise if one partner were to feel disadvantaged by another partner. This is a contentious issue because of fears about detrimental effects of extrinsic rewards, not withstanding the fact that “group rewards” are considered as very possibly “increasing the frequency and level of elaboration of explanations in the group” (Webb, 1991, p. 383). None of Study 2’s conditions were designed to allow LB-Rewards or task structure to make dyad members positively interdependent to any large extent, and every condition allowed individual accountability/control through dyad members’ opportunities for separate academic rewards based on individual achievement of a mastery goal. Ability is considered in the present research in order to better identify dyadic structures that lead to optimal outcomes in all of the domains. Ability compositions of groups are argued to have “substantial effects on peer interaction and achievement” (Webb, 1991, p. 371).
This section has three main sub-sections. The first section is the examination of hypotheses which will be discussed for effects of LB-Rewards and Ability-structure on, in turn, MWPS and SDQ-I Peer outcomes. The second section is the discussion of exploratory studies’ results that addresses the High, Medium and Low ability analysis and the SDQ-I Maths analysis in turn. The third section briefly discusses Study 2a’s achievements and explains its links to the parallel analyses, 2b and 2c that will follow. Note that the strengths and weaknesses and implications will be discussed for all parts of Study 2 in a general concluding section following Study 2c.

4.4.2 Examination of Hypotheses

The examination of the hypotheses will address effects of LB-Rewards and Ability-structure on, firstly, MWPS (Hypotheses 1 & 3) and, secondly, SDQ-I Peer (Hypotheses 2 & 4). This order of presentation is intended to allow easier comparison with Study 1.

4.4.2.1 MWPS

The findings for this dependent variable will be discussed in relation to Hypothesis 1 and Hypothesis 3. Findings based on the statistically significant main effects for pre-/post- X condition and through the inspection of Figure 4.3:4, Experimental Learning Condition, will be discussed.

Hypothesis 1 that – for MWPS, LB–Rewards conditions will lead to significantly greater gains than No–LB-Rewards conditions – was not supported except in relation to Equals in the cooperative conditions. In addition, converse to the hypothesis, Individual conditions had significantly greater gains with No-LB-
Rewards than with LB-Rewards. (Findings are at statistically and educationally significant levels.)

Hypothesis 3 for MWPS comprises three parts: (3a) there will be significant gains for all conditions with no significant differences across combined-Individual or combined-Cooperative conditions; (3b) there will be no significant differences between Individual and Mixed; Individual and Equal (for combined-: LB-Rewards and No-LB-Rewards; LB-Rewards; LB-No-Rewards categories), and (3c) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for combined-: LB-Rewards and No-LB-Rewards; LB-Rewards; LB-No-Rewards categories).

Hypothesis 3 was not fully supported or rejected. Findings are that: First, all conditions had MWPS statistically significant gains; second, combined effects of ability-structure and reward-structure were statistically significant only in that Equals–LB-Rewards had greater gains than Individual-LB-Rewards and Equals-No-LB-Rewards; and third, whilst Equal-ability conditions’ gains with LB-Rewards were higher than Individual-LB-Rewards, converse to the hypothesis, there were no statistically significant differences for Mixed conditions. (Findings are at statistically and educationally significant levels.)

For MWPS No-LB-Rewards is optimal for Individuals & LB-Rewards is optimal for Equals

The finding of Individual conditions’ higher gains when not rewarded in comparison to when rewarded suggests that learning-behaviour rewards are not very effective. Whilst this may seem consistent with the general fears about extrinsic rewards,
all learning conditions were offered academic mastery rewards. Thus, learning behaviour rewards are possibly a distraction to Individuals.

By contrast, Equals conditions that are rewarded appear more effective than when not rewarded, suggesting that simply being paired is not very effective and possibly a distraction. That is, partners of equal-ability might perceive that neither one is capable of helping the other and so desist from trying, whereas rewarding might encourage them to persist in exhibiting the cooperative learning-behaviour sufficiently to result in them helping each other.

However, those effects of rewarding cooperation do not generalize to all cooperative conditions as a principle for increasing MWPS gains, since the figure shows little difference for Mixed conditions whether rewarded or not. This would suggest that whilst some mixed-ability partners can perceive cooperation to be purposeful and easily productive, others will need incentives because they find cooperation difficult or unproductive. It seems likely that some mixed-ability structures could benefit by strategically administering or not administering cooperative-LB–rewards, but the analysis at this level is unable to identify within-group differences.

4.4.2.2 SDQ-I Peer

The results for the dependent variable of Peer–Self-Concept (For SDQ-I Peer) will be discussed in relation to Hypothesis 2 and Hypothesis 4.

_Hypothesis 2_ was: For SDQ-I Peer, LB–Rewards conditions will lead to significantly greater gains than No-LB-Rewards conditions.
It is partially supported. Contrary to the hypothesis of gains in peer–self-concept, all combined conditions had losses but there was a trend for the losses to be smaller in the LB-Rewards conditions compared to the No-LB-Rewards conditions. The Individual-No-Rewards condition shows the only gain in the findings and that gain is very small and not much more than there being no-change. The Equals-no-Rewards showed clear, statistically significant losses. For the Mixed conditions, there were no statistically significant differences between LB-Rewards conditions’ losses and No-LB-Rewards conditions’ losses.

**Hypothesis 4** that for SDQ-I Peer, (a) Combined-Cooperative conditions will have significantly greater gains than for Combined-Individual conditions; and (b) Mixed-ability conditions will have significantly greater gains than Equal-ability conditions (for: Combined LB-Rewards and No-LB-Rewards; LB-Rewards; and LB-No-Rewards categories).

Hypothesis 4a was not supported. – Figure 4 revealed clear losses for Equals-No-Rewards, and planned comparisons reveal the losses to be statistically and educationally significant compared to Individual-No-Rewards that showed a very slight gain. There were also educationally significant losses for Equals-No-LB-Rewards in comparison to losses for Equals-LB-Rewards and Mixed-No-LB-Rewards.

The hypothesis 4b that Mixed-ability conditions will have significantly greater gains than Equal-ability conditions was partially supported. Contrary to the hypothesized gain there was a loss for Peer–Self-Concept in both conditions. However, the directional rank-ordering for ability grouping supported the hypothesis in that Mixed-No-Rewards losses were educationally significantly less than Equal-No-Rewards losses.
For SDQ-I Peer (Study 2a) there were losses in cooperative conditions

In common, for both studies 1 and 2a, the Individual conditions showed least change of Peer–Self-Concept, especially with No–LB-Rewards. However, in Study 2a, cooperative conditions showed losses in comparison to Study 1’s gains. There were several differences between the studies, not including the changes to conditions already described that were expected to enhance peer outcomes in cooperative dyads. One difference is that the use of computer-based instruction (CBI) was unable to continue at the same level in the second study, and instead of individuals and dyads all having access to the “Zarc’s Primary-5 Mathematics Adventure” software’s interactive activities, the teachers showed the software’s demonstration of the topic as the lesson to the whole class; then the computer was used to project the software’s questions that formed the MWPS exercises for the children who worked alone or in dyads on pencil and paper solutions. Therefore, it is possible that children’s attitudes about using interactive software are more conducive to being playful which in turn may be more conducive to positive feelings about peer relationships (see Malone & Lepper, 1987), and it may be the playfulness that accounted for the results of Peer–Self-Concept for cooperative dyads that increased in Study 1 and decreased in Study 2, in contrast to the more stable outcomes for Individuals who would play games in the former study but not with a peer.

Another difference between the two studies that may account for discrepant Peer–Self-Concept loss and gain was the administering of additional questionnaires, such as the SLQ–Alone-&-Partnered. The content of the questionnaire may have alerted or reminded students in cooperative conditions to be more consciously aware of the problems of cooperation. Alternatively, students in individual-learning conditions may have responded better to the improved structure of the programme and, without experiencing the difficulties of cooperation, may have increased their confidence about anticipating trying to learn with
a partner which would be something new. This possibility seems more likely because of the overall pattern of loss that affected the Individuals, albeit to a lesser extent than the cooperative conditions.

*For SDO-I Peer, No-LB-Rewards was optimal for Equals and LB-Rewards was optimal for Individuals*

Furthermore, contrary to the hypothesized order of success, the Equals No–LB-Rewards condition was found to have greater losses than the other conditions, especially at an educationally significant level in comparison to the Mixed LB-Rewards condition. Note that Equals-No-LB-Rewards also had educationally significantly greater losses than Equals–LB-Rewards, and the graph shows little difference between Equals–LB-Rewards, Mixed–No-LB-Rewards and Mixed–LB-Rewards.

An explanation for this needs to take into account the differences between Equals and Mixed dyads particularly in relation to LB-Rewards which appears to have the greatest influence on different comparative outcomes. The literature does recognize several problems that arise in cooperative groups such as free-riding and negative social comparisons (e.g., Bossert, 1988) and conceptualising specific effects of wide and narrow ability-structure (e.g., Webb, 1991). The finding of successful use of Learning Behaviour Rewards in apparently limiting otherwise marked losses of Peer–Self-Concept that affected Equals–No-LB-Rewards suggests that cooperation for this group was not intrinsically rewarding and caused difficulties. A number of explanations are possible.

1. Some of the cooperative learning literature documents student reports or researcher observations of increased arguing. Usually, the explanation, which appears to refer to Piagetian cognitive-conflict, dismisses this as being problematic by suggesting

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that the arguing represents some sort of ‘constructive conflict’ (e.g., Solomon, Watson, Schaps, Battistich & Solomon, 1990) without making it clear how theoretically or practically this is expected to transfer to positive social relationships or positive peer–self-concept. There is recourse to vague, over-broad categorizations such as the Learning Together model’s “interpersonal and small group skills” (e.g., Johnson & Johnson, 1989) that infer overarching ideals such as democratic processes, mutual respect, rational rules for debate and the like. In fact, often the literature claims to account for failure of cooperative interventions by the difficulty for children of learning to interact without conflict (e.g., Cohen, 1986). As such, difficulty with cooperation on an interpersonal level may particularly affect the Equal-ability students. Being at similar stages of thinking, they are the dyadic structure most susceptible to failing to reach a mutually acceptable cognitive resolution since it would be difficult for them to cognitively help each other or evaluate a partner’s different approach to problem-solving (e.g., Tudge, 1989).

2. Because Equal-ability students are closer in ability, their academic status is less clear than for Mixed-ability students, and this may result in them arguing to establish a hierarchy.

3. Since Equal-ability students are the dyad least likely to be able to recognize what they may have to offer each other by cooperating, without rewards as an incentive to make an effort, they may enter into conflict over what they consider suitable rules for interactions, such as frequency, purpose, or who can initiate it.

4. It may even be possible that the Mixed dyads whose heterogeneous pairings would be more susceptible to other problems such as deliberate or accidental free-riding are less likely to argue if one partner has seen opportunities to benefit (at least in the short term) from the efforts of their more skilled partner.
An additional observation about LB-Rewards is relevant in relation to the two main dependent variables in Study 2a. Equals have optimal outcomes for Peer-Self-Concept (SDQ-I Peer) when Learning Behaviour Rewards are used, but it is a different case for Maths (MWPS) where Learning Behaviour Rewards are detrimental and their absence is optimal. Typically, the cooperative learning literature suggests that there are positive effects for both cognitive academic gains and social gains (e.g., Marsh, 1990; Slavin, 1990), with the inference that the effects for both domains occur in the same direction of losses or gains – and which was consistent with Study 1’s findings (c.f., Study 2b’s discussion of MWPS and SDQ-I Peer correlations).

There are broad implications for these findings in recognizing that ‘academic maths’ and ‘cooperation for learning’ are two distinct objectives that do not necessarily covary. The cooperative learning field already promotes the advantages in training for cooperative roles (Bossert, 1988; Johnson & Johnson, 1989) so that children or adults can learn proper techniques for successful interaction such as soliciting or offering help (Cohen, 1986). However, it is problematic that disadvantages are rarely considered and that most studies in the field report gains but not losses. For example, it has been reported in a few studies that in mixed dyads often the lower-ability partner makes academic progress while the higher-ability partner makes social or affective progress (e.g., Ehly & Topping, 1998; Topping, 1988), however, the converse of those results – possible or actual academic losses to the higher-ability partner and social or affective losses to the lower-ability partner are not widely recognized or reported (cf., Anderson et al., 1997; cf., Tudge, 1989). Thus, given that different social, cognitive or affective objectives may have divergent optimal conditions, decisions to optimize one objective should aim to take into account the possibility of negative effects on the other objective (Bossert, 1988; Joyce et al., 2000).
4.4.3 Two Exploratory Analyses: Dependent Variables Outcomes in Ability Categories, and Overall SDQ-I Maths Results

In an exploratory study there is no hypothesis. The analysis takes into consideration the main effects for pre-/post- and condition as well as including inspection of graphs for any patterns that may be used in understanding the data. Thereafter, much of the analysis takes place outside of the actual statistical results in theorizing what they mean. This is widely recognized, for example, Behrens and Smith (1996) state that,

*Good data analysis, regardless of the [quantitative or qualitative] approach, is a mixture of science and art. Data analysis employs creativity in search of meaning, intelligibility, and pattern rooted in systematic methods that emphasize open-mindedness and public scrutiny. Regardless of the theoretical emphasis, data analysis seeks revelation – the unveiling of the world around us.* (p. 945)

As pointed out above, exploratory analysis can also involve developing systems for explanatory frameworks. For example, in undertaking the exploratory analyses of Study 2, it has been assumed that wherever there is a significant finding, it indicates an area of particular importance to the condition or the ability category in which it occurs. Theories can then be built and conceptually tested in terms of whether the comparisons show effects of relative difficulty and ease, relative preference or avoidance and so on, whilst also constructing theories about which of the dyadic members in the pairwise comparison categories is most likely to be affected by each of the two contrasting effects. In other words, theory-building does involve “fishing” for interesting patterns and the explanations they will fit into – the results themselves can only confirm or deny the viability of a theory, they do not supply the theory.
4.4.3.1 Exploration of High-, Medium- and Low-Ability Categories

The present study’s explorations of High-, Medium- and Low-ability categories will be discussed, addressing in turn the effect of ability on Peer–Self-Concept and academic maths performance. Furthermore, analysis of this exploratory study’s results reveals a number of interesting patterns which inform the construction of a theory of within-dyad dynamics.

4.4.3.1.1 High-Ability

For High-ability students, which includes HI, H(H-H), H(H-M) and H(H-L), there were educationally significant differences within high-ability pairings for Maths (MWPS) and for Peer–Self-Concept (SDQ-I Peer). The High-ability category was unique in having statistically significant findings for MWPS (i.e., no statistically significant differences were found for Mediums and Lows). It can be conjectured that children of high-ability are the most likely to have an academic orientation; it is more difficult to conjecture about possible explanations for the peer–self-concept difference.

The findings suggest that Highs achieve higher Maths gains as well as the higher Peer–Self-Concept gains when they study alone than when they study with an Equal-ability partner; however, in a dyadic situation, the outcome for Peer–Self-Concept was more favourable showing less losses for Highs when they are paired with a Medium-ability partner than when paired with Equal-ability partner. Regarding these outcomes of Peer–Self-Concept for High-ability students, if they work “alone” they may be comparing themselves to the whole class where most other students are less competent at Maths than themselves. And since the Peer–Self-Concept outcome for a H(H-M) appears less damaging for Highs than H(H-H), it can be speculated that many Highs would have an
academic orientation and could resent the being held back in their own progress when paired with a less competent peer.

The findings are consistent with Webb’s analysis of ability grouping outcomes of “partially unexpected results [that] in homogeneous high-ability groups students assumed (often incorrectly) that they all knew how to solve the problem. Consequently they made little effort to give explanations to each other” (1991, p. 380). The findings also appear to support a theory that High-ability students compete with each other in ways that damage social relationships, whereas when paired with Medium-ability students they improve their peer-self-concept (see Webb’s, 1991, discussion of “relative ability”). It may be that Equals find it hard to resolve the cognitive conflict and so the conflict remains as interpersonal conflict. It may be that the Mixed dyadic structure allows Highs pleasure and opportunities to develop empathy with a less competent peer through helping them learn, or that the Mediums show gratitude for any help given to them. Or, given a related finding that Mediums suffer losses in this ability-structure paired with a more able dyadic partner, it may be that the close comparative situation allows Highs in this condition to consider that they have higher status in the eyes of their less competent peer and/or vice-versa.

4.4.3.1.2 Medium-Ability

For Medium-ability students there were educationally significant findings that suggest the least optimal condition in relation to Peer–Self-Concept (SDQ-I Peer) is for a Medium to be paired with a more competent High-ability peer, and this contrasts with the optimal conditions for a Medium to be paired in Equals dyads or paired with a less competent Low-ability partner. That is, for Mediums, pairings with higher-ability partners appeared to produce losses of Peer–Self-Concept and pairings with lower-ability partners produced gains; and in some instances those effects were the converse patterns to gains or
losses of Maths (MWPS). These findings point to a possible explanation that in mixed-dyadic structures, Peer–Self-Concept is affected by comparisons of relative academic competence. That is, being the partner who is more competent academically in Maths can lead to a positive comparison with gains in Peer-Self-concept and being the partner who is less competent can lead to a negative comparison and losses. Social comparison within the pairing may be more powerful for Mediums than their actual relative losses or gains in the Maths academic programme which do not appear to change unidirectionally with Peer–self-concept.

4.4.3.1.3 Low-Ability

Lows had educationally significant differences between different ability-categories, only for Peer–Self-Concept (SDQ-I Peer). LI and L(M-L) had losses, suggesting again that negative comparisons are damaging to Peer–Self-Concept for the partner who may compare negatively, as well as it making sense that Lows are the most likely ability category to seem worse academically than partners of different abilities. It is interesting to note that the wider mixed-ability category, L(H-L), was the condition for Lows that showed the greatest mean gains. Thus, it may be that the relatively wider ability difference is effective for keeping competitive behaviour or negative self-comparisons in check. Research has found that recognition of status can have a shaping role in behaviour. For example, Dembo and McAuliffe’s (1987) study of the effects of bogus problem-solving–ability found that status effectively shaped bogus high-ability students’ relative number of attempts to lead and the bogus low-ability students’ relative recognition of their superior status in relation to problem-solving. As such, the clear recognition of respective status amongst mixed-dyad members rather than struggle to establish status may make the difference between
cooperative and competitive attitudes, aside from the greater ease with which a more competent peer may be able to provide effective peer-tutoring.

The findings overall suggest that for Peer–Self-Concept, the occurrence of differences is more marked across the board in relation to ability-pairings than to MWPS. Gains in Peer–Self-Concept appear to be more prevalent for the partner who can compare favourably in the mixed-dyad rather than for the partner who is most likely to be helped academically.

4.4.3.2 Exploration of SDQ-I Maths

The Maths–Self-Concept (SDQ-I Maths) dependent variable is considered on an exploratory level because it is not possible to be certain how to interpret mean gains or losses. That is, in Study 1, it was assumed that gains in Maths–Self-Concept would indicate a relationship with actual gains in the academic Maths (MWPS) measure (cf., Marsh, 1990). In fact, a gain in Maths–Self-Concept appeared to indicate a relationship with being in a cooperative condition. This was because in the Individual condition, Maths–Self-Concept had remained stable but had superior academic Maths gains to the cooperative Jigsaw-DT condition and equivalent gains to the other cooperative conditions. Therefore, it is uncertain to what extent a gain on the Math-Self-Concept measure does indicate an increase in Maths performance levels or what else it might indicate.

Research into learned helplessness (Bandura, 1997; Buhrans & Dweck, 1995; Dweck, 1975; Elliott & Dweck, 1988; Seligman, 1975; Smiley & Dweck, 1994) assumes that low-ability students need to overcome their fear of failure or lack of persistence consistent with a self-concept of failure. Research on self-esteem in relation to clinical depression has described that approach as needing “positive illusions” (Harter, 1993); however, it has recently been questioned in relation to people whose self-esteem is high and
who are maladaptive in over-estimating their competence or worth. As such, the maintenance of a realistic and probably stable self-esteem is considered healthiest (Baumeister, 1993; Harter, 1993; Tennen & Affleck, 1993), and it seems very likely that this may apply to Maths–Self-Concept. If it did, it would mean that for the majority of students who do not need to overcome a fear of failure, only a slight improvement that realistically accords with assessments of their improvement in Maths is desirable. Gains in Maths–Self-Concept for low-ability students would still be constructive insofar as it may lead to their overcoming fear and being prepared to increase effort in Maths. However, where Maths–Self-Concept gains may be detrimental is if they are related to comparisons in the dyad where one student compares as more competent to the other and such students might therefore reduce their effort by considering that the acceptable norms are lower than if they compared themselves to the whole group and realized perhaps that they could aim to do better. There are also issues about how those comparisons might affect the less competent partner.

Therefore, for the analysis of Maths–Self-Concept outcomes, consideration needs to be given to gains (in comparison to no change or losses), on the one hand as possibly being positive and a desirable outcome, and on the other hand as possibly being negative and a detrimental outcome. As such, no change in the means may indicate stability. The interpretations to follow will refer to the results shown in the graphs of the previous chapter (Study 2, Figures 4.3:1-4.3:7).

The first four graphs compare the effects of learning conditions. The findings from inspecting results for Maths–Self-concept (SDQ-I Maths) in Figure 4.3:1 are that “Combined-Individual” means stay closer to zero in comparison to “Combined Cooperative” that has larger means gains and a greater confidence level with the error bar being clear of zero. This is consistent with the findings of Study 1, that changes were more
a reflection of differences in learning condition than differences in academic Maths (MWPS) outcomes.

The findings for Maths–Self-concept from Figure 4.3:2 for ‘Combined’ condition with and without Learning Behaviour (LB) Rewards are that, whether or not LB-Rewards are used, there are mostly similarities in means gains and levels of confidence with the error bar being clear of zero; however, even though there would be no statistically significant difference between those two conditions, visual inspection of the graph suggests that No-LB-Rewards results in changes that are approximately a third greater in means gains and confidence levels. If the Maths–Self-Concept gains were to be interpreted as a good outcome, this would be expected to reflect related gains in academic Maths (MWPS) and/or gains that help students overcome negative Maths–Self-Concept and encourage their future task persistence. It would consider No-LB-Rewards by a small margin to be the optimal condition, attributing its success to keeping a focus on the maths task. On the other hand, if the maths-self-concept gain were interpreted as being detrimental, that would be seen to reflect that there may be maladaptive effects of “positive illusions”. Since the LB-Rewards condition strays the least from the mean which indicates the least change, that condition would by a small margin be the optimal condition, and the success of LB-Rewards would be attributed to encouraging a focus on the helping behaviours that would allow Individuals, Equals and partners of Mixed Ability opportunities to learn how to improve their maths. A further point in consideration of advantages of keeping any Maths–Self-Concept gain in check is that students involved in learning about helping themselves or helping others (the appropriate learning behaviours targeted in the LB-Rewards) might be expected to develop a better self-awareness of how much help they themselves need. However, some dyadic situations risk higher-ability partners maladaptively adopting positive self-comparisons with lower-ability partners.
The findings for Maths–Self-Concept in Figure 4.3:3 are that means and error bars show no statistically significant differences but visually detectable results as follows: “Combined Mixed” has the greatest gains in means and an error bar widely clearing zero, followed by “Combined Equal” that has moderate gains and an error bar just clearing zero and which in turn is greater than for “Combined Individual” that has a modest gain and an error bar straddling zero. Interpreting the gains positively would suggest that Mixed-ability structures are optimal because they allow opportunities for the less competent partner to be given competent assistance as well as for the more competent partner to elaborate their understandings (e.g., Webb, 1991), and thus the gains could reflect advantages to both partners. By contrast, Equals do not have the same advantages of competent assistance but they do elaborate their thinking with each other and comparatively make moderate gains. Individuals, however, do not improve other than by what would be expected in a well-designed learning programme. Interpreting the gains negatively, on the other hand, would suggest that Individuals made some progress in the maths programme and could assess their relative standard and future needs accurately. However, Equals may have noticed that their peers made mistakes which they did not or have found that requests for help moved them slightly forward in maths (but not significantly) which may have resulted in them moderately overestimating their maths abilities. And, furthermore, Mixed may have positioned more competent partners to think that they are especially capable in ways that resulted in larger distortions of their self-assessment based on their relative performance. For example, by being able to advise a partner and being right in the dyad most of the time might detract their focus from where they do have difficulties, as well as distracting them from focusing on how they might excel.

Figure 4.3:4 shows results for the effects of both Ability-Structure and LB-Rewards. The Mixed-No-LB-Rewards condition made the greatest change in Maths-Self-Concept.
with a substantial mean gain at least two-thirds more than in any other condition and an 
error bar widely clearing zero. This reached statistical significance in comparison to 
Individual-No-LB-Rewards, which made very slight losses reflecting little change. To 
consider the effect of rewards, comparison of Mixed-No-LB-Rewards with Mixed-LB-
Rewards which each have comparable Maths (MWPS) bars showing strong gains with error 
bars clearing zero, it appears that Rewarding learning behaviours may help to contain 
maths-self-concept, keeping the means relatively stable in Mixed-ability dyads. 
Comparison of Maths outcomes for Individual conditions shows that, with No-LB-
Rewards, there is the most stability in Maths–Self-Concept (a slight loss) that occurs in 
relation to the most substantial Maths gain that has very clear confidence levels. In contrast, 
Individual-LB-Rewards, which has a Maths–Self-Concept gain sitting four or five times 
higher, occurs alongside a moderate Maths gain that has a confidence bar straddling zero. It 
is very hard to make an argument for the Individuals that Maths–Self-Concept gains are a 
positive and desirable outcome. In addition, for Individuals, it would appear that the effect 
of learning behaviour Rewards might also be maladaptive or “corrupting”. This possible 
effect of maladaptation needs a more complex explanation than the standard arguments 
about extrinsic motivation causing an instrumental focus but loss of interest in the task or 
relevant skills. For example, in terms of Maths–Self-Concept, gains elicited by learning 
behaviour rewards (distinct from and in addition to academic merit awards) that may be 
detrimental because, in reinforcing the ‘displaying’ of learning behaviors for their own 
sake, it risks encouraging students to maladaptively develop too much “positive illusion” 
and too little awareness of where they may need to adjust to improve their actual 
performance, and that may not be in students’ best interests. 

The next three graphs compare the effects of actual ability which is especially 
useful in beginning to theorise the learning dynamics of each condition and aiming to
overcome any counteracting effects of mixed results for students in mixed-ability pairs. In Figure 4.3:5, for Highs, there is a visibly detectable trend for Maths-Self-Concept (SDQ-I Maths): The conditions’ mean gain sizes and lengths of error-bar rise proportionately in the order of HI < H-H < H(H-M) < H(H-L), that could indeed reflect the pattern for these students to have progressively greater opportunities to make positive comparisons of themselves in relation to a dyadic partner – it does not reflect a pattern that would suggest their opportunities to have expert assistance to advance in maths.

In Figure 4.3:6, for Mediums, there is also a similar progression in the order of MI (slight loss) <; M-M (↔ no change) <; M(H-M) (slight gain) <; M(M-L) (moderate gain). The interpretation would be similar as for Highs. Notably, the M-M which has no change might reflect that Mediums normally would compare as medium in relation to the whole class, comparison with someone of equal-ability would also probably lead to stability of self-concept.

Figure 4.3:7, for Lows, does not have the same pattern as for the above analysis of Mediums and Highs. It is also in this Low ability-level that effects of “positive illusion” in Maths–Self-Concept may be adaptive for enhancing self-efficacy that may increase the likelihood of persistent effort. L(M-L) was the only low-ability category that had significant mean gains for Maths–Self-Concept. LI, L-L and L(H-L) all had moderate mean gains. It is noted that there was a wide dispersion (SD =1.58) as seen in the long error bar for H(H-L). The pattern of SDQ-I Maths gains does seem to reflect MWPS gains, but this pattern for SDQ-I Maths differs from the pattern for SDQ-I Peer gains. More specifically, for L(M-L), there is a significant inverse relationship between SDQ-I Maths and SDQ-I Peer. At the non-significant level, this pattern is observed for LI. However, L(L-L) and L(H-L) appear to have all dependent variables’ mean gains in the same direction.
These patterns may be explained as SDQ-I Maths working well in most cases for Lows, possibly because for them their Maths self-concept will improve with any level of Maths progress. For L(M-L) in particular, the coinciding of gains in MWPS and SDQ-I Maths with losses in SDQ-I Peer can be explained by a context for cognitive conflict which could lead to interpersonal conflict, since the maths problems and cooperative relationship may not be fully resolved. This could arise because Mediums are the more competent peer but also more fallible than Highs. Thus, for example, Lows may be aware that they negatively compare to Mediums, and discussions about problem-solving may have become quite heated causing them to express indignation if Mediums gave them wrong or confusing advice. In turn, Lows might feel that their Medium-ability peers did not like or respect them. Pairings with L(H-L) and L-L have dependent variables in the same direction, which can be explained by High-ability partner’s relatively better skill at helping them which may make them feel liked, or even in some cases a relatively better skill at ignoring them which could cause relatively less conflict; and equal ability partner’s not having a status difference against which they could compare negatively to undermine themselves.

4.4.4 Conclusions of Study 2a

To conclude, the contribution of Study 2a to the thesis will be briefly outlined. Following on from Study 1, the present study improved its conceptual and research design sophistication in the conditions for Individual and Cooperative learning so that clearer comparisons could be undertaken. Its main investigations were the effects of learning-behaviour rewards, and comparing individual, mixed- and equal- ability-structures on Maths Word Problem Solving and Peer–Self-Concept.

The findings about learning-behaviour rewards have addressed existing mixed findings and contention in the field (Bossert, 1988; CTEHP, 1994; Slavin, 1995), and they
provide some clarity. For example, in relation to Maths Word Problem Solving they appear to be detrimental for Individuals but have desirable effects on the Equals cooperative conditions and ambivalent effects on Mixed cooperative conditions.

However, the findings for Peer–Self-concept do not covary with the Maths Word Problem Solving findings, and are likely to be more contingent on an overall dynamic in relation to the interactions of an individual’s ability, the within-dyad comparative ability structured among partners, and the effects of rewarding for demonstrating learning behaviours. The overall dynamic will be explored further in the studies to follow.

To some extent Study 2a has also clarified issues about the relevance of Maths–Self-Concept that were problematised in Study 1. That is, in cooperative conditions there can be changes to Maths-self-concept that, compared to the Individual condition, do not appear to be as contingent upon actual changes in maths performance. Too high a self-concept could be detrimental to students who do not have an existing poor self-concept of their maths.

Furthermore, the present study’s methodological enhancements include exploratory levels of analysis of the effects of high-, medium- and low-ability which contribute towards the study’s findings, not least of all by demonstrating that the effects of learning conditions are not unidimensional with regard to cognitive and affective, social-emotional outcomes. Not only does this add to the thesis goals of demonstrating the integration of affective, social-emotional and cognitive domains that are affected by learning experiences, but it also opens the possibility of future research and practical classroom applications of the findings of tailoring the pairing of dyads and use of learning behaviour rewards in ways that on a small scale might target specific objectives for Maths Word Problem Solving or for Peer–Self-Concept.
Study 2a is one of three inter-related studies, and therefore, it will be developed further by the following two studies, and it is following these that their combined strengths, limitations and directions for further research will be discussed. In the studies to follow, Study 2b will investigate perceived self-efficacy for both cooperative- and individual-learning as an additional affective measure, and will theorise the particular relationships that occur between dyadic members. Study 2c will refer to the relationships between dyadic members, which are theorized in Study 2b, drawing upon the children’s self-report responses to the cooperative learning experiences to illustrate them.
CHAPTER 5

STUDY 2B: PERCEIVED SELF-EFFICACY FOR LEARNING MATHS ALONE OR WITH A PARTNER

5.1 Introduction

Study 2b is a supplementary investigation that was conducted within the programme for Study 2a’s Maths revision course run with Grade-5 children in Singapore (reported previously) in conjunction with Study 2c (reported later). The present study is exploratory and aims to contribute to the thesis by extending the examination of affective aspects of cooperative and individual learning, specifically by investigating aspects of children’s perceived self-efficacy for learning maths alone or with a partner. The study will define the factors of learning in both cooperative and individual-learning structures and, in addition, will seek to explain the relationship of children’s self-efficacy for those factors to the learning conditions specified in the experimental design of Study 2a (i.e., cooperative- or individual-learning structures, learning-behaviour reward structures, and broad ability-structures as well as specific high-, medium- and low-ability dyadic-structures).

5.1.1 Overview of Chapter

The study will be presented in five parts of this chapter. First will be a discussion about exploratory research. Second will be a description of how the Student Learning Questionnaire (SLQ-Alone-&-Partnered) was constructed, the Factor Analysis solutions to the questionnaire and discussion of those results including the development of original scales for individual- and cooperative-learning. Third will be a description of methods used for the statistical analyses of the intervention outcomes and methods informing the study’s theory development. A fourth part will present pertinent findings for the ‘SLQ-Alone-&-Partnered self-efficacy to learn maths alone or with a partner’ questionnaire, set within a
framework of four inter-related dimensions of learning. Those dimensions are then developed as an exploratory theory: “A theory of Incentive-values–Exchange in Individual- and Cooperative-learning factors influencing self-efficacy”. Fifth will be brief conclusions for Study 2b. (NB: Study 2c to follow, provides supporting illustrations in the children’s written reflections about their learning experiences, and conclusions for all sections of Study 2 follow that.)

5.1.2 Exploratory Research

Exploratory studies are often used in theory-building and are noted for being especially powerful in studies that combine a variety of methodologies to investigate the same phenomenon (Tashakkori & Teddlie, 1998). Study 2b has a greater level of detail than Study 2a and it is also informed by Study 2c which adds a qualitative, illustrative dimension of the outcomes for perceived self-efficacy in the learning intervention – these methodological dimensions are useful for theorizing the dynamic relationships between the cognitive, social and affective domains that occur in cooperative learning.

Study 2b is exploratory in several ways. The test instrument used was exploratory because the Student Learning Questionnaire (SLQ-Alone-&-Partnered) was specifically developed for this study where it was used for the first time. It is intended to measure perceived self-efficacy for learning maths, both cooperatively and individually. Self-efficacy is Bandura’s central construct in a theory of motivation that explains and predicts an individual’s goal perseverance (Bandura, 1997; Stipek, 2002), which has been widely applied to explaining learning in general. Bandura (1997) briefly discusses the relevance of self-efficacy to cooperative learning. However, while the potential role of cooperative learning for increasing self-efficacy for individual learning is recognized, there appears to be no systematic research focusing on students’ beliefs of their self-efficacy for cooperative
learning. The SLQ-Alone-&-Partnered instrument and its results from a factor analysis were used to develop two scales: an individual-learning scale and a cooperative-learning scale, each comprising 6 factors. The SLQ-Alone-&-Partnered results have a relatively low level of refinement compared to many standardized tests. Nevertheless, this only means that the present investigation remains an exploratory activity, which is generally the case with factor analysis (Dancey & Reidy, 2002).

Another exploratory aspect of Study 2b is its statistical analysis and interpretation. The 12 factors for the individual-learning and cooperative-learning scales formed the basis for comparisons with outcomes for Study 2a’s dependent variables of Maths (MWPS) and Maths- and Peer-Self-Concept (SDQ-I Maths & SDQ-I Peer), as well as in comparisons of the effects of ability-structure. Due to the breadth and complexity of the statistical results, rather than being constrained by more standard methods of hypothesis testing, the analysis drew on more exploratory methods to identify pertinent patterns in the results and offer potential explanations for the differences across conditions. The measures of gains and losses in factors on this affective measure have allowed exploratory theory building: The directions of exploration generated a clearer understanding of how learning, particularly cooperative learning, produces multi-faceted outcomes of students’ perceived self-efficacy; and those outcomes indicate its likely impact upon students’ motivation to learn and motivation to cooperate.

Thus, the present study’s findings and theory building were undertaken in developing “exploratory propositions” for each factor and in analyses of the correlations of Maths and Peer-self-efficacy outcomes (See Electronic Appendices E.2.7 – E.2.16 where the propositions are presented). The exploratory propositions aimed to account for the complex patterns of results by finding explanations for losses and gains in learning factors from individual or cooperative-learning experiences, in terms of who is affected, in what
ways and at what cognitive and affective benefits and costs. The theoretical position most applicable to the findings revives aspects of early social psychology’s social exchange theories (Adams, 1965; Foa & Foa, 1975; Homans, 1961; Thibaut & Kelley, 1959), especially aspects of loss and cost that are sometimes ignored in cooperative learning studies, and in this way, the explanations of motivation to learn and cooperate are developed without ignoring outcomes of de-motivation. The exploratory propositions are synthesised into a theoretical model by further categorising the factors into four classes of learning outcomes and devising explanatory configurations. The resultant, speculative theory is that for each of these configurations, the dyadic relationships appear to demand specific “value-calculations” on the part of dyadic members in terms of their incentives to help themselves or their partner to develop within the relevant learning factors. As such, the results of the solved-factors of the SDQ-Alone-&-Partnered are summarized and synthesized into a theory of “Incentive-values–Exchange …” which highlights the interrelationships of cognitive academic and social-emotional affective outcomes of learning.
5.2 Student Learning Questionnaire (SLQ) of Self-Efficacy for
Cooperative Learning and Individual Learning

5.2.1 Rationale

Following Study 1, a number of issues pointed towards the need for a new test. Firstly, the Maths-self-concept results (from applying Marsh’s, 1993, SDQ-I Maths test), indicated a trend of changes that occurred for the cooperative conditions with some relation to actual academic maths achievement changes. However, in contradiction to this relationship, no change in maths-self-concept occurred in the Individual conditions. Additionally, since the relevance of changes in self-concept is unclear, this pointed towards it being appropriate to test instead for perceived self-efficacy which is accepted as a useful indicator of academic success in that it describes a person’s willingness to attempt problems in the future and persist with purposeful and on-task behaviours (Bandura, 1997). Social psychology considers the benefits of such willingness to have special applicability in overcoming self-hindering approaches used by low-achieving students (Schunk & Zimmerman, 1994; Zimmerman, 1995). This is described clearly by Ferguson (2000):

*In most instances self-efficacy refers to confidence regarding performance attainment and reflects appraisal of one’s abilities. However, it also may include a belief that one can exert influence over events that affect one’s life. A belief in one’s efficacy has been shown to help people cope with stressors, to persist in activities even in the face of repeated failure, and to tackle challenges. Self-evaluation of inefficacy has been shown to lead to anxiety, high levels of physiological stress responses, and reduced effort in reaching challenging goals. The value of the self-efficacy construct is that self-appraisal of ability is not necessarily related to actual ability, and*
reactions to failure as well as to success are often related to self-efficacy beliefs rather than to actual ability. (p. 227)

Therefore, as a construct in the present study, its relevance is especially pertinent to lower-achieving students due to the possibility that if they experience success during pair-work this may help them overcome their de-motivation from believing they will fail, but only if the cooperative experiences are structured to avoid frustrating outcomes (Monteil & Huguet, 1999; see also Tudge, 1989, 1990, 1992 on damaging consequences of cognitive conflict).

A second, related issue was Study 1’s findings of similar Maths gains for Individual and most Cooperative conditions (other than Jigsaw-DT) but quite different patterns occurring in the other dimensions, such as the Maths–self-concept (SDQ-I) outcomes staying relatively stable for the Individual condition but increasing for Cooperative conditions. The recent tendency towards exaggerated dichotomizing of the social and individual aspects of the learning-styles has been criticised on conceptual and theoretical grounds (Anderson et al., 1997; Bossert, 1988; Karmiloff-Smith, 1995; Slavin, 1995). Thus, it was intriguing to explore the similarities and the differences of the individual- and cooperative-learning styles, but no instrument applicable to both learning styles was available. Furthermore, there was the issue that Study 1’s SDQ-I Peer–self-concept results indicated an educationally significant difference across conditions and, based on teacher comments and from the disappointing outcomes of the Jigsaw-DT condition in particular, it appeared that some conditions had inadvertently set in place interpersonally destructive conflict. Therefore, Study 2 aimed to avoid repeating the problems between peers in some
conditions in Study 1 in order to find optimal learning conditions, and it was enticing to broaden the investigation of peer issues. A major concern was lessening the problems of positive-interdependence by allowing individual recognition of academic mastery together with using rewards for learning-related behaviours. Even though rewarding cooperation is a highly contentious issue (Bossert, 1988; CTEHP, 1994; Slavin, 1995), it can support a hypothetical expectation that rewards for appropriate learning behaviours may serve as an incentive for more successful cooperation. Thus, as a supplement to using SDQ-I Peer in Study 2, additional data about students’ perceived self-efficacy for successfully learning with a peer could be directly targeted by devising and administering relevant questions.

5.2.2 Design and Development of Questionnaire Items

In designing the questionnaire, perceived self-efficacy needed to be operationalised and, additionally, the relationship between perceived self-efficacy and learning-styles needed to be targeted.

Perceived self-efficacy is considered to affect students’ motivation and learning (Bandura, 1977, 1982, 1986, 1993, 1997; Pajares, 1996; Schunk, 1989; Zimmerman, 1995). It can be defined as ‘beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). It influences people’s choices of courses of action to pursue, how much effort to invest, levels of perseverance in the face of obstacles and failures, and whether their thought patterns are self-hindering or self-aiding (Bandura, 1997).

Two related terms will be defined for comparison. Self-concept is self-appraisal that takes life experiences into account when understanding personal attitudes, capacities and

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7 The Jigsaw-DT condition developed for Study 1 may have been overly reliant on task-interdependence that Slavin (1995) claims can lead to limiting cognitive processing, and in particular the condition’s positive-interdependence for academic rewards appeared to unfortunately increase the likelihood of the dyadic partners failing together. This in turn led to claims of unfairness by students and observed frustration, interpreted as interpersonally destructive conflict.
tendencies, and is thought to develop out of evaluations by significant others. Self-esteem, the other related term, is an internalized and typically very stable measure of personal judgments of self-worth. However, self-efficacy is considered to be more changeable, as well as more likely to change over a shorter time period. Although it takes into account past performance, being forward-looking, self-efficacy can take into account recent changes or anticipated changes.

The anticipated greater predictive power of self-efficacy in comparison to self-concept and self-esteem can be explained through Bandura’s (e.g. 1977) claim that aspirational levels, anticipated support levels and commitment levels are the best predictors of goal-related effort, including academic performance, compared to self-concept, perceived usefulness of the subject area, prior experience or gender (Pajares, 1996; Pajares & Miller, 1994; Pajares, Miller & Johnson, 1999). That is, high ratings of likely success (self-efficacy) have a direct relationship to intentions of high effort and low ratings have a direct relationship to intentions of low effort, whereas aspects of “liking” (self-concept) and considering oneself as “typically being good at” something (self-esteem) may bear little relationship to how much the goal is valued and the motivation to extend personal effort. For example, if a student perceives that they have newly-improved skill levels, or that they will be better resourced and supported, this should improve their self-assessment of their likelihood of being able to succeed in relation to a forthcoming goal. As such, much educational interest appears to focus on how self-efficacy can be effectively manipulated to improve attitudes towards learning. Bandura (1997) elaborates on the role of self-efficacy as a predictor of future success as follows:

Efficacy beliefs have several effects on the operation of personal goals.

Efficacy beliefs influence the level at which goals are set, the strength of commitment to them, the strategies used to reach them, the amount of
effort mobilized in the endeavor, and the intensification of effort when accomplishments fall short of aspirations. Some authors posit that goal setting affects efficacy beliefs (Garland, 1985) or that they influence each other bi-directionally (Eden, 1988). Efficacy beliefs, in turn, influence performance. (p. 136)

As such, Bandura describes self-efficacy as a mechanism pivotal to “self-regulation of affective states” which influences a person’s self-assessments of ability using thought, action, and affect (1997, p. 137). The thought-oriented mode of efficacy beliefs creates attentional biases based on reactions to previous experiences and reactions to perturbing cognitive thoughts; the action-oriented mode regulates courses of action taken to control the environment’s impact on emotional states; and the affect-oriented mode involves re-adjustment of aversive emotional states once they are aroused. Bandura (1997) describes self-efficacy as tapping into personal appraisals of capability through “can do” questions, as distinct from personal appraisals of intention or “will do” statements. As such, this affective term was operationalised in the questionnaire by “I can …” statements indicating high self-efficacy and “I cannot …” statements indicating low self-efficacy.

Given the study’s concern with cooperative learning, another aspect that the instrument needed to target was learning styles. It is notable that there appears to be increasing recognition of cooperative- and individual-learning each being useful learning styles rather than one form of learning being superior to another. For example, Bossert (1988, p. 243) states that “children should learn how to work effectively in all types of groups–cooperative, competitive, and individualistic.” In targeting cooperative learning, dual goals of “cooperating to learn” and “learning to cooperate” are widely acknowledged (Slavin, Sharan, Kagan, Hertz-Lazarowitz, Webb & Schmuck, 1985). For example, the
goals of group instruction, whilst argued to not be a panacea, are promoted as enabling students to achieve “meaningful learning of subject matter of appropriate difficulty and interest, [and learning pro-social skills ... and] growing in social intelligence” (Good, McCaslin & Reys, 1992, p.119). Some popular models of cooperation suggest that cooperation comprises component competencies (Johnson et al.’s Learning Together model), sometimes taking place in a sequence of stages (Good, Mulryan & McCaslin, 1992; Stipek, 2002) by which students can help each other. It would seem likely that individual learning also would have component competencies by which students can help themselves.

Learning styles were operationalised in the questionnaire in the following manner. Johnson and Johnson’s five essential “Cooperative Learning” elements were adopted as the basis for categorizing components in a trial scale for cooperative learning. I, as this study’s researcher, was unaware of any existing comparable list of “Individual Learning” elements\(^8\), so therefore I generated a parallel trial scale and set of components for this. The next step in the research was to speculatively conceptualize and describe example instances of the learning components on each scale. Through this activity, questionnaire items comprising statements to operationalise the components for use with 6-point Likert-type scales were generated for the trial “Cooperative Learning” scale and “Individual Learning” scale (see Tables 5:1 and 5:2).

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\(^8\) Solomon, Watson, Schaps, Battistich and Solomon (1990, p. 243-5) devised a questionnaire comparing likes and dislikes of cooperative and individual learning and observational scale of behaviours; however, this is a measure of self-concept and the measure required for Study 2 was of self-efficacy to learn.
### Trial Cooperative Learning Scale Showing Components with Example Items for Pilot Test

<table>
<thead>
<tr>
<th>Cooperative Learning components</th>
<th>Example Item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When I learn in pairs:</strong></td>
<td></td>
</tr>
<tr>
<td>Positive Interdependence</td>
<td><em>I can feel as proud of my partner’s result as my results.</em></td>
</tr>
<tr>
<td>Promotive Interaction</td>
<td><em>I can help my partner to learn maths.</em></td>
</tr>
<tr>
<td>Individual Accountability (partnered)</td>
<td><em>If my partner has said the problem is impossible, I will still try it by myself.</em></td>
</tr>
<tr>
<td>Interpersonal and Small Group Skills</td>
<td><em>If my partner is cleverer than me, I am not worried that he/she might know I don’t understand.</em></td>
</tr>
<tr>
<td>Group Processing</td>
<td><em>If my partner tells me that my explanation has difficult words, I can explain in easier words.</em></td>
</tr>
</tbody>
</table>

### Trial Individual Learning Scale Showing Components with Example Items for Pilot Test

<table>
<thead>
<tr>
<th>Individual Learning components</th>
<th>Example Item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When I work by myself:</strong></td>
<td></td>
</tr>
<tr>
<td>Positive Intra-dependence</td>
<td><em>I can feel more proud of my results.</em></td>
</tr>
<tr>
<td>Promotive Self-encouragement</td>
<td><em>I can stop myself from looking at other classmates’ answers even if it is easy to see their answers.</em></td>
</tr>
<tr>
<td>Individual Accountability (alone)</td>
<td><em>I can pay attention to a maths task even if no one is helping me.</em></td>
</tr>
<tr>
<td>Intrapersonal Skills</td>
<td><em>I can feel okay about not answering the question if I cannot work it out.</em></td>
</tr>
<tr>
<td>Individual Processing</td>
<td><em>I can think about where I made mistakes, so I can solve more problems correctly the next time.</em></td>
</tr>
</tbody>
</table>

Approximately 60 items were conceptually generated by the researcher, which were later extended and refined through pilot testing.
5.2.3 **Item Development and Pilot Testing**

In order to refine the questionnaire items into appropriate children’s language for use in Study 2, a one-morning, small-scale, exploratory cooperative intervention was held with a class of 28 Grade-5 students. This took place in Australia because it is where the researcher is studying, even though it was possible that the language and attitudes by Australian children could differ in some ways from those of Singapore children. A metropolitan government primary school in a middle-class area was selected.

The programme for the pilot session included a cooperative learning experience, having the children write and talk about their thoughts and feelings about the experience, a trial of some questionnaire items, and opportunities for students to be informally interviewed by the researcher about cooperative learning. This session will be described in more detail.

At the start of the session, to ensure some recent and shared experience of individual and cooperative activities, the children undertook some problem-solving activities. Using coloured “matchsticks”, they were given some problems to solve individually with instructions to not show their partner and to raise their hand when they had finished (see Electronic Appendix E.2.3, Mathematical Activity 1-4). The problems became progressively more difficult. When the majority of the students could not solve the problem, the researcher changed the approach to allowing “cooperation” and introduced it gradually in the following way. A student who had solved the problem was asked to think of a hint about the solution without actually saying which sticks to move. When ready, others in the class were asked to indicate if they would like to be helped, and the former student would select someone to whom he or she would whisper the hint. The selected student was then typically easily able to complete, and classmates were able to observe his or her facial reactions from understanding the hint and then completing the task. Those
students could then whisper a hint to a peer, and the pattern of helping continued until everyone appeared satisfied with their attempts to solving the problem. Finally, a child would be called to the blackboard to detail their moves so that everyone could check their own solutions.

Children were then asked to write their experiences and feelings about the cooperative activity, in pairs with the person nearest themselves. This was opened up to a whole-class discussion where different attitudes and opinions were compared about learning in pairs generally. Researcher observations of this discussion were used in several ways that allowed the test to become more relevant to the concerns of students. It was noted that the children liked being helped, as well as liking being able to help others. They appeared surprisingly aware of and open about their own ability in maths in comparison to others in the class, including how their ability was likely to affect their experiences of pair work. For example, one girl who had been given a hint that she passed on to someone else, explained that she had really liked helping and often wanted to help other children, but usually nobody would accept her help because they could always read a problem and work it out before she could. The initial reactions were about fun, sharing and helping, and spending time with friends, but some children stated that they prefer to work alone or expressed some skepticism and reservations about pair work. The strongest and most commonly expressed reluctance about learning together was due to the risk of being paired with someone who could get them into trouble; it seemed as if one or two class members were widely recognized as high risk in this regard. One boy stated that it was faster for him to solve the problems alone. A minority of children, even amongst those who had acted competitively with high success during the matchstick activities, openly admitted how easy and tempting it can be to cheat. Thus, even though the researcher had expected that most
children would give socially acceptable answers, they appeared to respond honestly in the discussion phase.

Using a Likert-scale drawn on the blackboard, the researcher trialed some items with the whole class, explaining that it was important for them to put the correct answer for themselves. The children’s reactions were informative. They were reluctant to answer questions without knowing with whom they would be working. They were also concerned about whether the work would be difficult or easy. One student wanted to mark fractions of points on the scales. Some words needed to be clarified and ultimately changed, for instance “resolve arguments” was a confusing phrase for some children. The children wanted more clarification on what “disagreeing” meant. There were items referring to shouting and hitting that the children treated as having dubious validity.

The researcher concluded the activities as a class and explained to the students that their efforts would be used in the development of a test that would ultimately help teachers in the future better understand how children their age learn and for which they would be able to help by answering questions the following day. They were advised that if they were interested in talking further with the researcher they could do so either by themselves or in small groups.

Three children individually and two groups of three and four children respectively participated in the post-class discussions. All except one of the volunteers positioned themselves as eager to help others learn, and this was consistent with most of these children volunteering to further help with the research. One sequence in the interviews was fascinating in that the children’s responses and strong facial expressions were mirrored successively by each of the participants and it seemed as if they each held a strong identity of being responsible and moral class members. When I asked if they would be prepared to help their enemy do well, each child responded with solemn expressions and verbally
affirmed that they would help. When asked why, they would patiently explain that it was the right thing to do and it was simply a good outcome when people learned successfully. When asked if their enemy should trust them, they would pause and look innocently wide-eyed in surprise at the question, and then appearing confident and relaxed would state that of course their enemy should trust them. When asked if they would trust their enemy, however, without hesitation their expression would dramatically change to a dropped jaw and hands raised in horror, and they would emphatically state, “No way!” By contrast, one of the boys in a group positioned himself as a nuisance and unreliable, seeming to enjoy confessing that he was more than willing to take advantage of others or abuse anyone’s trust. The others in the group openly disapproved of him, taking him into their gaze when responding to the question sequence about their enemy, but nevertheless not hesitating to affirm that they were completely happy to help their enemy succeed. In fact, the self-confessed ‘helpful children’ made it quite difficult for me to ask probing questions about this other boy’s perspective of pair learning, probably because they took for granted that adults appreciated their skill and readiness to silence a self-confessing trouble-maker.

The ideas raised by the pilot study programme were then incorporated into modifying some of the items and generating further items. A total of 100 items, mostly about learning in a pair, were generated, instructions were written, and the pilot questionnaire was printed to be trialed the following day.

For piloting of the questionnaire, the same children from the Grade-5 class in a middle-class government school participated in trialing the items. The researcher read out the instructions, and read out each item whilst the children recorded their answers.

Some children were reluctant to hear the instructions, having done the trial items the previous day. Most of the children found the items very repetitive. The greatest problem
was that some children were overwhelmed by the number of items and seemed fatigued. Towards the end of the task, the researcher needed to allow the children to have some hand-stretching breaks. Whilst some of the children seemed to take completion of the questionnaire as a challenge, the researcher needed to coax others to finish, for example, by telling them that it was hard but they were making a terrific contribution to research. The administration of the pilot questions took approximately two hours.

Upon completion, the questionnaire papers were collected and the researcher thanked the children for their marathon effort and cooperation.

5.2.4 Rasch Analysis

A Rasch analysis was undertaken and the results were used to determine which items were highly discriminating through looking at the item characteristic curves. The best four items for each of the cooperative and individual learning components were chosen, and in some cases of low discriminating items, modifications attempting to improve the item were made.

5.2.5 Finalisation of SLQ-Alone-&-Partnered

The final SLQ used in Study 2, “Learning Mathematics Alone” and “Learning Mathematics with a Partner” comprised 20 items for each of the two learning styles. The introductions for the items were worded as follows: “When I learn mathematics alone: …” and “When I learn mathematics with a partner: …” (see Accompanying Appendix A.2.7). Instructions and example items were finalized. Short instructions are desirable, but this section was longer than in a typical test because it seemed unwise to risk compromising on clarifying any of the points of confusion experienced in the pilot study. Different colours of paper were used to assist students in differentiating between the two parts of the tests. After
final writing up and printing, the Student Learning Questionnaire was ready for use during Study 2 in Singapore. Identical tests were used for pre- and post-tests.

5.2.6 Scoring of the SLQ

The scoring of the SLQ-Individual and SLQ-Cooperative scales was undertaken as follows: Responses to positively worded items (i.e., items entailing the words “I can”), were given the following scores: “Strongly disagree” = 1, “Moderately disagree” = 2, “Disagree slightly more than agree” = 3, “Agree slightly more than disagree” = 4, “Moderately agree” = 5 and “Strongly agree” = 6. Negatively-worded items, (i.e., items entailing the words “I cannot”), were reverse-scored. This had the effect of allowing all items to be scored in the same direction. In other words, reversing allowed the scores to be appropriate as if negative items were to read as “I can”.

5.2.7 Factor Analysis on SLQ

To summarise the essential information that can be used to represent relationships among sets of many interrelated variables, a principal component analysis with Orthogonal (Varimax) rotation procedure was performed for the items in both the SLQ-Individual and SLQ-Cooperative scales.

A scree test was performed to identify the best solution to selecting the correct number of factors (Kline, 1997). Cattell’s (1966) methodology, that identifies where the factors plateau at the end of the downward slope, indicating all factors with eigenvalues >1 was used as the best solution for selecting the number of factors (Kline, 1997). On this basis, six factors for each of the Individual Scale and the Cooperative scales emerged (see Figure 5.1 for Individual Scale Scree Plot and Figure 5.2 for Cooperative Scale Scree Plot).
Figure 5:1  Scree Test of Eigenvalues for SLQ-Individual Scale

Figure 5:2  Scree Test of Eigenvalues for SLQ-Cooperative Scale
The rotation sum of squared loadings for each scale is shown in Table 5.3

Table 5:3.

Percentage of Variance Explained by Rotated Factors for SLQ-Individual and Cooperative Scales

<table>
<thead>
<tr>
<th>Individual scale</th>
<th></th>
<th>Cooperative scale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>% of variance</td>
<td>Factor</td>
<td>% of variance</td>
</tr>
<tr>
<td>1</td>
<td>15.25</td>
<td>1</td>
<td>11.10</td>
</tr>
<tr>
<td>2</td>
<td>8.13</td>
<td>2</td>
<td>8.84</td>
</tr>
<tr>
<td>3</td>
<td>7.21</td>
<td>3</td>
<td>8.78</td>
</tr>
<tr>
<td>4</td>
<td>7.02</td>
<td>4</td>
<td>8.77</td>
</tr>
<tr>
<td>5</td>
<td>6.89</td>
<td>5</td>
<td>8.40</td>
</tr>
<tr>
<td>6</td>
<td>5.70</td>
<td>6</td>
<td>6.02</td>
</tr>
<tr>
<td>Total</td>
<td>50.20</td>
<td>Total</td>
<td>51.91</td>
</tr>
</tbody>
</table>

As can be seen from Table 5.3 the six factors for SLQ-Individual and SLQ-Cooperative scales accounted for 50.20% and 51.91% of the variance, respectively. Items with a rotated loading equal to or greater than .30 were regarded as salient (Kline, 1997) and therefore were incorporated within an index.

In addition, a Cronbach alpha-coefficient was calculated as an index of internal reliability. Children’s pre-test data were used so as to avoid confounding the results from their different experiences in the experimental conditions. Since the SLQ-Individual and SLQ-Cooperative scales were considered to be multi-faceted, an alpha-coefficient was calculated for each of the solved factors (six for each scale) rather than being obtained from the total score (Saggino & Kline, 1996). Table 5:4 shows the number of contributing items and the alpha-coefficients for each solved factor.
Table 5:4.

**Alpha-Coefficients for Each Factor of the Solved SLQ- Scales**

<table>
<thead>
<tr>
<th>Factor #</th>
<th>Number of items</th>
<th>Alpha-coefficient</th>
<th>Factor #</th>
<th>Number of items</th>
<th>Alpha-coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>.73</td>
<td>1</td>
<td>4</td>
<td>.70</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>.46</td>
<td>2</td>
<td>5</td>
<td>.48</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>.26</td>
<td>3</td>
<td>5</td>
<td>.57</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>.39</td>
<td>4</td>
<td>6</td>
<td>.53</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>.38</td>
<td>5</td>
<td>6</td>
<td>.50</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>.16</td>
<td>6</td>
<td>3</td>
<td>.26</td>
</tr>
</tbody>
</table>

In this way, a range of alpha-coefficients of .16-.73 was established for factors on the Individual learning scale, and a range of .26-.70 was established for factors on the Cooperative learning scale. Reliability is therefore low to moderately high. This establishes that cautious interpretation and application of the results is necessary, especially with the factors that have low alpha-coefficients, and serves as a reminder that Study 2b’s contribution to the thesis is as an exploratory study.

The following tables (5:5-10) show the six factor solution to the SLQ’s Individual-learning scale: The salient items and loadings are shown, followed by the description of the factor name and the description of commonality amongst items upon which the name is derived.
The six factor solution to the SLQ’s Individual-learning Scale (Tables 5.5-10)

Table 5:5.

Individual-Learning Factor 1’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>.71</td>
<td>I can think back about where I made mistakes before, so that I can solve similar maths problems correctly the next time.</td>
</tr>
<tr>
<td>2</td>
<td>.70</td>
<td>Even when other classmates finish more quickly than me, I can encourage myself to keep trying to work out the maths problem.</td>
</tr>
<tr>
<td>20</td>
<td>.68</td>
<td>When I see my classmates giving up, I can keep trying to solve the maths problem.</td>
</tr>
<tr>
<td>4</td>
<td>.66</td>
<td>If I think of two different methods to solve a maths problem, I can be careful not to rush into solving the maths problem using any method, but can choose the best method.</td>
</tr>
<tr>
<td>6</td>
<td>.66</td>
<td>If the teacher tells the class that the maths problem is difficult, I can still try to solve it on my own instead of waiting to be told the answer.</td>
</tr>
<tr>
<td>12</td>
<td>.41</td>
<td>If many of my classmates got a maths problem correct but I got it wrong, I can keep trying to do well instead of thinking too much about feeling ashamed of myself.</td>
</tr>
<tr>
<td>3</td>
<td>.40</td>
<td>If I realize that I am thinking about other things instead of my maths problem, I can make myself think about the maths problem.</td>
</tr>
</tbody>
</table>

Factor name and description  ‘Loafing Resistant’: Willingness to do one’s best even in the face of temptations to give up trying.
Table 5.6.
Individual-Learning Factor 2’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>.62</td>
<td>If a maths problem is very difficult, I <strong>cannot</strong> encourage myself to keep trying to solve it.</td>
</tr>
<tr>
<td>15</td>
<td>.62</td>
<td>I <strong>cannot</strong> think back about how I learned maths to know the best way of working out a similar maths problem next time.</td>
</tr>
<tr>
<td>7</td>
<td>.50</td>
<td>I <strong>cannot</strong> learn faster alone than when I learn in a pair.</td>
</tr>
<tr>
<td>5</td>
<td>.48</td>
<td>I <strong>cannot</strong> feel okay about myself for not being able to work out a maths problem when I have tried my best.</td>
</tr>
</tbody>
</table>

*NB*: Possible response bias: Care must be taken due to so many ‘cannots’ in items that being reverse-scored should be read as ‘can’.

Factor name and description

*‘Self-motivated’*: Able to push oneself to tackle the problem alone.

Table 5:7.
Individual-learning Factor 3’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>.72</td>
<td>If my teacher says that a maths problem is easy but it is too difficult for me to work it out, I <strong>can</strong> still feel okay about myself.</td>
</tr>
<tr>
<td>9</td>
<td>.63</td>
<td>If I have tried my best but got the maths problem wrong, I <strong>can</strong> feel okay about myself.</td>
</tr>
<tr>
<td>19</td>
<td>-.41</td>
<td>I <strong>cannot</strong> follow the teacher’s instructions without asking other students what to do.</td>
</tr>
<tr>
<td>12</td>
<td>.30</td>
<td>If many of my classmates got a maths problem correct but I got it wrong, I <strong>can</strong> keep trying to do well instead of thinking too much about feeling ashamed of myself.</td>
</tr>
</tbody>
</table>

Factor name and description

*‘Resilient self-worth’*: Maintaining a positive view of oneself in the face of others being more successful.
Table 5:8.

Individual-learning Factor 4’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>.69</td>
<td>When my classmates finish more quickly than I do, I can stop myself from just writing any answer without thinking very hard.</td>
</tr>
<tr>
<td>17</td>
<td>.64</td>
<td>Even if I could easily copy a cleverer classmate’s answer without anyone seeing me copy, <em>I can</em> make myself work out the maths problem and hand in my own answer even if I am not sure if it is correct.</td>
</tr>
<tr>
<td>3</td>
<td>.42</td>
<td>If I realize that I am thinking about other things instead of my maths problem, <em>I can</em> make myself think about the maths problem.</td>
</tr>
<tr>
<td>11</td>
<td>.38</td>
<td><em>I can</em> stop myself from asking my classmates how to solve the maths problem.</td>
</tr>
</tbody>
</table>

Factor name and description

‘Free-riding resistant’: Determined to work out the answer oneself, even when faced with opportunities and temptations not to do so.

Table 5:9.

Individual-learning Factor 5’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>.80</td>
<td><em>I can</em> concentrate better when I learn alone than when I learn in a pair.</td>
</tr>
<tr>
<td>18</td>
<td>.62</td>
<td><em>I can</em> feel happy that I learned alone, even though I may have got slightly higher marks learning in a pair.</td>
</tr>
<tr>
<td>7</td>
<td>.49</td>
<td><em>I cannot</em> learn faster alone than when I learn in a pair.</td>
</tr>
</tbody>
</table>

Factor name and description

‘Proudly Independent’: Capable, when alone, of high quality of learning (possibly done reasonably quickly), and taking pride in achieving through one’s own effort.
Table 5:10.

Individual-learning Factor 6’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.77</td>
<td><em>I can</em> make fewer mistakes than when I learn in a pair.</td>
</tr>
<tr>
<td>5</td>
<td>.58</td>
<td><em>I cannot</em> feel okay about myself for not being able to work out a maths problem when I have tried my best.</td>
</tr>
</tbody>
</table>

Factor name and description

‘Self-empowering’: Comparatively effective with the individual learning approach with capacity to avoid defeatist self-doubts.

The six factor solution to the SLQ’s Cooperative-learning Scale (Tables 5.11-16)

Table 5:11.

Cooperative Learning Factor 1’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>.78</td>
<td>If I know my partner has worked out the answer without showing the answer to me, <em>I can</em> still work out the problem by myself and not ask to copy.</td>
</tr>
<tr>
<td>33</td>
<td>.77</td>
<td>If my partner gives me the answer, <em>I can</em> still try to work out the steps to solving the maths problem by myself.</td>
</tr>
<tr>
<td>21</td>
<td>.76</td>
<td>If my partner gives up on a maths problem, <em>I can</em> still try to finish the problem by myself.</td>
</tr>
<tr>
<td>34</td>
<td>.36</td>
<td>If my partner and I got different answers to the maths problem, and I looked at both of our workings, <em>I can</em> find out which of us had made mistakes.</td>
</tr>
</tbody>
</table>

Factor name and description

‘Conscientious Worker’: This combines resistance to both free-riding and loafing, and implies the student will work through problems regardless of temptations not to do so, such as being able to use a partner’s answer or in de-motivating contexts such as having seen the answer.
Table 5:12.

Cooperative Learning Factor 2’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>.69</td>
<td><em>I can</em> help my partner find out how much help I need.</td>
</tr>
<tr>
<td>37</td>
<td>.63</td>
<td>If my partner told me that I had given away the answer to him or her, <em>I can</em> give my partner better hints next time that do not give away the answer.</td>
</tr>
<tr>
<td>39</td>
<td>.49</td>
<td>If I am explaining a maths problem to my partner, <em>I can</em> ask questions that will let me find out if my partner understands.</td>
</tr>
<tr>
<td>25</td>
<td>.48</td>
<td>When I work with a partner, <em>I can</em> decide the best way to work together.</td>
</tr>
<tr>
<td>26</td>
<td>.36</td>
<td>If I realize that my partner and I have been talking about other things instead of our maths, <em>I cannot</em> tell my partner next time that we must only talk about the maths problem.</td>
</tr>
</tbody>
</table>

*NB:* Item #26 is one of many with "cannot" that would be reverse-scored and should be read as “can” or “do not find it hard to”.

Factor name and description

*‘Person-focused leader’: Able to strategically guide cooperative effort and engagement with problem by clarifying needs of partner and self.*

Table 5:13.

Cooperative Learning Factor 3’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>.66</td>
<td>If I realize that my partner and I have been talking about other things other instead of our maths, <em>I cannot</em> tell my partner next time that we must only talk about the maths problem.</td>
</tr>
<tr>
<td>32</td>
<td>.63</td>
<td>If my partner is sometimes lazy, <em>I cannot</em> encourage him or her to keep thinking about the maths problem so that we both can succeed at learning maths.</td>
</tr>
<tr>
<td>36</td>
<td>.58</td>
<td>If my partner is not interested in doing the maths problem, <em>I cannot</em> keep trying by myself.</td>
</tr>
<tr>
<td>22</td>
<td>.55</td>
<td><em>I cannot</em> give explanations that my partner will easily understand.</td>
</tr>
<tr>
<td>38</td>
<td>.45</td>
<td>If my partner understands the maths problem better than I do but makes fun of me, <em>I cannot</em> ask my partner nicely to not make fun of me.</td>
</tr>
</tbody>
</table>

*NB:* Possible response-bias.

Factor name and description

*‘Good Influence’: No difficulty in asserting opinion or preferences with an aberrant partner.*
### Cooperative Learning Factor 4’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>.72</td>
<td><em>I can</em> care about both my partner and I doing well together more than just about myself doing well.</td>
</tr>
<tr>
<td>34</td>
<td>.52</td>
<td><em>I can</em> find out which of us had made mistakes.</td>
</tr>
<tr>
<td>30</td>
<td>.45</td>
<td><em>I can</em> think of better ways to solve a maths problem when I work in a pair than when I work alone.</td>
</tr>
<tr>
<td>38</td>
<td>.42</td>
<td><em>I cannot</em> ask my partner nicely to not make fun of me.</td>
</tr>
<tr>
<td>40</td>
<td>.39</td>
<td><em>I can</em> feel happy that my partner helped me, even if I believe that my mark is slightly worse than what I would have achieved by working out the maths problem by myself.</td>
</tr>
<tr>
<td>28</td>
<td>.35</td>
<td><em>I can</em> admit to that without worrying that my partner will make fun of me.</td>
</tr>
</tbody>
</table>

**Factor name and description:** *‘Team-oriented’: Highly successful in cooperative learning: socially, performatively and affectively.*
**Cooperative Learning Factor 5’s Salient Items and Loadings, with Factor Name and Description**

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>.68</td>
<td>If I disagree with my partner’s answer, I <em>can</em> be nice to my partner while I explain the mistake he or she made.</td>
</tr>
<tr>
<td>29</td>
<td>.61</td>
<td>If my partner disagrees with my answer and makes fun of me, and my partner’s answer is right, I <em>can</em> let my partner know I agree with his or her answer.</td>
</tr>
<tr>
<td>28</td>
<td>.40</td>
<td>If I do not understand a maths problem, I <em>can</em> admit to that without worrying that my partner will make fun of me.</td>
</tr>
<tr>
<td>32</td>
<td>.39</td>
<td>If my partner is sometimes lazy, I <em>cannot</em> encourage him or her to keep thinking about the maths problem so that we both can succeed at learning maths.</td>
</tr>
<tr>
<td>40</td>
<td>.34</td>
<td>I <em>can</em> feel happy that my partner helped me, even if I believe that my mark is slightly worse than what I would have achieved by working out the maths problem by myself.</td>
</tr>
<tr>
<td>38</td>
<td>-.33</td>
<td>If my partner understands the maths problem better than I do but makes fun of me, I <em>cannot</em> ask my partner nicely not to make fun of me.</td>
</tr>
</tbody>
</table>

**NB:** Item 32 is poorly worded with both ‘cannot’ and ‘can’, and thus may have confused the children.

**Factor name and description**

*‘Socially-confident–problem-solver’: Can stay focused on working out the maths problem rather than being drawn into arguments over personal comments.*
Table 5:16.
Cooperative Learning Factor 6’s Salient Items and Loadings, with Factor Name and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
<th>Text of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>.82</td>
<td>If my classmates were choosing partners, I <em>can</em> be amongst the first to be chosen.</td>
</tr>
<tr>
<td>25</td>
<td>.40</td>
<td>When I work with a partner, I <em>can</em> decide the best way to work together.</td>
</tr>
<tr>
<td>40</td>
<td>-.36</td>
<td><em>I can</em> feel happy that my partner helped me, even if I believe that my mark is slightly worse than what I would have achieved by working out the maths problem by myself.</td>
</tr>
</tbody>
</table>

Factor name and description: *Identifiable team-asset*: Feeling that one has much to offer a partner and can lead the dyad towards success.

In summary, the twelve factors elicited from the factor analysis are shown in Table 5:17.

Table 5:17.
Lists of Factors for Self-Efficacy in Solved Individual Learning and Cooperative Learning Scales

<table>
<thead>
<tr>
<th>Individual Learning factors</th>
<th>Cooperative Learning factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Loafing-resistant</td>
<td>1. Conscientious worker</td>
</tr>
<tr>
<td>2. Self-motivated</td>
<td>2. Person-focused leader</td>
</tr>
<tr>
<td>4. Free-riding resistant</td>
<td>4. Team-oriented</td>
</tr>
<tr>
<td>5. Proudly-independent</td>
<td>5. Socially-confident–problem-solver</td>
</tr>
</tbody>
</table>
5.2.8 Discussion of Factors Identified for Cooperative- and Individual-Learning Scales

In relation to Study 2a’s conclusions theorizing that Individual Accountability (IA), or at least its revised conceptualization as Individual Accountability Control (IAc), needs to be prioritised over Positive Interdependence, the priority of Conscientious Worker on the Cooperative-learning scale confirms that premise. However, although there are obvious similarities between the SLQ-Alone-&-Partnered self-efficacy factors and the “Learning Together” elements, there is no direct correspondence of scales. To some extent, the differences are accounted for by the influence from piloting the SLQ-Alone-&-Partnered in which children’s concerns and discriminating items pointed towards descriptors that operationalised elements that were more qualified, which was often achieved by combining aspects of more than one element from the Learning Together model. For example, in an item “If my partner has said the item is impossible, I will still try it by myself”, the second half is what counts as the Learning Together element of “Individual Accountability” which is taking personal responsibility for doing what needs to be done. However, the first half of the item, which qualified the second half, could be an example of the other elements, such as (a) having to overcome the problem of a partner whose discouraging comments make them very weak on the Learning Together model’s Promotive Interaction, and (b) having to use good Interpersonal and Small Group Skills to not get distracted into arguing about whether or not the problem is impossible. Thus, that item is not a pure form of the Learning Together model’s “Individual Accountability”.

There are several noteworthy similarities and differences across the learning-styles. The factors integrate cognitive aspects with social (peer) domains and affective (emotional) domains. To some extent, this integration can be accounted for in the design of the
questionnaire items although patterns sufficiently regular for a factor to be found add to their validity. It is also notable that the first factors on each scale appear to be very similar although they are not identical. Loafing-resistant on the Individual-scale is very similar to Conscientious-worker on the cooperative scale, identifying that, whether or not either learning style allows peer-interaction in the classroom, the major factors for efficacious learning involve self-regulation to maximize one’s own cognitive effort regardless of others’ fluctuating effort or attitudes. This fits with the field’s typical rationale for encouraging self-efficacy as an adaptive emotional response leading to increased task persistence. Additionally, the social domains are integrated into the factors in each scale, however, it is not surprising that they appear as both more of a priority and more obvious in the majority of factors on the cooperative scale. As such, the social focus is obvious in the cooperative-learning scale’s second factor of Person-focused leader and all successive factors on the scale, but on the individual-learning scale a social focus is only as obvious as a third and fourth factor. The social focus contrasts as being more descriptive of how students interact on the cooperative-learning scale and more descriptive of how students block others out on the individual-learning scale.

Although the original questionnaire aimed to test for equivalent cooperative-learning and individual-learning factors, the lists produced in the factor analysis are not directly equivalent across the two learning styles. The first factor in each of the scales, as the most extreme case, can serve to illustrate this: for cooperative learning, the factor nominated “conscientious worker” incorporates both resistance to ‘social loafing’ and resistance to ‘free-riding’ which often arise together, but for individual learning “loafing-resistance” and “free-riding resistant” are two separate factors. Since the point of factor analysis is to indicate separate factors, consideration needs to be given for what could be
discrepant inclusions and exclusions in the categorisation. Scrutiny will begin with comparing and contrasting the terms.

The relevant factors’ distinguishing features are as follows. Loaﬁng is a reduction of effort, for example, as a reaction to others not being on task, and in the simplest sense the outcome is that reduced effort will prevent the loafer from attaining the target results, and being resistant entails persevering with a task despite others playing, being lazy or not cooperating. Free-riding is failing to put in the effort but beneﬁting from someone else attaining the target results, and being resistant entails being prepared to put in the effort even when it may be possible to free-ride.

Conceptually and in light of the literature, it does indeed seem reasonable that free-riding and loaﬁng can count as a single factor in the cooperative learning list but count as separate factors in the individual learning list. This is because it is more common in group situations for there to be inter-relationships between any disincentives to making an effort. For example, in groups, as one person begins free-riding, a ‘sucker effect’ occurs in others who loaf as a strategy to avoid being exploited (Forsyth, 1999; Kerr, 1983). This can also work the other way around in dyadic learning where if one partner is over-enthusiastic about sharing answers this will act as a disincentive for the assisted partner to make their own effort, thus imposing an opportunity to free-ride which sets up a pattern leading to loafing. Alternatively, through cooperating in sharing effort, maths problems may be divided so that partners take turns to loaf and free-ride. By contrast, in an individual-learning situation, the opportunities and temptations to loaf and free-ride are less likely to be inter-related. Loaﬁng can occur relatively passively as a reaction to perceiving that others have reduced their effort. However, free-riding in the individual learning situation differs from a group or dyadic situation where a partner takes over or is left to do the work, since it is likely to involve more actively using another’s work and can more readily be
defined as ‘copying’. The lack of direct equivalence between these individual-learning and cooperative-learning factors of conscientiousness reflects the fact that each learning style creates its own dynamics and places its own demands upon the learner.

It is notable that a characteristic of the SLQ-Alone-&-Partnered questionnaire design and the factor analysis original to this study is that aspects are informed by input from children’s perspectives. The “Learning Together” theoretical framework which Johnson and Johnson developed from meta-analyses of the field’s literature was used as the basis of conceiving the comparative factors for the two learning styles. In the present study, the piloted questionnaire items were based on the researcher’s operationalisation of the Learning Together model’s framework, incorporating aspects in relation to observations from Study 1 and other ideas gleaned from literature in the field of social psychology. However, the field is informed by studies of varying social contexts and is dominated by studies of adult groups. Therefore, an important facet for the present factor analysis was that the items used in the questionnaire were adapted after trial by the Grade-5 Australian class, and solutions to the factor analysis identified the response characteristics of the Grade-5 Singapore classes participating in Study 2.
5.3 Results of Solved Factors on SLQ

The SLQ-Alone-&-Partnered questionnaire is an affective measure of students’ self-efficacy for learning maths in relation to factors of cooperative and individual learning. The overall goal of analysis was to explore the learning intervention’s pre-post changes to the 12 cooperative and individual learning factors and draw upon the findings to develop a theory of cooperative learning that integrated cognitive, social and affective domains of learning. This part of the study has very complex information that is useful for building a broad perspective, but it does have inherent difficulties. Thibaut and Kelley (1959) explain that, compared to individual psychology, analysis of social interaction will necessarily involve some speculation about cause and effect:

[When groups or dyads are set up in experiments] the possibility is now introduced that each subject will introduce control over the other. ... Methodologically, the complexity that is added by reciprocal control may be denoted by the loss of a clear separation between independent and dependent variables. Each subject’s behaviour is at the same time a response to a past behaviour of the other and a stimulus to a future behaviour of the other, each behaviour is in part dependent variable and in part independent variable; in no clear sense is it properly either of them. (Thibaut & Kelley, 1959, p. 2)
For the theorizing, it was necessary to establish an explanatory framework and, in this regard, aspects of social psychology were useful. The results’ patterns of gains and losses were explored and speculative explanations of the dynamics for each factor were developed. Self-efficacy is itself an ‘expectancy X value’ theory of motivation.

In essence, in the ‘expectancy X value’ theory, the concept of ‘expectancy’ encapsulates perceived confidence about likely future success and the concept of ‘value’ encapsulates perceived desirability of achieving success; and the theory is that both are needed for motivation. This was the broad framework for the explorations of the effects of learning conditions (Individual vs Cooperative; reward structure, and ability structuring) on each of the factors. What is notable is that the results included many pre-post intervention losses along with the gains, demanding complexity in the speculative explanations of the way conditions may affect the way students place ‘values’ on aspects of learning and cooperation. The questionnaire was designed to go further than the standard self-concept tests, to explore students’ perceived self-efficacy for learning both individually and cooperatively. Therefore, this study’s theorizing had to move beyond standard behaviourist explanations of motivation in order to theorise the more complex dynamics of Learning Behaviour (LB) reward structures and dyadic pairing.

Social exchange theory (Thibaut & Kelley, 1959) argues that there is a rewards/cost ratio that, depending on whether or not partners perceive a profit to themselves by exchanging their efforts or assets for possible gain to themselves, will determine motivation. What is actually exchanged can be similar (such as taking turns to give support in checking by partners of equal ability), or it can be different (such as a more competent peer’s advice in exchange for status recognition by a less competent peer). Thus, the social exchange concept of the rewards/cost ratio underlies theorizing about students’ motivation
to cooperate with each other, with the teacher’s use of LB-Rewards being another element on the reward side that might influence students’ perceptions of overall profit. Rewards and costs may be evaluated subjectively and, therefore, the theorizing needs to consider how working alone or with a partner might vary in whether it counts as a reward or cost, and how it might vary amongst partners. The theorizing of possible incentives-values is speculative as the data do not indicate how students perceived the various aspects. However, some aspects that students might count as costs and benefits associated with learning maths with a partner are: The physical rewards for LB-Rewards (for which it is also possible that attaining them increased or decreased the opportunities for Maths Mastery Rewards); Academic rewards in forms of giving and receiving assistance with Maths; Intrinsic rewards of skill mastery of particular factors that should improve maths performance; Maths Self-esteem Rewards from positive comments by partner or greater awareness of how to persevere with problems; and Pairwork esteem rewards such as companionship and leadership opportunities.

Equity theory states that partnerships are most satisfactory when there is a perceived “equality” of effort and outcomes (e.g. Adams, 1965). This theory differs from behaviourist theory and is useful for explaining instances where it does not appear to be the case that the highest levels of extrinsic rewards are the most effective. That is, explanations are required where a No-LB-Rewards condition may be more effective than an LB-Rewards condition, and this theory is potentially powerful regarding how notions of fairness may affect motivation in paired learning.

Social comparison theory (Festinger, 1954) states that people in groups compare themselves with others, and in some cases it is the opportunities for comparison that may cause them to join or leave a group. These basic concepts from social psychology can be applied to considering the extent to which studying with a partner, especially in mixed-
ability pairings, can be enhance or decrease perceived self-efficacy. It is assumes that such changes indicate where the learning conditions were motivating or demotivating. The social psychology concepts have informed theorizing in the present study about the integration of cognitive, social and affective domains of cooperative learning.

Results for self-efficacy outcomes measured on the Student Learning Questionnaire (SLQ) for each factor in Individual- and Cooperative-learning were analysed to explore and develop speculative explanations of learning motivation. It is notable that the twelve factors, derived from the Factor Analysis within each of the Individual and Cooperative scales, are orthogonal across a sample at pretest. However, the analysis of results for pre-post changes pointed towards the possibility of a further synthesis of factors. This synthesis was derived in two interrelated ways. The first and main way of deriving the synthesis was from noticing that the outcomes of pre-post changes appeared to have similar patterns of underlying dynamics within various experimental conditions and ability categories, thus suggesting that some factors could be grouped into sets. A second way was noticing how some of the factors which had similar patterns of results also appeared to be a priori related to a similar psychological construct. For the resultant four sets, category names were chosen to describe what each of their factors may have in common as a psychological construct: “Individual Cognitive Endeavour”, “Companionate Positive Influence”, “Individualistic Attitudes Development” and “Social-emotional Endeavour”. These categories of psychological constructs will, henceforth, be referred to as “Learning Dimensions”. The distinctive patterns of results within each of these learning dimensions might be explained by distinctive configurations of all the motivating elements. Thus, in the present study’s proposed theory of cooperative learning, the constructs are called ‘Learning Dimensions’ and the explanations for how they work are called ‘Configurations’.
Only the main findings pertinent to the development of the theory will be presented here. For the full set of results, refer to Electronic Appendices for descriptive statistics (Electronic Appendices E.2.7 - E.2.8) ANOVAs (Electronic Appendices E.2.9 - E.2.14) and Correlational Analysis (Electronic Appendices E.2.15 - E.2.16).

For ease of reference and to allow conciseness to this analysis, rather than presenting the factors in the order in which they were examined, or in the order of statistical significance, they will be presented in a sequence that pre-empts the study’s further synthesis of the twelve factors into four learning dimensions and configurations (see Table 5:18). The relevant results for each configuration and its factors will be presented and possible interpretations of these results will be made drawing from the various aspects of social psychology that seem to have explanatory power. The theory that will ultimately be developed, and will be explained later in the chapter, is named “Incentive-values–Exchange”. It proposes that for each specific, distinctive learning dimension, the dynamics between dyadic members’ abilities and use of learning-behaviour rewards, can be explained as broad configurations of calculable exchanges of perceived profitable and costly effort and outcomes.

An index of the factors by configuration will be presented in Table 5:18.
### Incentive-values–Exchange in Individual- and Cooperative-learning: Dimensions (D’s) of Learning by Configurations and factors influencing self-efficacy

<table>
<thead>
<tr>
<th>Dimensions of learning dynamics</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.1 Configuration 1: Individual endeavour</td>
<td>D.1.1 Coop1 Conscientious worker</td>
</tr>
<tr>
<td>D.1.2 Ind1 Loafing-resistant</td>
<td></td>
</tr>
<tr>
<td>D.1.3 Ind4 Free-riding–resistant</td>
<td></td>
</tr>
<tr>
<td>D.1.4 Ind2 Self-motivated</td>
<td></td>
</tr>
<tr>
<td>D.2 Configuration 2: Companionate positive influence</td>
<td>D.2.1 Coop2 Person-focused leader</td>
</tr>
<tr>
<td>D.2.2 Coop3 Good influence</td>
<td></td>
</tr>
<tr>
<td>D.2.3 Coop6 Identifiable team-asset</td>
<td></td>
</tr>
<tr>
<td>D.3 Configuration 3: Individualistic attitudes development</td>
<td>D.3.1 Ind5 Proudly independent</td>
</tr>
<tr>
<td>D.3.2 Ind6 Self-empowering</td>
<td></td>
</tr>
<tr>
<td>D.4 Configuration 4: Social-emotional endeavour</td>
<td>D.4.1 Ind3 Resilient–self-worth</td>
</tr>
<tr>
<td>D.4.2 Coop5 Socially-confident problem-solver</td>
<td></td>
</tr>
<tr>
<td>D.4.3 Coop4 Team-oriented</td>
<td></td>
</tr>
</tbody>
</table>

### 5.3.1 Configuration 1: Individual Endeavour

#### 5.3.1.1 Preview of Configuration 1: Individual Endeavour

Configuration 1 pertains to the learning dimension of “Individual Endeavour”. It comprises four factors: Cooperative Factor 1 - Conscientious Worker; Individual Factor 1 - Loafing Resistant; Individual Factor 4 - Free-riding–Resistant and Individual Factor 2 - Self-motivated. Configuration 1 proposes a premise that over-rewarding may be
detrimental to the learning of “Individual Endeavour”, in some cases of cooperative conditions. Furthermore, it proposes that Individual and Cooperative learning are not dichotomous forms of learning. Instead, the Cooperative learning attributes subsume aspects of Individual learning attributes such as Individual Endeavour.

5.3.1.2 Main Results/Discussion of Configuration 1: Individual Endeavour

5.3.1.2.1 Cooperative Factor 1 - Conscientious Worker

![Figure 5.3](image)

Figure 5.3 Mean Cooperative Factor 1 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)

Analysis of the first factor in Configuration 1, Cooperative Factor 1 - Conscientious Worker, suggests that Individuals No-LB-Rewards had higher mean gains than Individuals LB-Rewards, where there appears to be mean losses (see Figure 5.3). However, this trend is only approaching educational significance ($d = 0.17$). LB-Rewards appear to be ineffective (and to some extent detrimental) in enhancing Individual Endeavour amongst Individuals. LB-Rewards may distract students learning alone by motivating them to focus overly on
displays of specific behaviours such as checking rather than focusing on using checking strategies for problem solving with the single, end goal of enhancing their maths achievement.

In addition, there is some suggestion that Mixed LB-Rewards had greater mean gains than Individual LB-Rewards, but only at approaching educationally significant levels ($d = 0.17$; see Figure 5.3). The reason that LB-Rewards might be effective for Mixed conditions is that they might motivate the more competent peer to model studying conscientiously or to monitor the less competent peer in this aspect. Thus, it is possible that the more competent peer gains because of wanting to set a good example while the less competent peer gains by attempting to emulate the behaviour of the more competent peer, hence resulting in an overall gain for the Mixed condition.

![Figure 5.4](image.png)

**Figure 5.4** Mean Cooperative Factor 1 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)

The analysis conducted for each ability category indicates that Low ability students studying alone had educationally significantly greater losses than when paired with High
ability partners ($d = 0.37$), and than when paired with Medium ability partners ($d = 0.33$; see Figure 5.4). Furthermore, Low ability students also had educationally significantly greater mean losses on Cooperative Factor 1 - Conscientious Worker when paired with another Low ability partner than when paired with a High ability partner, where there were mean gains ($d = 0.24$); or when paired with a Medium ability partner ($d = 0.21$). The results indicate that Lows are less conscientious when studying alone or when studying with an equal. This could be explained with reference to the importance of Lows being encouraged by a more competent peer to try, even if they realise that they have little chance of success and which typically would lead to them giving up.

5.3.1.2.2 Individual Factor 1 – Loafing-resistant

For the Second factor in Configuration 1, Individual Factor 1 - Loafing-resistant, three trends are observed.

![Mean Individual Factor 1 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)](image)

Figure 5.5 Mean Individual Factor 1 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)
The first trend suggests that Equal No-LB-Rewards had greater mean gains than Equal LB-Rewards that had losses, at approaching educationally significant levels \((d = 0.16; \text{ see Figure 5.5})\). It is possible that amongst Equals, LB-Rewards might lead to loafing as a result of attempting to display cooperative behaviours. Equals may realize that the effort of at least one of the partners is redundant to task completion; and hence the sense of redundancy may lead partners to reduce effort. Taking turns performing the task, or not performing in order to deter free-riding by a partner, could be reactions that lead to ‘loafing’.

The second trend points towards Mixed LB-Rewards having greater gains than Mixed No-LB-Rewards that appear to have mean losses. Conversely to the Equals conditions, LB-Rewards appear to be more effective for Mixed conditions than No-LB-Rewards. This might be explained by the more competent peer’s ability to stay focused on the task, and that tangible incentives help motivate them in monitoring their partner’s independent effort.

![Figure 5.6](image-url)  
**Figure 5.6**  Mean Individual Factor 1 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)
The final trend for this factor is that Mediums studying with High ability partners appear to have mean losses as compared to those studying with another Medium ability partner, at approaching educationally significant levels ($d=0.17$; see Figure 5.6). This might be explained as the Medium ability student being discouraged to have an input by the task of problem-solving being taken over by their High ability partner, more than if the Medium-ability student were to study with an equal ability partner. Mediums with High ability partners may also be more susceptible to initiate their loafing if they are sensitive about not wanting to slow down their more competent partner.

5.3.1.2.3 Individual Factor 4 – Free-riding Resistant

![Figure 5.7 Mean Individual Factor 4 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)](image)

Analysis of the third factor of Configuration 1, Individual Factor 4 - Free-riding Resistant, indicates that Low ability students pairing with Medium ability partners had
educationally significantly greater mean gains than those studying with a High ability partner, who had mean losses ($d = 0.22$; see Figure 5.7). This could be explained by Low ability students having a greater likelihood of merely copying or being given the answer from a High ability partner than from a Medium ability partner, who comparatively may work at a pace that allows Lows more involvement and whose occasional fallibility is an incentive to try on one’s own.

![Figure 5.8](image)

**Figure 5.8** Mean Individual Factor 4 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)

The results from the analysis of the experimental conditions from Individual Factor 4, indicate that Mixed No-LB-Rewards had educationally significantly greater mean gains than Individual No-LB-Rewards, who had mean losses ($d = 0.22$; see Figure 5.8). In addition, Mixed conditions with or without LB rewards have similar results (with no significant or educationally significantly differences between the conditions). These findings can be explained as most likely reflecting the effects on the more competent peer
increasing their resistance to free-riding because their partner makes mistakes; and also efforts to avoid feeling used by not letting their less competent partner free ride.

From Figure 5.8, there also appears to be a trend that Equal No-LB-Rewards had showed greater stability than Equal LB-Rewards, who had mean losses. A loss of free-riding resistance when LB-Rewards are used amongst Equals could be explained as encouragement to seek or offer help even when it is not required or requested, which can result in increasing the chances of one partner seeing an answer and then not making their own effort to solve the problem.

5.3.1.2.4 Individual Factor 2 – Self-motivated

![Graph showing mean individual factor 2 gain scores](image)

**Figure 5.9** Mean Individual Factor 2 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)

Analysis of results for the final factor in Configuration 1, Individual Factor 2 - Self-motivated, indicated that for the Low ability category, Low ability Individuals or Low
ability students studying with a High ability partner had educationally significantly greater mean gains than those studying with a Medium ability partner. Both the former and latter comparisons had an effect size of $d = 0.33$ (see Figure 5.9). This may be explained by High ability partners being able to model for and monitor Low ability students in behaviours and attitudes associated with Self-motivation, or at least not impeding Low ability students’ gains in Self-motivation from taking part in the learning programme the way that Medium ability partners appear to do.

5.3.1.3 Summary of Main Results/Discussion of Configuration 1: Individual Endeavour

In summary, based on the main findings for Configuration 1, it is evident that in some cases over-rewarding may be detrimental to the learning dimension of “Individual Endeavour”. The study is based on the premise that ‘learning behaviours’ (i.e., checking problem-solving strategies) will lead to getting the sums correct. For Individuals, following the learning behaviour strategies has a direct, positive effect on maths outcomes. However, for cooperative pairs, individual learning behaviour strategies are not explicitly rewarded outside of Maths mastery rewards, and the requirement for cooperative learning behaviour strategies is an additional aspect. Thus, it seems as if for dyads, the cooperative learning behaviours and maths mastery constitute two separate goals. However, cooperative learning behaviours may be redundant for Equals for whom LB rewarding may increase the likelihood of turn-taking (loafing) or one partner taking over (free-riding). Rewarding learning behaviours may encourage High ability partners to model and monitor effective behaviour for a Low ability partner. In Mixed conditions, being paired with a partner who makes mistakes is itself a disincentive to free-ride. Furthermore, taking a broader perspective, the findings also suggest that Individual and Cooperative learning are not
dichotomous forms of learning. Instead, Cooperative learning attributes subsume aspects of Individual learning attributes such as Individual Endeavour.

5.3.2 Configuration 2: Companionate Positive Influence

5.3.2.1 Preview of Configuration 2: Companionate Positive Influence

Configuration 2 pertains to the learning dimension of “Companionate Positive Influence”. It comprises three factors: Cooperative Factor 2 - Person-focused Leader, Cooperative Factor 3 - Good Influence, and Cooperative Factor 6 - Identifiable Team-asset. The main finding for this Companionate Positive Influence configuration is that partners may need to perceive equality in the values of each other’s contributions, which can be affected by proximal distance in ability and LB-Rewarding.
5.3.2.2 Main Results/Discussion of Configuration 2: Companionate Positive Influence

5.3.2.2.1 Cooperative Factor 2 – Person-focused Leader

![Figure 5.10](image_url)

Figure 5.10 Mean Cooperative Factor 2 Gain Scores for High-, Medium- and Low-Ability Categories (error bar represent 95% confidence intervals)

Analysis of the first factor in Configuration 2, Cooperative Factor 2 – Person-focused Leader, suggests that for the High ability category, Highs studying individually had educationally significantly greater mean gains than Highs paired with a Low ability partner, that had mean losses ($d = 0.21$). For the Medium ability category, Mediums paired with another Medium had educationally significantly greater mean gains than those paired with a High ability partner ($d = 0.38$), and those paired with a Low ability partner ($d = 0.21$). In addition, Mediums studying alone had educationally significantly greater mean gains than those paired with a High ability partner ($d = 0.23$). For the Low ability category, Lows paired with a High ability partner appeared to have the best outcome. This pairing had educationally significantly greater mean gains as compared to Lows studying alone ($d =$...
with another Low ability partner \(d = 0.41\), or with a Medium ability partner \(d = 0.29\).

This set of results suggest that Highs have the best outcomes when studying alone as compared to studying cooperatively, possibly because they are able to self-direct themselves and already have the right approach for solving problems. Mediums gain the most from studying with an equal, possibly because it may be intrinsically rewarding and motivating for them to study in a pair where members have the same level of understanding (of maths problems) and can understand each other’s needs. For Lows, they tend to have the greatest mean gains when paired with a High ability partner, possibly because Highs may have the capacity to connect with Lows by helping them to understand the right approach to the problem. From this point of view, it is somewhat ironic that Highs paired with Lows suffer the greatest losses in self-efficacy to be a Person-focused leader.

### 5.3.2.2.2 Cooperative Factor 3 – Good Influence

![Figure 5.11](image_url)

**Figure 5.11** Mean Cooperative Factor 3 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)
Analysis of the second factor in Configuration 2, Cooperative Factor 3 - Good Influence, indicates that Equal LB-Rewards had statistically and educationally significantly greater mean gains than Equal No-LB-Rewards ($p < .018$, $d = 0.23$; See Figure 5.11). This finding suggests that LB-Rewards may be an incentive for students in equal ability pairings to go through the processes of helping and being helped to a greater extent than may be usual for students of the same ability, resulting in the belief that they are a good influence.

In addition, Equal LB-Rewards had statistically and educationally significantly greater mean gains than Mixed LB-Rewards that had mean losses ($p < .018$, $d = 0.29$). This finding suggests that LB-Rewards have a different effect in Equals versus Mixed conditions. It is likely that in equal ability pairings, the similarity of perspective leads Equals to mostly agree with each other, thus increasing the perceived self efficacy of both partners to be a good influence. By comparison, in mixed ability pairing, the differences of perspective may mean that mainly the more competent peers are able to be a good influence, but as they are enticed to offer assistance, even they become aware of the limitations of their ability to help less competent peers; hence, reducing their perceived self-efficacy to be a good influence.
When the analysis for Cooperative Factor 3 is conducted for each of the ability categories, it is noted that for the High ability category, Highs studying alone had educationally significantly greater mean gains than those paired with a Medium- ($d = 0.26$) or a Low-ability partner ($d = 0.28$). A pattern similar to that observed for High Individuals is also noted for Highs studying with another High ability partner. Highs paired with another High ability partner had educationally significantly greater gains than Highs studying with a Medium ($d = 0.22$) or a Low ability partner ($d = 0.24$). For Medium ability categories, Mediums studying with another Medium had educationally significantly greater mean gains than those studying alone ($d = 0.21$), or with a High ($d = 0.33$), or with a Low ability partner ($d = 0.25$).

The most successful ability pairings for Good Influence appeared to be Equal ability Highs and Equal ability Mediums. When a High or Medium partner is paired with a slightly less competent peer, this appears to be less effective than when paired with an Equal. This
may be accounted for by these students’ recognition of it being difficult to influence the success of a partner who is less competent but who does not have a wide difference in proximal ability.

For Low ability categories, Lows studying alone had educationally significantly greater mean gains than those studying with a Medium ability partner, who had mean losses ($d = 0.21$). Lows studying with a High ability partner had also educationally significantly greater mean gains than those studying with a Medium ability partner ($d = 0.27$). The results suggest that Lows study best with a High-ability partner; or at very least with an Equal or alone than with a Medium-ability partner. The success for a Low ability paired with a High ability partner might be explained by the High ability partner feeling less threatened by the Low ability partner’s challenges or questions than may be the case for a Medium. Mediums may feel more threatened than High ability students by Low ability students’ questions as the proximal distance between Mediums and Lows is narrower than that for Highs and Lows. As a result of low threat, Highs would be more able to foster a context where Highs can scaffold for the Lows as well as let them own their success; for example, it is possible that Highs act impressed and willing to be led by their partners.
5.3.2.2.3 Cooperative Factor 6 – Identifiable Team-asset

Analysis of the final factor in Configuration 2, Cooperative Factor 6 - Identifiable Team-asset, indicates that Individual LB-Rewards had statistically and educationally significantly greater mean gains than Equal LB-Rewards that had mean losses ($p < .018, d = 0.22$; See Figure 5.13). This finding is paradoxical in that, for those offered LB-Rewards, it was the individuals without the cooperative learning experience who gained more perceived self-efficacy as a recognizable Team-asset than the Equals who had actual experience of the cooperative condition. For Individuals, LB-Rewards and experiencing the SLQ-Alone-&-Partnered questionnaire could have created an inflated sense of confidence that they could be a recognizable Team-Asset. In contrast, the experience of cooperative learning conditions, such as by Equals LB-Rewards, could have created a more
disillusioned perspective of problems in team work, and hence lowered their sense of confidence, as compared with the Individuals LB-Rewards.

For Equals, the loss may also be explained with subsequent results where Equal-No-LB-Rewards also appeared to have greater mean gains than Equal LB-Reward; however, this is only approaching educational significance \((d = 0.19)\). The loss for Equal LB-Rewards may be explained by LB-rewards inducing some students to make more unsolicited offers of checking and so on, but this would have been done with the aim of earning a reward without much regard for the extent to which help was really needed. The comparative gain for Equal No-LB-Rewards suggests that without the use of such rewards, cooperation may be more focused on need.

![Figure 5.14](image)

**Figure 5.14** Mean Cooperative Factor 6 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)

When the analysis is conducted for each of the ability categories, it is noted that for the High ability category, Highs studying individually had educationally significantly
smaller mean losses than Highs studying with a Medium partner \( (d = 0.20; \text{ see Figure 5.14}) \). For the Medium ability category, Mediums studying alone or with a low ability partner had educationally significantly greater mean gains than those studying with a High ability partner (with the effect size of \( d = 0.21 \) and \( d = 0.20 \) respectively), who had mean losses. In addition, Mediums studying with another Medium, appear to maintain their sense of being a Team-asset better than those studying with a High ability partner. However this is only approaching educational significance \( (d = 0.18) \).

These results suggest that – compared to when Highs and Mediums study as Individuals, or Mediums study with Lows or Equals – when Highs and Mediums constitute a pair, there may be comparatively more disagreements; hence, both partners suffer losses of perceived self-efficacy for being an Identifiable Team-asset. Disagreement may arise over Highs dominating the task or criticizing Mediums, or from Mediums challenging Highs. For Mediums, pairing with a High ability partner also appears to be less favourable as compared to pairing with a Low or equal ability partner. Mediums increase their self-efficacy for being an identifiable team asset when paired with a Low compared to being paired with a High, probably because they have most to offer when the partner is of Low ability. Even when Mediums are paired with Equals, they gain on this factor compared to being paired with Highs.

For the Low ability category, Lows studying with a Medium ability partner had educationally significantly greater mean gains than those studying with a High ability partner, who had mean losses \( (d = 0.20) \). This may be explained by Lows having a narrower proximal distance to a Medium partner than a High ability partner. This in turn may result in having more opportunities to contribute to the team goals and possibly receiving comparatively more support from Medium partners who may empathise more due to awareness of their own fallibility.
5.3.2.3 Summary of Main Results/Discussion of Configuration 2:
Companionate Positive Influence

In summary, based on the main findings for Configuration 2, it can be argued that an equality of benefits from a cooperative exchange needs to be perceived in order for people to study together as Companionate Positive Influence. And this perceived equality of benefits from a cooperative exchange can be influenced by proximal distance in ability pairing, with closeness in proximity appearing effective as well as LB-Rewards affecting the balance.

Rewards are observed to have an unclear effect on the quality of cooperative exchanges for equal-ability pairs. For Equal ability pairs, they can do the maths task without much need for each other’s assistance, and LB-Rewards appear to sometimes be enhancing and at other time be detrimental. They appear to encourage Cooperative Factor 3 – Good Influence, possibly by encouraging students to make more than the usual effort to check their work. The LB-Rewards appear to be detrimental to Cooperative Factor 6 – Identifiable Team-asset, possibly because they lead to unwanted offers of assistance and unwelcome companionship, and negative reactions to such efforts could reduce Equals’ perceived self-efficacy to be a Companionate Positive Influence.

In addition, proximal distance in ability pairings may also affect the self-efficacy of Companionate Positive Influence. In general, similarity as Equals, or a relatively narrow proximal distance (e.g., Lows paired with Mediums) seem the most effective ability pairings for the factors in this learning dimension. It does seem as if Equals are not ordinarily motivated to try to influence each other, and therefore LB-Rewards may act as an incentive for students to actively cooperate, or even as compensation for what they may perceive as a nuisance. Proximal distance for Lows with Mediums rather than with Highs may allow partners a sense of similarity, and crucially may provide the less competent peer
with a better chance to contribute to the task at hand, allowing for effects of Companionate Positive Influence to occur.

5.3.3 Configuration 3: Individualistic Attitudes Development

5.3.3.1 Preview of Configuration 3: Proudly Independent

Configuration 3 pertains to the learning dimension of “Individualistic Attitudes Development” comprising two factors: Individual Factor 5 - Proudly Independent, and Individual Factor 6 - Self-empowering. The main premise of Configuration 3 is that sometimes cooperative learning is a vehicle for students to study with peers to develop attitudes that may enhance their capacity for individual learning. (NB: The gains made by Low ability students in the factors for this configuration can be taken on face value as being worthwhile, whereas gains made by High ability students are somewhat ambiguous in value.) The main findings for Configuration 3 are that ‘Individual Attitudes Development’ may be motivated by an exchange of recognizably distinctive contributions, such as expertise by a ‘donor’ and conferred status by a ‘recipient’, which may be affected by proximal distance of partners’ relative ability, and by LB-rewarding.
5.3.3.2 Main Results/Discussion of Configuration 3: Individualistic Attitudes Development

5.3.3.2.1 Individual Factor 5 – Proudly Independent

![Figure 5.15](image)

Figure 5.15 Mean Individual Factor 5 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)

Analysis of the first factor of Configuration 3, Individual Factor 5 - Proudly Independent, indicated that Individual No-LB-Rewards had statistically and educationally significantly greater mean gains than Individual LB-Rewards, who had mean losses ($p < .018; d = 0.34$; See Figure 5.15). Comparisons of extrinsic and intrinsic rewards to explain the failure of LB-Rewards would not be fully relevant to this result because academic rewards were offered in all learning conditions.

A second main finding is that Individual No-LB-Rewards had statistically and educationally significantly greater mean gains that Equal No-LB-Rewards who had mean losses ($p < .018; d = 0.25$, See Figure 5.15). It makes intuitive sense that, regardless of LB-
rewards, Individuals have more opportunity to be responsible for their own work and, hence, are more likely to develop gains on being Proudly Independent as compared with Equals, which is a cooperative condition. Additionally, Equal LB-Rewards had educationally significantly greater mean gains than Individual LB-Rewards who had losses ($d = 0.23$); suggesting that LB-Rewards may enhance/promote being proudly independent amongst Equals. Conceptually, this difference may be psychological – for example, amongst Equals whose learning condition demands that they avoid studying independently of each other, being of similar ability may make them see it as futile and therefore they value independent learning. The losses for Individuals in LB-rewards conditions may be related to their experience of alternative routes to rewards, and although they have no experience of cooperation, they may consider it in a positive light, thus reducing the pride they place in studying independently.

![Figure 5.16](image)

**Figure 5.16** Mean Individual Factor 5 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)

The analysis was conducted for each ability category for Individual Factor 5. From the Low ability category, the results indicated that Low ability students studying with a
High ability partner or an Equal had educationally significantly greater mean gains as compared to Lows studying alone (with effect sizes $d = 0.33$ and $d = 0.21$, for each comparison, respectively). In addition, Lows paired with a High ability partner had educationally significantly greater mean gains than those studying with a Medium ability partner ($d = 0.22$).

From the Medium ability category, there was a trend towards Mediums paired with a Low ability partner having greater mean gains than Mediums studying alone, but this result was only approaching educational significance ($d = 0.19$). The results from both the Low and Medium ability categories suggest that the more competent partner (i.e., the Medium with the Low, or the High with either the Medium or the Low ability partner) may feel they would take more pride in studying alone, which could be a disillusioned reaction to having had to help a less competent partner.

5.3.3.2.2 Individual Factor 6 – Self-empowering

Figure 5.17 Mean Individual Factor 6 Gain Scores for All Experimental Conditions (error bars represent 95% confidence intervals)
Analysis of the final factor in Configuration 3, Individual Factor 6 – Self-empowering, indicated that Equal No-LB-Rewards had statistically and educationally greater mean gains than Individual No-LB-Rewards who had mean losses ($p < .018; d = 0.29$), and than Equal LB-Rewards ($p < .018; d = 0.22$), and than Mixed No-LB-Rewards ($p < .018; d = 0.21$) (See Figure 5.17). In addition, Individual LB-Rewards had educationally but not statistically significantly greater mean gains than Individual No-LB-Rewards ($d = 0.27$). It also appears that Individual LB-Rewards had greater mean gains than Equal LB-Rewards; however, this was only approaching educational significance ($d = 0.19$).

This factor, Self-empowering, can be described as individualistic in that the goal is to persevere to solve problems alone even in the face of failure. Rewarding learning behaviour appears different in Individual versus Equal conditions. Offering LB-Rewards to Individuals increases their self-efficacy in this individualistic factor of being self-empowering. However, this is not true for Equals when they are offered LB-Rewards. A possible explanation is that, what Equals are rewarded for is helping each other (arguably, excessively); and that excessive helping behaviour is antithetical to individualistic goals of being self-empowering. Therefore, the LB-Rewards for cooperative learning behaviours may encourage Equals to take losses in this factor.
The analysis of the ability categories in Individual 6 (See Figure 5.18), indicated that in the High-ability category, High ability students studying with a Medium ability partner had educationally significant mean gains as compared to those studying alone ($d = 0.33$), or with another High- ($d = 0.28$), or with a Low-ability partner ($d = 0.22$). For the Medium ability category, Mediums studying with a Low ability partner had educationally significantly greater mean gains than those studying with a High-ability partner ($d = 0.21$).

It would appear that studying with a slightly weaker partner enhances self-efficacy to study alone in the face of failure. It needs to be pointed out that the ‘Self-empowering’ factor was developed from Bandura’s theories of phobias, and will have the most relevance to Low-ability students. Aspects of the factor (i.e., of not worrying much about failure) may be less functional for Medium or High-ability students.

For the Low ability category, Lows studying alone have greater mean gains than those studying with an Equal, who had mean losses ($d = 0.32$); and than those studying
with a Medium at approaching educationally significant levels \( (d = 0.18) \). Correlational analysis using gain scores amongst dependent variables (MWPS, SDQ-I Maths, SDQ-I Peer and 12 SLQ factors) indicated that for Low Individuals, gain scores on Individual Factor 6 correlate positively at moderate levels with gain scores on MWPS \( (r(15)=.53, p <.05) \). In contrast, gain scores on Individual Factor 6 correlate negatively at a moderately low levels with gain scores on SDQ-I Maths \( (r(9)=-.49, n.s.) \). These results suggest that Lows gain more when studying alone than when studying with an equal, and changes on the Self-empowering factor are positively related to gains on Mathematics performance. It is unclear what the negative correlations for Low Individuals between gain scores in the Self-empowering factor and SDQ-I Maths (Maths Self-concept) would suggest, but it is likely that problems highlighted previously about the SDQ-I Maths measure also apply to these results (See sections 3.4.2.2.2 and 4.1.4 in Study 1, and 4.4.3.2 in Study 2a).

However, when Lows are paired with Highs, correlational analysis indicates that gains on Individual Factor 6 are moderately negatively related to gains on SDQ-I Peer \( (r(11)=-.67, p <.05) \). This result suggests a decrease in the quality of peer relations may be associated with increased confidence in one’s ability to do better alone (and vice versa). This result is ambiguous to interpret: It could either be a desirable outcome for encouraging a student’s Self-empowerment, or it could be a concerning outcome based on disillusionment with the cooperative learning experience.

In addition, for Lows paired with High ability partners, it is noted that gain scores on Individual Factor 6 – Self-empowering are moderately highly correlated with gain scores on Individual Factor 5 - Proudly Independent, \( (r(11)=.75, p<.01) \); and with gain scores on Cooperative Factor 4 - Team-oriented, \( (r(11)=.72, p<.05) \). These results suggest that, for Lows in this pairing, losses or gains in Self-empowerment are related to losses or gains on being ‘Proudly Independent’ and ‘Team-Oriented’. A conceptual level of
explanation points towards these factors all appearing to have a common attitude of striving individually. This striving has varied directions for each factor; namely, to contribute towards one’s own perseverance, towards individual problem-solving, and towards the team outcome. Therefore, it would seem as if the likely success for Lows paired with Highs will be related to the extent to which they can share the same attitudes about individual striving. It can be surmised that similarity in this regard may allow for an attraction where Highs will help Lows in a supportive peer-tutoring relationship; whereas difference leads to repulsion where Highs will criticize or ignore Lows in an ineffective and detrimental relationship.

5.3.3.3 Summary of Main Results/Discussion of Configuration 3: Individualistic Attitudes Development

In summary, from the general patterns of results for Configuration 3’s factors, it is evident that sometimes the real value of cooperative learning is not so much an end in itself, but rather it can be a vehicle for some students to be helped by peers to build skills and attitudes that may later be useful to their individual learning. An important point to note is that gains made by Low ability students can be taken on face value as being desirable outcomes, whereas the applicability of these factors to High ability students is somewhat ambiguous. As such, these factors for the learning dimension of ‘Individualistic Attitudes Development’ appear to be successful in conditions where peer-tutoring activities can occur, with less competent students benefiting from guidance by more competent students. Configuration 3’s main finding is that, for the least skilled partner to be successfully inducted into developing appropriate individualistic attitudes, a wide proximal distance of partners’ relative ability can allow for an effective exchange of distinctive contributions to
the paired relationship, where expert support by the ‘donor’ (tutor) is exchanged for status recognition and cooperation by the ‘recipient’ (tutee).

5.3.4 Configuration 4: Social-emotional Endeavour

5.3.4.1 Preview of Configuration 4: Social-emotional Endeavour

Configuration 4 pertains to the learning dimension of “Social-emotional Endeavour”. It comprises three factors: Individual Factor 3 - Resilient Self-worth, Cooperative Factor 5 - Socially-confident Problem-solver, and Cooperative Factor 4 - Team Oriented. Configuration 4 proposes that learning involves several social-emotional factors. In addition, it proposes that students at different ability levels may place different values on their own learning and on cooperation, which cause different reactional biases to the academic maths tasks, the interpersonal relationships amongst peers, and the intrapersonal feelings of individual students.
5.3.4.2 Main Results/Discussion of Configuration 4: Social-emotional Endeavour

5.3.4.2.1 Individual Factor 3 – Resilient Self-worth

![Figure 5.19 Mean Individual Factor 3 Gain Scores for High-, Medium- and Low-Ability Categories (error bars represent 95% confidence intervals)](image)

For Configuration 4’s first factor, Individual Factor 3 - Resilient Self-worth, analysis suggests that in the High-ability category (See Figure 5.19), Highs studying with Medium ability students had educationally significantly greater mean gains than those studying with Lows, who had mean losses ($d = 0.28$). Highs studying alone also had educationally significantly smaller mean losses than those studying with Lows ($d = 0.21$). It is also noted that Highs studying with an equal ability partner had smaller mean losses than those studying with a Low ability partner at approaching educationally significant levels ($d = 0.18$). These results, where it is Highs who have losses, seem paradoxical given that this factor is the closest to describing “self-efficacy” which is generally considered to be critical.
to successful learning. Some of the items for this factor encapsulate avoiding learning phobia by not worrying overly about failure. The losses by Highs may indicate that typically their attitude towards failure, whilst not phobic, is greater than average concern about it. In fact, that may be how Highs motivate their high levels of effort that result in maintaining above average performance.

For the Low ability category (See Figure 5.19), Lows studying with Medium ability partners had educationally significantly greater mean gains than those studying with Highs, who had mean losses ($d = 0.23$). This result would suggest that if the goal is for Lows to increase in Resilient Self-worth, it is more likely with a Medium ability partner than with a High ability partner.

For the Medium ability category (See Figure 5.19), a trend is noted where Mediums studying with an equal ability partner appear to have greater mean gains than those studying with a Low ability partner, who had mean losses at levels approaching educational significance levels ($d = 0.18$). This result would suggest that Mediums have a lower Resilient Self-worth when paired with a less competent peer than when studying with an equal. It is important to note that the pairing of Mediums and Lows affects this factor by being beneficial for Lows but risky for Mediums.

Correlational analysis using gain scores amongst dependent variables (MWPS, SDQ-I Maths, SDQ-I Peer and 12 SLQ factors) indicated that for Lows studying with another Low ability partner, there were moderate relationships between gain scores in Individual Factor 3 Resilient Self-worth and gains scores in the following three factors:

Individual Factor 1 - Loafing Resistant ($r(22) = .63, p < .01$);
Cooperative Factor 2 - Person-focused Leader ($r(22) = .54, p < .01$); and
Cooperative Factor 5 - Socially-confident Problem-solver ($r(22) = .61, p < .01$).
These results indicate that for Lows of Equal ability, there is a relationship between gain scores on Resilient Self-worth and gains scores on Loafing Resistant, Person-focused Leader and Socially-confident Problem-Solver; this may be explained as all of these factors entailing applications of a constructive attitude towards learning.

5.3.4.2.2 Cooperative Factor 5 - Socially-confident Problem-solver

Analysis of Configuration 4’s second factor, Cooperative Factor 5 - Socially-confident Problem-solver, indicates that for the High ability category, High ability students studying Individually, or with another High ability student, had educationally significantly greater mean gains than those studying with Mediums ($d = 0.23$; and $d = 0.24$, respectively). Highs studying with Lows appeared to have lesser mean losses compared
with Highs studying with Mediums at approaching educationally significant levels ($d=0.19$).

For the Low ability category, Low studying with another Low ability partner had educationally significantly greater mean gains: than those studying Individually ($d=0.34$), than with a High-ability partner ($d=0.22$), and than with a Medium-ability partner ($d=0.34$). Hence, Lows studying with an equal had the most gains in Socially-confident Problem Solver. Lows studying with a High-ability partner also had educationally significantly greater gains than those studying with a Medium-ability partner; who appeared to have mean losses ($d = 0.21$). The order of most gains for the Low ability category is as follows: Lows studying with another Low; Lows studying with a High-ability peer; Lows studying individually and Lows studying with a Medium-ability peer.

For Highs or Lows, it is observed that the Socially-confident Problem-solver factor increases the most when paired in conditions when the partner is either at their own ability level (i.e. Equal Highs or Equal Lows), or in Mixed pairings where the partners have a wider ability difference (i.e., Highs and Lows paired together rather than being paired with Mediums which would be a narrower ability difference).
5.3.4.2.3  Cooperative Factor 4 - Team-oriented

Figure 5.21  Mean Cooperative Factor 4 Gain Scores for All Experimental Conditions
(error bars represent 95% confidence intervals)

For the final Configuration 4 factor, Cooperative Factor 4 - Team Oriented, analysis
indicates that Individual No-LB-Rewards had educationally significantly greater mean
gains than Mixed No-LB-Rewards who had mean losses ($d=0.26$; See Figure 5.21). The
result suggests that for Individuals taking part in the learning programme especially if not
rewarded can give them a positive idea of their self-efficacy in team work, even though that
idea is not based in experience. For Mixed, it may be that the experience of studying in a
pair when there are no learning behaviour rewards (i.e. no incentives to help each other)
can decrease Team Orientation. A possible explanation is that Mixed students can find
cooperation and trying to relate to someone on a “different wavelength” difficult, and
consequent disillusionment from experiencing difficulties may affect the extent to which
students care about their partner’s learning outcomes.
The analysis conducted for each of the ability categories (see Figure 5.22) indicates that for the High ability category, Highs studying alone had educationally significantly greater mean gains than those studying with a Medium who had losses ($d = 0.38$). In addition, Highs studying with a Medium had losses that were educationally significantly different to the gains for those studying with an equal ability partner ($d = 0.21$). It also appeared that Highs studying with a Medium ability partner had different mean gains scores (losses) from those studying with a Low ability partner (slight losses) at approaching educational significance ($d = 0.17$). Therefore, in the High-ability category, Highs studying with Mediums appear to have the worst outcomes for Team-Oriented, in the form of losses.

Two trends were also noted for Medium and Low ability categories. Mediums studying alone appeared to have greater mean gains than those studying with a High ability partner who appeared to have mean losses at approaching educationally significant levels ($d$
There is also the suggestion that Lows studying with another Low had greater mean gains than those studying with a Medium ability partner, who had mean losses at levels approaching educational significance ($d = 0.17$).

The results for cooperative conditions would be the most relevant to understanding the effects of this factor. Those results indicate that when Highs and Lows are paired with Mediums they suffer losses of Team Orientation, but if paired with each other, this is less of a problem, and Lows may have some benefit from being paired with Equals.

Correlational analysis using gain scores amongst dependent variables (MWPS< SDQ-I Maths, SDQ-I Peer and 12 SLQ factors) indicated that there were moderately strong positive relationships between gain scores in Cooperative Factor 4 - Team Oriented and Individual Factor 6 - Self-empowering for:

- Highs studying with Low ability partners ($r(15) = .72, p < .01$); and
- Lows studying with High ability partners ($r(11) = .72, p < .01$).

Correlational analysis also indicated that there is a moderate positive relationship between gain scores in Cooperative Factor 4 and Cooperative Factor 2 - Person-focused Leader for:

- Mediums studying with High ability partners ($r(21) = .63, p < .01$); and
- Mediums studying with Low ability partners ($r(22) = .62, p < .01$).

These correlations are central to the argument about how Configuration 4 for “Social Emotional Endeavour” may function. In the Team Oriented factor, the first two of these correlational results suggest that for both Highs and Lows there is a positive relationship between Team Orientation and a task-focused factor of Self-empowering (i.e. an attitude conducive to task persistence). The second two of the correlation results suggest
that for Mediums there is a positive relationship between Team Orientation and a person-focused factor of Person-focused Leader (i.e. being able to constructively communicate each other’s learning needs). Since being Team Oriented requires the combination of both foci, in wanting good results and caring about the outcomes for a partner, this pattern is a noteworthy finding suggesting attitudinal differences amongst ability levels.

In addition, correlation analyses also indicate that there is a moderate relationship between gain scores on Cooperative Factor 4 - Team Orientation and Individual Factor 5 - Proudly Independent for Lows studying with Medium-ability partners ($r(16)=.60, p <.05$). Also, for Highs studying with Medium-ability partners, gain scores on the Cooperative Factor 4 correlate moderately with gain scores on the SDQ-I Peer (Peer Self-concept) ($r(18)=.62, p <.01$).

Both correlations are observed where there are narrow-ability–pairings (i.e., close proximity of Low with Medium, and High with Medium). The relationship between gain scores on Team Orientation and gain scores in Proudly Independent for Lows studying with Mediums suggest that the partnership works best when the Low and Medium ability partners have the correct attitude which may contribute to the team outcome as well as optimize their own development (or vice versa). The results also indicate that for Highs studying with Mediums there is a relationship between Team Orientation and Peer Self-concept. This suggests that there is a relationship between caring about the team outcomes and the level of respect by a slightly less or more competent partner (or vice versa).

### 5.3.4.3 Summary of Main Results/Discussion of Configuration 4:

**Team-oriented**

In summary, based on the main findings for Configuration 4, it is evident that learning involves several social-emotional factors and that students at different ability
levels may place different values on their own learning and on cooperation, which cause

different reactional biases to the academic maths tasks, the interpersonal relationships
amongst peers, and the intrapersonal feelings of students. For instance, when High and Low
students study with each other, there is a relationship between Team Orientation and Self-
empowerment. In comparison, when Mediums study with a High or a Low ability partner,
their Team Orientation appears to be related to Person-focused leadership. Hence, Highs
and Lows appear to be more task-focused in their approach to cooperation with each other;
while Mediums tend to be more person-focused when studying with a High or a Low
ability partner.

More broadly, it also appears that Configuration 4 - Social-emotional endeavour is
an important dimension of learning that is particularly shaped according to prior MWPS
ability. The finding points towards the possibility that specific ability pairings can optimize
negotiation between cooperative partners over approaches to the academic tasks and the
development of their interpersonal relationship. However, attitudinal and reactional biases
(that may be pre-existing or an effect of their learning conditions) may work to differentiate
between students in High, Medium and Low ability categories and maintain the differences
in ability levels.
5.4  Summary of Major Theoretical Points and Relation to Previous Literature

The SLQ-Alone-&-Partnered solved factor analysis will be developed as a new theory of cooperative learning. However, it is worth reiterating that the SLQ measure was derived from the cooperative and individual learning scales that were derived from parallels to the Johnson and Johnson team’s model of cooperative learning, called “Learning Together”. That model stipulates that there are five essential elements for cooperation: Positive interdependence, individual accountability/personal responsibility, face-to-face promotive interaction, interpersonal and small group skills, and group processing (Johnson, Johnson & Holubec, 1994). The present study has attempted to gain greater insight into the motivational dynamics of learning conditions (especially reward and ability structures) as well as students’ effects on each other (according to ability and ability pairing).

One of the aims concerning learning conditions was to examine the similarities and differences between cooperative and individual learning. A notable pattern in the SLQ-Alone-&-Partnered results, which has theoretical importance, is that pre-post changes were not confined to the learning condition to which students had been assigned. That is, cooperative learning appeared to have affected students’ self-efficacy for individual learning, which would support any hope that peer support will lead to some useful transfer of appropriate skills and attitudes (even though not all of the changes on the individual-learning scale were gains). Likewise, individual learning conditions appeared to have affected children’s self-efficacy for cooperative learning – however, such an occurrence is not a topic in the field and is therefore more difficult to explain. One possibility is that gains or losses in general may transfer between a student’s perceived self-efficacy ‘for helping oneself’ to perceived self-efficacy for ‘helping a partner’. The programme’s
structure explicated maths problem-solving skills, possibly boosting Individuals’ confidence that they would then know with greater clarity what a partner may need to learn. Another possibility is that an increase in student’s self-efficacy for one learning style may be countered by losses in self-efficacy in the other learning scale, especially if the factors define qualities that may seem opposing (such as ‘Proudly Independent’ and ‘Team Oriented’).

The new theory of cooperative learning will be explicated in this section. The theory is “Incentives-values–exchange”, and it is a speculative overview of cooperative learning that draws from some basic social psychology concepts to develop a set of broad explanatory configurations to theorise the complex findings of the SLQ Solved Factor Analysis. It will be argued that, when students study cooperatively, they need to perceive not only that the learning conditions are profitable to themselves, but also that there is an element of equity between the contribution values of partners. Learning behaviour rewards can be offered in some cases as an incentive to enhance students’ willingness to help each other and maintain reasonable attitudes towards peers; although, sometimes offering learning behaviour rewards as incentives can be de-motivating. These potential ‘wins’ and ‘losses’ for students occur to a large extent because learning has several dimensions to its outcomes. This is true of individual learning as well as of cooperative learning. This study classifies those dimensions as ‘Individual Endeavour’, ‘Companionate Positive Influence’, ‘Individualistic Attitudes Development’, and ‘Social-emotional Endeavour’.

‘Individual Endeavour’ is highly important for both the Individual- and the Cooperative-learning scales, and this finding is a step towards overcoming the theoretically problematic false dichotomy of Individual vs Social noted to be prevalent even in social-cognitive models of learning processes (Anderson et al., 1997; Karmiloff-Smith, 1995). It would seem that an essential part of successful learning is for students to not be distracted
by others to the point of reducing their own effort. What successful students need to avoid in maintaining their individual endeavour differs slightly for Individual and Cooperative conditions. Classes set up for individualistic learning are still social contexts, and it seems that a student might ‘Loaf’ if others are not working, or might ‘Free-ride’ by actively looking at someone else’s answers, generally in the form of “cheating”. In classes where students are paired, these sorts of detractions from their own effort might happen more often through the normal interactions, whereby redundancy of effort in a pair may lead to turn-taking or ‘Free-riding’ which then is de-motivating for the partner who responds by ‘loafing’. Less competent partners in mixed ability groups would appear most vulnerable to this problem. Previous literature has noted that cooperative learning programmes that do not demand improvements by all individuals tend to be ineffective (e.g., Slavin, 1977).

In light of the Incentives-values–Exchange theory, it would seem that rewarding individuals for learning behaviour is a form of over-rewarding, evident from cross-referencing to Study 2a’s findings of losses in MWPS. In cooperative conditions, it appears that learning behaviour rewards do have an effect. Amongst Equals, who ordinarily would not benefit much from their partner’s help due to being at the same ability level, using LB-Rewards seems to be less effective for Loafing-Resistant and Free-riding resistant factors than when such rewards are not used. Thus, it would seem that these Equals students do exchange ‘help’ such as checking work when they are rewarded for doing so, and quite possibly the additional interactions can lead to overall slight improvements in MWPS results; but it comes at a cost to their self-efficacy in the Individual Endeavour learning dimension. However, for Mixed conditions, although the temptation to rely on a more competent partner’s efforts would seem greater, it would also appear that LB-Rewards can be used to achieve comparatively better outcomes for the factors of Conscientious Worker, Loafing-resistant and Free-riding Resistant. Here, it may be that rewards act as incentive
for less competent partners to make the effort individually because the rewards are sufficient incentive not to use another’s efforts. The rewards may also be an incentive for the more competent peer to allocate the necessary time to ensuring that their partner does maintain their own effort and to build up their partner’s confidence about doing so. Thus, if time spent cooperating with a partner is considered to be a threat to the more competent partner’s academic merit awards, then it is probable that hurrying the less competent partner by giving them answers could reduce that threat; but on the other hand, learning behaviour rewards might serve to reduce any concerns about the person costs of helping someone else.

Another learning dimension is ‘Companionate Positive Influence’. This comprises several factors whereby a student makes learning better for their partner. The finding for these factors is that it is difficult to discern a pattern but ability structure may play a part in the strongest findings. It would seem that for Equals, rewarding does help to improve self-efficacy for being a ‘Good Influence’, but this is converse to the results for being an ‘Identifiable Team-asset’. The Incentives-values–Exchange theory would explain this as possibly being due to rewards encouraging Equals to urge their partners to check work, without being convinced that they need to, with the gains being quite small since they are not equipped to help them progress much in problem-solving; and the interactions, by seeming futile, having the effect of them sensing themselves to be perceived by their partner as a nuisance rather than an asset. The ability patterns seem to suggest that ‘friendship’ is part of the mechanism for this learning dimension. For some of the factors, it is helpful to be close in ability to a partner, such as Mediums with a Low, and Lows with a Medium, can be an identifiable Team-asset; and Equal Mediums is beneficial for Person-focused Leader and Good Influence factors. For those results, it would seem as if the influence is motivated by similarity in outlook rather than one partner’s expertise. Another
more surprising result is that for Lows, being paired with a High is beneficial for Person-focused Leader and Good Influence factors. Since this is not the case for Highs paired with Lows, it would seem that again something more than expertise is needed to explain this result. It would seem as if the High ability student must be engaging the Low ability partner to feel that they are assisting them. Incidentally, that may be a good ‘teaching’ strategy, e.g. providing opportunities for elaboration of problem-solving (e.g., Webb, 1989, 1991). For, the Incentives-values-Exchange theory, there is no obvious mutual benefit, and it may be that its effectiveness is related to an aspect that was not measured, such as perceived ‘likeability’ of the less competent partner, or ‘helpful disposition’ of the more competent peer. Enjoyment of being with the partner and of encouraging another person may be what makes cooperation worthwhile.

This configuration for Companionate Positive Influence can be understood in relation to the historical background to cooperative learning programmes in the USA that were primarily developed with the goals of achieving social integration. The present trend in cooperative research and in the present study is to find optimal methods that can apply to any or to all students for increasing academic cognitive skills and increasing social-emotional affective skills. The interesting results of the present study of the effects of ability appear to corroborate the Team Games Tournament cooperative methods designed by DeVries and Slavin (1978) that included a variety of abilities in each group. Thus it would seem that something about companionship, (e.g., the subjective value of ‘friendship’), which may be relevant to the ‘Learning Together’ model’s element of Interpersonal Skills, is critical to explaining the motivational dynamics in the Companionate Positive Influence dimension.

The configuration for the learning dimension of ‘Individualistic Attitudes Development’ is one where it would appear most beneficial to Low ability students,
especially those who need to be inducted to not give up trying. In the Self-empowering factor this means persevering even in the face of failure, and in the Proudly-independent factor this means valuing persevering with one’s own effort even though a partner’s effort might attract better grades. It does appear that proximal distance in ability between partners plays a part in the motivational dynamics. Highs helping Lows appears to be beneficial for them being Proudly Independent, as does Lows working together. An explanation is that Highs are best positioned to induct Lows into this learning attitude, and what motivates them is that they place a great value on this quality which it is rewarding to pass on to others; and that with another Low partner there is the highest motivation in pairings to not rely on the partner’s efforts so that valuing being Proudly Independent makes sense in those conditions.

Self-empowering is a factor in which Lows appear to benefit when working individually. It may be that making comparisons of the self with others heightens any sense of failure. Additionally, more competent partners may finish their maths problems sooner thus having the effect of emphasizing the ability difference and opening up opportunities (and even pressures) to give up or ‘free-ride’. The dynamic in learning conditions can also affect the development of learning attitudes. Thus, in the Incentives-values–Exchange theory, motivation for a less competent peer to develop the right attitudes may rest upon the extent to which a more competent partner will allow the Low ability student to benefit only from persevering with their own efforts. For this learning dimension, mixed-ability pairings would need a strongly structured learning programme, as well as close monitoring to avoid its vulnerabilities. To explicate the main risk, Johnson and Johnson’s argument is a good explanation. Typically group members are motivated when effort does not need to be replicated and when the “actions [of more capable group members can be a] substitute for the actions of the less capable members” (1990, p. 30). In other words, there can be a
strong temptation to ‘carry’ a less capable partner. Additionally, Johnson and Johnson’s explanation can be used to infer that a weaker group member will not be motivated to put in effort if he or she considers that they are replicating a partner’s efforts. The Self-empowering factor is the one most central to the SLQ’s concerns with self-efficacy. That construct, as any psychological theory that claims to be predictive, is concerned with ‘potential’. A concern about some of the cooperative learning literature to inferences about potential for task-persistence is relevant to the point being made here, that cooperation can either enhance opportunities by providing support or can reduce the incentive for persistence. However, some studies that compare cooperative- and individual-learning by measuring students’ perceptions of the intervention’s difficulty levels or their positive or negative attitudes towards a subject, sometimes misinterpret findings of gains on these scores. That is, in studies where there may be no differences, or even comparative losses, in academic outcomes for cooperative-learning conditions, ‘gains’ such as student reports of finding the learning easier are sometimes interpreted as indicators of likely future success or improved self-efficacy – (e.g., Chin, Teh & Fong, 1988; Garton & Pratt, 2001). Such interpretations are not necessarily valid. While it stands to reason that if learning is easier or considered to be more interesting, then a student’s self-efficacy for success or persistence may increase; an alternative and more likely explanation of such perceptions is that students may find learning easier (or even more fun) because they were not learning as much as when they learned individually. That is, if students experience a partner substituting effort for them, this would indicate lost opportunities for their own skills development (as would be possible in the light of poorer test performances), and this is not likely to lead to increased potential for future success.

For an Incentive-values–Exchange to occur for Individualistic Attitudes Development, it would seem that success in cooperative conditions might depend on
partners placing a high value on “trying”, and that the incentives are the more competent partner’s expertise and support (in the form of not doing the problem-solving for the weaker partner) can be exchanged for the less competent students’ status-recognition and willingness to be guided by a partner.

The learning dimension of “Social-emotional endeavour” comprises affective factors such that it may be the cooperative learning scale’s counterpart to the previous dimension that has factors from the individual learning scale. Its factors, Resilient Self-worth, Socially-confident Problem-solver, and Team-oriented, have in common the ability to make interactions effective and not debilitating. For example, cooperative learning would be dysfunctional for a person who let studying with someone argumentative or comparatively more capable damage their sense of self-worth (unless it was already over-rated). Similarly, disagreements have to be used to constructively solve problems, rather than set up dysfunctional resentments. The results suggest that higher-ability partners may exchange a loss academically for an increase in peer self-concept, and lower-ability partners tend to exchange a gain academically for a decrease in peer self-concept. Lew, Mesch, Johnson and Johnson (1986) did a study on impact of reward contingencies for using social skills, as well as positive interdependence and a contingency for academic achievement on performance within cooperative learning groups. The results indicated that the combination of positive interdependence, an academic contingency for high performance by all group members, and a social skills contingency, promoted the highest achievement.

This study’s findings suggest that the Social-emotional Endeavour dimension of learning may depend upon prior MWPS ability, which elicits particular attitudinal and reactional biases. Specifically, it seemed that Highs and Lows had a task-focus, and Mediums had a person-focus. The Incentives-values–Exchange theory would explain this
as being functional. Highs could maintain their superior academic position by being focused on the task of solving the most difficult problems possible. The only option available to Lows to succeed is to focus on the task, moving beyond any phobias of failure, and avoiding allowing anyone to take over the task for them. This common set of directions or shared values might of itself be an incentive studying as a pair. Mediums have different circumstances. They may find it hard to stay focused on the task when working in mixed-ability pairs. Their own fallibility and uncertainty may make it difficult to keep a less competent partner on task, or pairing with a more competent partner may lead them to take on the role of admirer or flatterer. This could occur, either because Mediums do not aspire to being above average, or because they have to use interpersonal skills, such as offering friendship to Highs in exchange for their help, since Highs would find it comparatively harder to see improvements in a Medium than in a Low. As such, particular attitudes and attentional biases may set up a dynamic where social-emotion endeavour is expressed in specific ways that differentiates between students in High, Medium and Low ability categories. This then means that for a student to progress upwards, they have to double their effort. For Lows, not only do they have to work harder at the academic task to make progress, but once they attain the academic levels of Mediums they have to also learn different ways of getting help from partners. Similarly, for Mediums aspiring to High levels of academic achievement, having reached there by using interpersonal skills to invite support, they would then have to become task-focused to maintain their position, rather than expend too much effort working on developing friendships with less competent peers. These differences would function to erect barriers between the ability levels, and generally stabilize and maintain the overall ability levels amongst students.

What the theory of Incentives-values–Exchange achieves is an overview of the learning field as comprising four distinctive dimensions. It goes beyond the Learning
Together model that lists processes of cooperation, which are sometimes stages, to emphasise aspects that have recently been neglected in other theories, namely ‘social’ and ‘values’. In relation to the learning dimensions, it describes four configurations that explain motivation in terms of changing self-efficacy that would account for the dynamics of learning behaviour rewards, ability pairing, and ability. It is a speculative theory which has synthesized the complex results of Study 2. The section which follows summarises the major applied points from the results.
5.5 Summary of Major Applied Points of Study 2a and Study 2b

Study 2b is an extra dimension of the Mathematics intervention study reported in Study 2a, and as such both studies are interrelated. Some of the analyses were exploratory: All analyses of Study 2a’s SDQ-I Maths (Maths Self-concept) measure; the analyses involving ability-categories of High, Medium and Low; and analysis of the 12 Factors from the SLQ-Alone-&-Partnered’ measure. Where the analyses are exploratory, the main application of the results has been forming a general overview of the dynamics of cooperative learning for theory building, but it has to be emphasised that the theory still needs further testing.

A summary of the results will be presented in a series of tables. To summarise major results for Study 2a, the tables will show each dependent variable (MWPS, SDQ-I Maths and SDQ-I Peer) for each ability category (see Table 5:19) and then for each experimental condition (see Table 5:20). To summarise major results of Study 2b, the tables will show each dependent variable (four configurations of learning dimensions which group twelve individual- and cooperative-learning factors) for each ability category and then for each experimental condition (see Table 5:21 to 5:28).

The tables will indicate conditions in which changes in their gain scores were notably different to other conditions (see previously reported statistical analyses). The scores may have various levels of significance in the results. Findings of statistically or educationally significant differences between conditions are shown as: those conditions with the best outcomes for the independent variable (usually highest gains, and some least losses) are classified as ‘Strong Potential for Beneficial Outcomes’ and are colour-coded red; and those conditions with the worst outcomes (usually least gains or highest losses) are classified as ‘Strong Potential for Risky Outcomes’ and are colour-coded blue. Findings of
trends for differences between conditions are shown as: those conditions with the best outcomes are classified as ‘Weak Potential for Beneficial Outcomes’ and colour-coded Yellow, and with the worst outcomes classified as ‘Weak Potential for Risky Outcomes’ and colour-coded Green. Where there were no apparent gains or losses, the classification is ‘Neutral – No Apparent Potential for Beneficial or Risky Outcomes’ colour-coded Grey.

A limitation of these representations is that the classifications only indicate whether there is a difference between conditions. Amongst those differences, the best are not always gains (i.e., they may indicate no mean changes or least mean losses vs most mean losses), and the worst are not always losses (i.e., they may indicate least mean gains, or no mean changes). Furthermore, because they are based on differences between conditions found in pairwise comparisons, if stand-alone pre-post- gain scores were considered there is no way of knowing whether or not for those changes there are high levels of certainty (95% confidence).
Table 5:19.

**Potentially Beneficial and Risky Outcomes for MWPS, SDQ-I Maths and SDQ-I Peer for Each Ability Category (Results of Study 2a)**

<table>
<thead>
<tr>
<th></th>
<th>High-Ability</th>
<th>Medium-Ability</th>
<th>Low-Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ind Paired With</td>
<td>Ind Paired With</td>
<td>Ind Paired With</td>
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<tr>
<td></td>
<td>High Med Low</td>
<td>High Med Low</td>
<td>High Med Low</td>
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<td>MWPS</td>
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<tr>
<td>SDQ-I Maths</td>
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<tr>
<td>SDQ-I Peer</td>
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</tbody>
</table>

Note: Ind = Individuals

**Colour Key:**

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**

- **Weak Potential for Beneficial Outcomes (Based on Trends)**

- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**

- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:20.

Potentially Beneficial and Risky Outcomes for MWPS, SDQ-I Maths and SDQ-I Peer for Each Experimental Condition (Results of Study 2a)

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
<th>Equal</th>
<th>Mixed</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No-LB-Rewards</td>
<td>LB-Rewards</td>
<td>No-LB-Rewards</td>
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<tr>
<td>MWPS</td>
<td></td>
<td></td>
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<tr>
<td>SDQ-I Maths</td>
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<tr>
<td>SDQ-I Peer</td>
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</tbody>
</table>

Colour Key:

- **Red**: Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)
- **Yellow**: Weak Potential for Beneficial Outcomes (Based on Trends)
- **Blue**: Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)
- **Grey**: Neutral – No Apparent Potential for Beneficial or Risky Outcomes
Table 5:21.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 1: Individual Endeavour for Each Ability Category (Results of Study 2b)

<table>
<thead>
<tr>
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<th>Medium-Ability</th>
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<th>Low-Ability</th>
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</thead>
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<td></td>
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<td>Paired With</td>
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<td>High</td>
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<td>High</td>
<td>Med</td>
<td>Low</td>
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<tr>
<td>Cooperative</td>
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<tr>
<td>Factor 1:</td>
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<tr>
<td>Conscientious</td>
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<tr>
<td>Worker</td>
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<td>Individual</td>
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<tr>
<td>Factor 1:</td>
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<tr>
<td>Loafing</td>
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<tr>
<td>Resistant</td>
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<td></td>
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<tr>
<td>Individual</td>
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<td>Factor 4:</td>
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<td>Free-riding</td>
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<tr>
<td>Resistant</td>
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<tr>
<td>Individual</td>
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<tr>
<td>Factor 2:</td>
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<tr>
<td>Self-motivated</td>
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</tr>
</tbody>
</table>

Note: Ind = Individuals

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Risky Outcomes (Based on Trends)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:22.
Potentially Beneficial and Risky Outcomes for Factors in Configuration 1: Individual Endeavour for Each Experimental Condition (Results of Study 2b)

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
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<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No-LB-Rewards</td>
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<td>No-LB-Rewards</td>
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<tr>
<td>Cooperative Factor 1: Conscientious Worker</td>
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</tr>
<tr>
<td>Individual Factor 1: Loafing Resistant</td>
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<td>[ ]</td>
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<tr>
<td>Individual Factor 4: Free-riding Resistant</td>
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<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Individual Factor 2: Self-motivated</td>
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<td>[ ]</td>
</tr>
</tbody>
</table>

Colour Key:
- Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)
- Weak Potential for Beneficial Outcomes (Based on Trends)
- Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)
- Weak Potential for Risky Outcomes (Based on Trends)
- Neutral – No Apparent Potential for Beneficial or Risky Outcomes
Table 5:23.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 2: Companionate

Positive Influence for Each Ability Category (Results of Study 2b)

<table>
<thead>
<tr>
<th>Factor 2: Person-focused Leader</th>
<th>High-Ability</th>
<th>Medium-Ability</th>
<th>Low-Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ind</td>
<td>Paired With</td>
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</tr>
<tr>
<td></td>
<td>High</td>
<td>Med</td>
<td>Low</td>
</tr>
<tr>
<td>Cooperative Factor 3: Good Influence</td>
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<tr>
<td>Cooperative Factor 6: Identifiable Team-asset</td>
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</table>

Note: Ind = Individuals

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:24.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 2: Companionate Positive Influence for Each Experimental Condition (Results of Study 2b)

<table>
<thead>
<tr>
<th>Cooperative Factor 2: Person-focused Leader</th>
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<td>No-LB-Rewards</td>
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<td>No-LB-Rewards</td>
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<tr>
<td>Cooperative Factor 3: Good Influence</td>
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<tr>
<td>Cooperative Factor 6: Identifiable Team-asset</td>
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</tr>
</tbody>
</table>

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:25.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 3: Individualistic Attitudes Development for Each Ability Category (Results of Study 2b)

<table>
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<th>High-Ability</th>
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<td>Individual Factor 5:</td>
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</tbody>
</table>

Note: Ind = Individuals

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Risky Outcomes (Based on Trends)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:26.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 3: Individualistic Attitudes Development for Each Experimental Condition (Results of Study 2b)

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
<th>Equal</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No-LB-Rewards</td>
<td>LB-Rewards</td>
<td>No-LB-Rewards</td>
</tr>
<tr>
<td>Individual Factor 5: Proudly Independent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Factor 6: Self-empowering</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:27.

Potentially Beneficial and Risky Outcomes for Factors in Configuration 4: Social-emotional Endeavour for Each Ability Category (Results of Study 2b)

<table>
<thead>
<tr>
<th></th>
<th>High-Ability</th>
<th></th>
<th>Medium-Ability</th>
<th></th>
<th>Low-Ability</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ind</td>
<td>Paired With</td>
<td>Ind</td>
<td>Paired With</td>
<td>Ind</td>
<td>Paired With</td>
</tr>
<tr>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Individual Factor 3:</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Resilient Self-worth</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Cooperative Factor 5:</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Socially-confident</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Problem-solver</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Cooperative Factor 4:</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
<tr>
<td>Team Oriented</td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
<td>High Med Low</td>
<td></td>
</tr>
</tbody>
</table>

Note: Ind = Individuals

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Beneficial Outcomes (Based on Trends)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Weak Potential for Risky Outcomes (Based on Trends)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
Table 5:28.
Potentially Beneficial and Risky Outcomes for Factors in Configuration 4: Social-emotional Endeavour for Each Experimental Condition (Results of Study 2b)

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
<th>Equal</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No-LB-</td>
<td>LB-</td>
<td>No-LB-</td>
</tr>
<tr>
<td>Rewards</td>
<td>Rewards</td>
<td>Rewards</td>
<td>Rewards</td>
</tr>
<tr>
<td>Individual Factor 3: Resilient Self-worth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative Factor 5: Socially-confident Problem-solver</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative Factor 4: Team Oriented</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Colour Key:

- **Strong Potential for Beneficial Outcomes (Based on Statistical/Educational Significance)**
- **Strong Potential for Risky Outcomes (Based on Statistical/Educational Significance)**
- **Neutral – No Apparent Potential for Beneficial or Risky Outcomes**
The following section will explicate how to use the results in Tables 5:19 to 5:28, that indicate optimal MWPS and Peer Self-concept outcomes, to locate information on the related benefits and risks in the 12 Individual- and Cooperative-Learning factors. Using the tables, steps in the general decision-making algorithm for each ability category are as follows:

1. Look for the potentially most beneficial ability-category for the primary concern(s) that needs to be addressed by the intervention; e.g., MWPS and SDQ-I Peer.

2. Identify the broad experimental condition to be used (i.e., Individuals, Equals or Mixed). For example, if the potentially beneficial ability-category is Lows paired with Highs, then the broad experimental condition will be ‘Mixed’.

3. Decide whether or not LB-Rewards are worthwhile.

4. List potential cost and benefits of LB rewarding or not rewarding based on the results for the experimental conditions for all the factors. Then decide on whether or not to use LB-Rewards. The decision about LB-Rewards may be dependent on whether the cost might be addressed using other intervention methods (such as confidence building, self-esteem activities that can incorporated with MWPS learning); or upon other secondary concerns (i.e., apart from improving MWPS and SDQ-I Peer, e.g. a specific factor such as ‘Conscientious Worker’). It should also be noted that findings from the experimental conditions may have an as yet unidentified interaction effect with the findings from the ability categories; in order words, some of the risk can be minimised because of the ability category which has been selected,
but at the same time that selection may contribute to risks in other aspects.

5. Next, using the ability category as in (1), list the risks and benefits for each of the 12 Individual- and Cooperative-learning factors. Again, to further maximise the potential benefits to the student(s) of the condition selected, it may be worth considering other means to reducing the cost and increase the benefit of the intervention.

The following section uses the above-mentioned decision algorithm to identify the costs and benefits of the optimal MWPS and SDQ-I Peer conditions within High-, Medium- and Low-ability categories respectively.

5.5.1 High-Ability Students

1. The potentially most beneficial category for MWPS and SDQ-I Peer for High-Ability students is the Individual condition.

2. The broad experimental condition is Individual.

3. Since there are no clear gains from using Individual LB-Rewards for MWPS and SDQ-I Peer, Individual-No-LB-Rewards is selected.

4. By not offering LB-rewards to Individuals, the potential benefits are improvements in:

   i. Cooperative Factor 1 – Conscientious Worker
   ii. Individual Factor 5 – Proudly Independent, and
   iii. Cooperative Factor 4 – Team Orientation

   The potential costs are losses in:

   i. SDQ-I Maths
ii Individual Factor 4 – Free Riding Resistant, and

iii Individual Factor 6 – Self-empowering

5. By selecting an Individual condition, the potential benefits are improvements in:

i Cooperative Factor 2 – Person Focused Leader

ii Cooperative Factor 3 – Good Influence

iii Cooperative Factor 6 – Identifiable Team Asset

iv Cooperative Factor 5 – Socially confident Problem-solver and

v Cooperative Factor 4 – Team Orientation.

The potential cost is losses in:

i Individual Factor 6 – Self-empowering

5.5.2 Medium-Ability Students

1. The potentially most beneficial ability-category for MWPS and SDQ-I Peer for Medium-Ability students appears to be Mediums with a Low-ability partner. This pairing appeared to stay the same for MWPS and SDQ-I Peer; compared to MI, M(M-M) and M(H-M) which had slightly greater mean gains than M(M-L) on MWPS but at the cost of SDQ-I Peer losses - the latter two categories showing significantly greater mean losses than M(M-L) on SDQ-I Peer.

2. The broad experimental condition is Mixed.

3. To improve MWPS and SDQ-I Peer, there is no difference between using and not using LB-Rewards. However, the decision about LB-Rewards may have implications for other Individual- and Cooperative-learning factors.
4. By not rewarding Mixed dyads, the potential benefits are improvements in:
   i  SDQ-I Maths
   ii  Individual Factor 4 - Free Riding Resistant

   The potential costs are losses in:
   i  Individual Factor 1 – Loafing Resistant
   ii  Individual Factor 6 – Self-empowering, and
   iii  Cooperative Factor 4 – Team Orientation.

   By using LB-Rewards in Mixed dyads, the potential benefits are improvements in:
   i  Cooperative Factor 1 – Conscientious Worker
   ii  Individual Factor 1 – Loafing Resistant

   The potential costs are losses in:
   i  Cooperative Factor 3 – Good Influence

5. By pairing Mediums with Lows, the potential benefits to Mediums are improvements in:
   i  Cooperative Factor 6 – Identifiable Team-asset
   ii  Individual Factor 6 – Self-empowering, and
   iii  Individual Factor 5 – Proudly Independent.

   The potential costs are losses in:
   i  Cooperative Factor 2 – Person Focused Leader
   ii  Cooperative Factor 3 – Good Influence, and
   iii  Individual Factor 3 – Resilient Self-worth.
5.5.3 Low-Ability Students

1. The potentially most beneficial category for MWPS and SDQ-I Peer for Low-ability students is pairing with another Low-ability student.

2. The broad experimental condition is Equals.

3. Since there are clear gains from using LB-Rewards and no clear gains from using No-LB-Rewards (for MWPS only); and furthermore, since SDQ-I Peer has strong potential risks from using No-LB-Rewards compared to neutral outcomes for LB-Rewards – the selected condition is Equal-LB-Rewards.

4. By selecting Equal-LB-Rewards, the potential benefits are improvements in:
   i. Individual Factor 1 – Loafing Resistant
   ii. Individual Factor 4 – Free-riding Resistant
   iii. Cooperative Factor 3 – Good Influence
   iv. Individual Factor 5 – Proudly Independent

   The potential costs are losses in:
   i. Cooperative Factor 6 – Identifiable Team-asset
   ii. Individual Factor 6 – Self-empowering

5. By pairing Lows with Lows, the potential benefits are improvements in:
   i. Individual Factor 5 – Proudly Independent
   ii. Cooperative Factor 5 – Socially-confident Problem-solver
   iii. Cooperative Factor 4 – Team Oriented.

   The potential costs are losses in:
   i. Cooperative Factor 1 – Conscientious Worker
   ii. Cooperative Factor 2 – Person-focused Leader and
   iii. Individual Factor 6 – Self-empowering.
In summary, this section has identified the major applied points of Study 2b’s findings by presenting coded tables of results highlighting some of the strongest results. The strength of this approach is that it simplifies very complex information allowing for a systematic approach for identifying the costs and benefits for each ability-category and experimental condition. However, a limitation is that it is not possible to know the interactions between the ability-categories and experimental conditions. For example, the ability-categories have very specific ability information (e.g. Lows paired with other Lows), but the information in the experimental conditions is not specific about ability, (e.g. Equals with LB-Rewards or No-LB-Rewards), that can encompass several categories (e.g. H(H-H), M(M-M), and L(L-L). Conversely, information in the experimental conditions about ability cannot be broken down into the more specific categories. This limitation could be addressed in future research.

Since the study is exploratory, the main application of the results is that they can also serve as a source to inform directions for further research. The information provides a pool of dependent variables from which a researcher can select their area of interest. Furthermore, the results can be used to guide hypotheses and construction of experimental designs. Ultimately, any of the exploratory findings that can be supported could then have practical application in guiding educational decisions about optimal conditions for particular learning outcomes and balancing the benefits and risks. Additionally, future research can be used to refine the ‘Incentives-Values–Exchange’ theory presented in the present thesis.
5.5 Conclusions of Study 2b

The achievements of Study 2b lie mostly in its conceptual advancements from exploring the effects of cooperative learning. It has devised an original affective test, the Student Learning Questionnaire (SLQ-Alone-&-Partnered), which is a measure that avoids perpetuating what Thibaut and Kelly (1959) pointed out as the paradoxical tendency in social psychology’s methods to miss analysis of social aspects, instead narrowing down its investigations to individual cognitive domains (e.g. Marsh’s SDQ tests are typical in having the affective measures of peer- and maths–self-concept as separate components). Instead, the present study’s Student Learning Questionnaire moves towards re-combining the ‘social’ aspect of peer and ‘individual’ aspect of Maths performance in its dependent variables; that is, it aims to measure self-assessments of the student’s perceived self-efficacy to learn maths with a partner. The Student Learning Questionnaire is founded on a conceptual unit that, compared to the existing affective measures, has more ecological validity for answering the study’s central questions about cooperative learning.

The factor analysis has also made theoretical advancements, including developing cooperative and individual learning scales that incorporate ‘a child’s perspective’, and addressing the false social/individual dichotomy assumed in most constructs to evaluate the different learning approaches. That is, the scales for Individual- and Cooperative-learning Factors demonstrate overlaps between individual and social learning endeavours in both styles of learning, enhancing the clarity for discerning the two learning approaches’ respective similarities and differences.

Analysis of the SLQ-Alone-&-Partnered in relation to the solved factor analysis has led to theoretical advancements in the form of a speculative theory of Incentive-values–Exchange in self-efficacy factors of learning motivation by identifying four motivational
configurations for different dimensions of learning – individual endeavour, companionate positive influence, individualistic attitudes development and social-emotional endeavour. These are theorized in terms of how they may be optimally structured for individual or mutual benefit through the conditions being intrinsically rewarding, through the use of learning-behaviour rewards and in relation to different ability-groupings and ability-level students. Identification of an integrated and dynamic system (in the fourth configuration) is based on the empirical evidence and consequent theorizing of how social-emotional effects appear to regulate relative ability-levels for cognitive learning. Within a motivational framework of ‘expectancy x values’ models, it explores the ‘expectancy’ aspect of perceived self-efficacy developed in the SLQ-Alone-&-Partnered, and in particular it recaptures the recently neglected ‘values’ aspect.

This study adds to the knowledge on the effects of social-comparison in cooperative learning situations (cf., Sharan & Shaulov; Webb, 1984). Bandura (1997, p. 137) discusses the relationship between thought, action and affect, arguing that there are attentional biases pivotal to regulating and maintaining behaviours that are self-hindering and self-aiding for a desirable outcome. He cautioned that cooperative learning experiences need to be carefully structured because otherwise they could cause greater divisions between high-ability students who would dominate and thrive and low-ability students who would be relegated to subordinate positions, likely causing greater differences in academic interest, perceived self-efficacy and achievement. The present study takes this proposition further by empirically demonstrating patterns of losses and gains on various measures. Furthermore, in highlighting these losses and gains, the findings have the potential to be developed into testable practical strategies for using specific task-structures, ability-structures and rewarding systems to target optimal learning outcomes.
To date, the field of cooperative learning, in focusing mainly on individual cognition and affect, struggles to combine broad theories of social aspects of psychology and learning, (such as Bandura’s and Vygotsky’s theories), with accurate observations of the dynamics within specific groups. That is, whilst social cognitivists recognize that people’s choices are affected by others, it is difficult for psychological measures to target social aspects. The SLQ-Alone-&-Partnered measure begins to bridge such divides of individual/social psychological effects by measuring the learners’ perceptions of how they will perform when having studied with others. Although the complexity of this study has meant that it has had to rely on small numbers in the ability explorations, and some of the SLQ-Alone-&-Partnered analyses do not have strong statistical significance, patterns from the evidence of trends and cross-referencing to other parts of the study have provided fledgling empirical support for this theory of the dynamics of dyadic learning and the effects of ability within a larger system.

In other disciplines, such as sociology, statistical probabilities have been used to show the effects of overall social systems. Notably, Bourdieu and Passeron’s (1977) sociological analysis of class reproduction empirically demonstrated a relationship between the status of a father’s occupation in relation to the son’s probable educational outcomes. The sociological system described by Bourdieu and Passeron demonstrates how certain relationships are advantageous or disadvantageous. In analysing the difficulty (but not the absolute impossibility) of upward social mobility, they developed a theory of “cultural capital”. This is not completely alien to cooperative learning research, which has been concerned with wider systems and group dynamics, and indeed at times has developed out of fears of the tendency for the educationally rich to get richer and the educationally poor to (unfairly) get poorer (e.g., Allport, 1954; Aronson et al., 1978; Slavin, 1979). However, the methodological difficulties of measuring effects of social dynamics, as well as what
appears to be a general reluctance in the field to acknowledge losses as well as gains that might occur from particular relationships, makes it difficult to coherently theorise cooperative learning. Nevertheless, the present exploratory study’s proposed configurations of Incentives-values–Exchange, which consider the dynamics of relative ability levels and self-efficacy, point towards an empirically based and testable theory of “psychological capital”.

The chapter which follows explores the learning factors further, showing illustrative examples of the children’s descriptions of their reactions to cooperative learning conditions.
CHAPTER 6

STUDY 2C - EXPLORATION OF CHILDREN'S WRITTEN REFLECTIONS ILLUSTRATING THE EFFECTS OF EXPERIENCES IN COOPERATIVE LEARNING DYADS FOR INDIVIDUAL- AND COOPERATIVE-LEARNING FACTORS

6.1 Sample Responses

The present study is a corroboration of the Incentive-values-Exchange theory developed in the previous chapter, Study 2b. Each of the factors for self-efficacy to learn maths on the individual learning scale (‘Self-motivated’, ‘Proudly Independent’ etc) and on the cooperative learning scale (‘Good Influence’, ‘Team Oriented’ etc) is illustrated with sample responses from students in the cooperative learning conditions that use their own words to show the social-emotional, or affective, effects of the learning experiences.

There is growing awareness of affect being integral to learning experiences and outcomes. The study’s underlying affective measure was of self-efficacy, which belongs to the broad category of motivation. Even though affective constructs are less tangible measures than academic achievement, they are worthy of investigation to further understand the psychology of learning. Volet (2001, p. 321) states that “[approaches with differing theoretical groundings] converge in research purpose – i.e., to understand the dynamics of motivation in real-life situations”. Volet argues that consensus exists in recognizing that individual and social dimensions of motivation “are dynamic constructs that mutually interact”. Thus, Study 2c investigated how experience in cooperative dyads affected students’ self-efficacy to learn individually and cooperatively with a partner.
For Study 2c, self-report data on learner attitudes was collected in the form of the students’ written reflections of their learning experiences in the programme. Response sheets titled “Today I learned maths alone” were completed by students in the individual-learning conditions, and sheets titled “Today I learned maths with a partner” were completed by students in the cooperative-learning conditions. Note that, with a goal of providing succinct examples to enrich the theoretical explanations without compromising their coherence, the data used has drawn only from responses by children in cooperative dyads. The response sheets elicited free-responses by students to what they had “enjoyed least/most”, “found most easy/difficult” and “found most useful/least useful”. The reflective exercises were undertaken on pedagogical grounds, and in addition, this made data available with potential to supplement Study 2a’s statistical measures of learning. Contemporary research methods to explain learning are moving towards an ideal of combining qualitative and quantitative data (Bossert, 1988; Good, McCaslin & Reys, 1992). Note that the data made it possible to add a qualitative dimension that is effective for illustrative purposes when considered in combination with Study 2b’s quantitative findings, and that to some extent has informed Study 2b’s theory development; however, the present study cannot be classified as a qualitative study in that it did not have a stand-alone research question and it did not deploy sophisticated qualitative observations (Behrens & Smith, 1996).

There was a theoretical potential for the present study to undertake a systematic and statistical analysis of the responses since the research design collected data for all children in every learning condition at four points of progression through the programme’s steps of problem-solving strategies. However, a less detailed analysis has been adopted mainly due to the difficulty that arises in categorizing free-response data. That is, in the present study, any reflection by a student describing his or her joys, problems and so on could have been
made in relation to any of the six factors on the individual learning scale or six factors on
the cooperative learning scale. Therefore, there is unavoidable researcher-subjectivity when
deciding which of the factors is illustrated by the data, even though every decision is based
on careful judgments drawing on familiarity with the existing literature and other findings
in the study. This is in addition to the interpretive problem that expression in open-ended
answers is often undeveloped or ambiguous, especially when coming from children.
Therefore, Study 2c has exploratory status but nevertheless aims to serve an illustrative
purpose.

The study serves as empirical evidence of the children’s learning experiences, and
what working with a partner meant to them; it aims to triangulate the various key findings
made in the factor analysis and theory development of Study 2b with samples of ‘real life’
examples. Volet (2001, p. 328) notes that, “empirical evidence of the reciprocal nature of
influences [on motivation] remains limited and fragmented, which reflects the difficulty of
operationalising and investigating interactive constructs.” One of the problems of
operationalising interactive constructs that becomes apparent when drawing on masses of
non-quantifiable data is that examples of what the other studies found as statistically
significant differences or trends are not completely obvious: that is, they are differences of
probability rather than absolute differences. Therefore, the extent to which the present
study’s illustrative examples can serve a triangulating function to provide conceptual clarity
to the theory development depends upon the accuracy and validity of the subjective
interpretations as well as the validity of the previous theorizing.

For ease of reference, the 12 illustrative analyses of each cooperative or individual
learning factor will repeat the presentation order used in Study 2b’s index to the four
configurations of learning.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Conscientious worker\(^1\): Effects of experience in cooperative-learning dyad

In mixed-ability (Mixed) Learning-Behaviour (LB)-Rewards conditions, the Low-ability partner may learn conscientiousness from a Medium- or High-ability partner.

<table>
<thead>
<tr>
<th>L(M-L); Mixed-LB-Rewards</th>
<th>↔</th>
<th>M(M-L), Mixed-LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What I found most useful about learning with my partner was</strong></td>
<td><strong>What I enjoyed least about learning with my partner was</strong></td>
<td></td>
</tr>
<tr>
<td>he can explain when I don't understand.</td>
<td>cheating.</td>
<td></td>
</tr>
<tr>
<td><strong>What I found least useful about learning with my partner was</strong></td>
<td><strong>What I found most difficult about learning with my partner was</strong></td>
<td></td>
</tr>
<tr>
<td>he is kind of selfish.</td>
<td>to solve the problem.</td>
<td></td>
</tr>
<tr>
<td><strong>What I enjoyed most about learning with my partner was</strong></td>
<td><strong>What I found most useful about learning with my partner was</strong></td>
<td></td>
</tr>
<tr>
<td>he is not arrogant.</td>
<td>calculate the answer.</td>
<td></td>
</tr>
</tbody>
</table>

Lower-ability students often do not have task-focus.

Higher-ability partner maintains and models conscientious task- and problem-solving-focus.

\(^1\) Cooperative-learning factor 1 (Dimension (D): Individual endeavour)  
Configuration index D.1.1

\(\leftrightarrow\) Indicates that the comparisons came from actual partners.
Loafing-resistant²: Effects of experience in cooperative-learning dyad

<table>
<thead>
<tr>
<th>Mixed-LB-Rewards conditions may lead to over-dependence.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M(M-L); Mixed-LB-Rewards</strong></td>
<td><strong>↔</strong></td>
</tr>
<tr>
<td>What I found most useful about learning with my partner was he does maths questions very fast.</td>
<td></td>
</tr>
<tr>
<td>LB-Rewards can be an incentive for fast completion.</td>
<td></td>
</tr>
<tr>
<td>It is frustrating if the partner does not cooperate.</td>
<td></td>
</tr>
<tr>
<td>Attempts to help may seem futile.</td>
<td></td>
</tr>
</tbody>
</table>

² Individual-learning factor 1 (Dimension: Individual endeavour)
Configuration index D.1.2

↔ Indicates that the comparisons came from actual partners.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Free-riding resistant\(^3\): Effects of experience in cooperative-learning dyad

Equals are the most effective dyads for free-riding resistance. Therefore, mixed-ability dyads need to ensure that copying is not easy and that both partners attempt the maths.

L(M-L), Mixed-LB-Rewards

A lower-ability partner may prefer to free-ride out of fear, embarrassment or opportunism.

Mixed-No-LB-Rewards experiences losses.

M(M-L), Mixed-No-LB-Rewards ↔ M(L-M), Mixed-No-LB-Rewards

Without LB-Rewards, persistence in demanding that a partner learn can turn to hostility, especially by the more competent partner.

\(^3\) Individual-learning factor 4 (Dimension: Individual endeavour)
Configuration index D.1.3

↔ Indicates that the comparisons came from actual partners.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

**Self-motivated**: Effects of experience in cooperative-learning dyad

Cooperation may be motivated by a desire to increase one’s individual performance.

In equal-ability dyads, it may not always be obvious to the students how improvement would occur.

<table>
<thead>
<tr>
<th>H(H-H); Equal-No-LB-Rewards</th>
<th>↔</th>
<th>H(H-H), Equal-No-LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>What I found most difficult about learning with my partner was My partner and I were unable to answer some questions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What I found least useful about learning with my partner was a lot of time was wasted in discussion.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In mixed-ability dyads, the more competent partner may provide ‘peer-tuition’ to a lower-ability partner that may model appropriate attitudes and skills.

<table>
<thead>
<tr>
<th>L(H-L), Mixed-No-LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>What I found most easy about learning with my partner was help me when I don’t know how to solve the Maths problem</td>
</tr>
</tbody>
</table>

---

4 Individual-learning factor 2 (Dimension: Individual endeavour)
Configuration index D.1.4

↔ Indicates that the comparisons came from actual partners.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Person-focused leader\(^5\): Effects of experience in cooperative-learning dyad

This factor may be successful where a partner enjoys being helpful to someone cooperative even though they may not receive help in return.

\(\text{M(M-L), Mixed-LB-Rewards}\)

Some higher-ability partners can use their competence and provide leadership for the complex combination of a task-focus as well as achieving their partner’s involvement in problem-solving.

\(\text{L(H-L), Mixed-No-LB-Rewards}\)

\(^5\) Cooperative-learning factor 2 (Dimension: Companionate positive influence)
Configuration index D.2.1
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

**Good influence**: Effects of experience in cooperative-learning dyad

Equals appear to prefer a mutual exchange of assistance and helping only when needed.

**M(M-M), Equals-LB-Rewards**

<table>
<thead>
<tr>
<th>What I found most easy about learning with my partner was</th>
<th>What I enjoyed most about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>she is so helpful</td>
<td>we didn’t talk about</td>
</tr>
<tr>
<td>ask her question</td>
<td>other people expect</td>
</tr>
<tr>
<td>when I did not understand</td>
<td>math problems</td>
</tr>
</tbody>
</table>

In equal-ability pairings, any sense of not being a good influence is minimized when the interaction is positive.

**L(L-L), Equal-No-LB-Rewards**

<table>
<thead>
<tr>
<th>What I found most difficult about learning with my partner was</th>
<th>What I found most useful about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>it was not so good in math</td>
<td>I can get more help in the math problem</td>
</tr>
</tbody>
</table>

Where there is a lack of willingness to cooperate, even a more competent partner will not necessarily confidently feel he/she is a good influence and may perceive the cooperative experience to be disruptive or one-sided.

**M(M-L), Mixed-LB-Rewards**

<table>
<thead>
<tr>
<th>What I enjoyed most about learning with my partner was</th>
<th>What I found most difficult about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>he was very patient</td>
<td>explanation every time</td>
</tr>
<tr>
<td></td>
<td>he was very helpful</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Cooperative-learning factor 3 (Dimension: Companionate positive influence)  
Configuration index D.2.2
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Identifiable team-asset\(^7\): Effects of experience in cooperative-learning dyad

For success, both partners must be willing to cooperate.

In some cases, partners are rejected at the cost of damaged esteem and peer relations.

L(M-L), Mixed-LB-Rewards

By contrast, cooperation can succeed and be appreciated.

L(M-L), Mixed-LB-Rewards

[NB: This is not the same student from the example above.]

---

\(^7\) Cooperative-learning factor 6 (Dimension: Companionate positive influence)
Configuration index D.2.3
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Proudly independent\(^8\): Effects of experience in cooperative-learning dyad

Cooperative learning is argued in the field to prepare children for individual learning situations. However, there may be losses to both medium- and low-ability partners in (M-L) mixed dyads.

<table>
<thead>
<tr>
<th>M(M-L), Mixed- LB-Rewards</th>
<th>↔</th>
<th>L(M-L), Mixed- LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>What I enjoyed least about learning with my partner was <strong>.copying</strong>.</td>
<td></td>
<td>What I enjoyed least about learning with my partner was <strong>he never</strong> teach me but only give me the answer.</td>
</tr>
<tr>
<td>What I found least useful about learning with my partner was <strong>playing</strong>.</td>
<td></td>
<td>Rewards may pressure partner to “give” answers.</td>
</tr>
</tbody>
</table>

Mediums find it hard to control Lows.

Equal-ability dyads may have little to exchange academically and may consider cooperation to be distracting. Therefore, Equals-No-Rewards partners’ interaction are likely to be based on mutual need or enjoyment, whereas Equal-LB-Rewards is likely to induce more interaction which is likely to be perceived as academic interference in relation to being proudly independent.

<table>
<thead>
<tr>
<th>H(H-H), Equal-No-LB-Rewards</th>
<th>↔</th>
<th>H(H-H), Equal-No-LB-Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>What I found most useful about learning with my partner was we both <strong>know how to do</strong> maths.</td>
<td></td>
<td>What I enjoyed most about learning with my partner was we have fun <strong>laughing together</strong>.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What I enjoyed least about learning with my partner was she was asking me when I am doing my homework.</td>
</tr>
</tbody>
</table>

Equal-LB-Rewards

| What I found least useful about learning with my partner was I just try even though my partner gave me the answer. |

\(^8\) Individual-learning factor 5 (Dimension: Individualistic attitudes development)

Configuration index D.3.1

\(\leftrightarrow\) Indicates that the comparisons came from actual partners.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Self-empowering\(^9\): Effects of experience in cooperative-learning dyad

The mixed-ability combinations of M(H-M) or L(M-L) may be undermining for the lower-ability peer.

\[
\begin{array}{c|c}
\text{H(H-M), Mixed- LB-Rewards} & \text{M(H-M), Mixed- LB-Rewards} \\
\hline
\text{What I found most difficult about learning with my partner was she is week in Math.} & \text{What I found most difficult about learning with my partner was she is week in Math.} \\
\text{What I enjoyed least about learning with my partner was I was the only one who wasn’t doing any work.} & \text{What I found most useful about learning with my partner was he would explain about different answers.} \\
\end{array}
\]

L(H-L) had the highest gains, suggesting a reduced fear of failure and increased self-efficacy to persist with the problem-solving challenge. Highs may take a ‘donor’ role and encourage a lower-ability partner to have task engagement as well as validating their worth by making the lower-ability student feel needed.

\[
\begin{array}{c|c}
\text{L(H-L), Mixed-LB-Rewards} & \text{H(H-L), Mixed-LB-Rewards} \\
\hline
\text{Lower-ability partners may become aware of how they are comparatively unskilled, which they may accept better if the partner does not obviously carry them.} & \text{A skilled higher-ability partner may find ways of avoiding the temptation for their lower-ability partner to leave the problem-solving to them.} \\
\end{array}
\]

The example suggests a High-ability partner enjoyed making careless “errors” which the Low-ability partner found motivating and game-like to find and explain.

\(^9\) Individual-learning factor 6 (Dimension: Individualistic attitudes development)  
Configuration index D.3.2

\(\leftrightarrow\) Indicates that the comparisons came from actual partners.
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Resilient–self-worth: Effects of experience in cooperative-learning dyad

Cooperation by dyadic members that allows the required task progress may encourage self-worth to grow even if partners’ approaches differ.

H(H-M), Mixed-No-LB-Rewards

Low-ability students can feel good about themselves when supported but vulnerable if their partner feels dragged down.

L(M-L), Mixed-No-LB-Rewards

Individual-learning factor 3 (Dimension: Social-emotional endeavour)
Configuration index D.4.1
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Socially-confident problem-solver\textsuperscript{11}: Effects of experience in cooperative-learning dyad

Openness about each partner’s level of understanding is essential.

M(M-L), Mixed-No-LB-Rewards

<table>
<thead>
<tr>
<th>What I found most useful about learning with my partner was</th>
<th>What I enjoyed most about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>if my partner don’t understand I will teach him.</td>
<td>if we think it is not the right way to do it we will tell each other.</td>
</tr>
</tbody>
</table>

What I found most useful about learning with my partner was my partner learn a lot.

Some students have difficulty persuading their partner who is competent to help them with a task.

L(M-L), Mixed-LB-Rewards

<table>
<thead>
<tr>
<th>What I enjoyed least about learning with my partner was</th>
<th>What I found most difficult about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>sometime I went to the other girl and discuss</td>
<td>when I do finish she will not check the work.</td>
</tr>
</tbody>
</table>

\textsuperscript{11} Cooperative-learning factor 5 (Dimension: Social-emotional endeavour)
Configuration index D.4.2
Samples of children’s written reflective free-responses to “I learned maths today with a partner”, illustrating SLQ-Alone-&-Partnered analytic points and exploratory propositions.

Team-oriented\textsuperscript{12}: Effects of experience in cooperative-learning dyad

Task-focus and person-focus differ according to relative ability-levels

High- and Low-ability students have a task-focus.

H(H-L), Mixed-No-LB-Rewards

<table>
<thead>
<tr>
<th>What I found least useful about learning with my partner was</th>
<th>What I found most useful about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>answer</td>
<td>dee, ideas and execodynamics</td>
</tr>
<tr>
<td>I don’t know the answer</td>
<td>I can share the best</td>
</tr>
<tr>
<td>i.e. my self</td>
<td>i.e. my self</td>
</tr>
<tr>
<td>very enjoy</td>
<td>very enjoy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What I enjoyed most about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>very enjoy</td>
</tr>
<tr>
<td>I am really doing math</td>
</tr>
</tbody>
</table>

Medium-ability students have a person-focus

L(M-L), Mixed-LB-Rewards

<table>
<thead>
<tr>
<th>What I found most difficult about learning with my partner was</th>
<th>What I found most easy about learning with my partner was</th>
</tr>
</thead>
<tbody>
<tr>
<td>these questions; we had different answers;</td>
<td>is an understanding person</td>
</tr>
<tr>
<td>and we took time to understand</td>
<td></td>
</tr>
</tbody>
</table>

Cooperative-learning factor 4 (Dimension: Social-emotional endeavour)
Configuration index D.4.3
6.2 Achievements of Study 2c

This is a small study of cooperative learning which offers a qualitative dimension to supplement the statistical and exploratory analyses in the other studies of the thesis. It provides examples of the children’s descriptions of their experiences in dyads that informed and illustrate the other studies’ findings and proposed theories. As such, Study 2c begins to address the need for empirical research to move beyond defining and measuring conditions for specific outcomes of learning experiences and to include investigation and explanation of the actual mechanisms underlying the outcomes. That is, the annotated examples of the children’s reflections on their learning, their interactions with a partner, and their emotional responses to the experience serve to illustrate some pertinent affective, social-emotional outcomes of cooperative learning. Additionally, the study demonstrates that the affective, cognitive and social domains of cooperative learning are integrated.

6.3 Achievements of Exploratory Studies 2b and 2c

The SLQ-Alone-&-Partnered learning-factor analysis and related theory building, and analysis of children’s free-responses about their cooperative learning experiences are exploratory studies that substantially support the experimentally designed Studies 1 and 2a. From different approaches, each of these studies substantively contributes aspects of “the child-learner perspective” of cooperative learning and contributes to progress in theory development and refinement. In this first major systematic, empirical investigation of factors in learning, particularly in cooperative learning, it has been possible to explore and theorise some of the dynamics at play in multiple and integrated domains of learning – cognitive, social and affective. Specifically, findings in relation to cognitive efforts by individuals, social implications of ability-status within dyads, and social-emotional
regulation of task-persistence, inter-personal status and person/task-focus tendencies have informed a theory of motivation: “Incentive-values–Exchange” pertaining to self-efficacy for learning maths with regard to Individual- and Cooperative-learning factors.

Several key issues and puzzles within the field of cooperative learning have been clarified or elaborated in the findings of these exploratory studies. The dichotomizing of “individual” and “cooperative” learning has previously been problematised (Anderson et al., 1997; Bossert; 1988; Karmiloff-Smith, 1995; Slavin, 1995), and this study’s factor analysis has mapped out a clearer understanding of their similarities and differences.

A concern that is fiercely debated in the cooperative learning field (CTEHP, 1994; Slavin, 1996) about the outcomes of rewarding cooperative behaviours has been systematically tested, adding insight into the complexity of learning behaviour rewarding and its positive and negative outcomes.

The studies’ insights regarding social-emotional responses to learning have relevance to broad educational goals for some students’ maladaptive tendencies to be replaced by adaptive tendencies, for example, proposals about self-efficacy beliefs in general by Bandura (1997) and proposals to overcome task-avoidance strategies by Dweck (1975). The present studies broaden the understanding of students’ adaptive and maladaptive tendencies and vulnerabilities, offering preliminary understandings of how they are affected by ability-structure and rewarding-systems.

The thesis has offered some clarification of issues of relative status-levels that have been addressed in some previous studies of cooperative learning interventions. For example, it has been noted that where the general academic standards have improved, even though it is amongst lower-achievers that most of the improvements in standards occurs, relative academic status levels within specific cohorts tend to remain stable (Sharan & Shaulov, 1990). The present studies broaden current understandings of the integration of
cognitive, social and emotional domains of learning and how they function as a social-
psychological system to maintain relative–academic-status through an array of inter-related
social-emotional–reactional biases that create or constrain opportunities to master ability-
related cognitive skill levels.

The studies are exploratory and require further research to test the proposed theory
and replicate the findings. They also point towards several possible future directions for
research. One direction is to refine the Cooperative-Learning and Individual-Learning
scales for Self-efficacy, possibly improving items with further input by children or
including additional issues in the items, such as how they feel rewarding will affect their
ability to learn alone or with a partner, or refining the items by separately analyzing
responses by children with varying attitudes or preferences. Another future research
direction is to refine the Student Learning Questionnaire and test its predictive power or
adapt it as a pedagogical tool. The cooperative-learning factors, and the individual learning
factors, could be scrutinised – as has been suggested for the elements of the Learning
Together model (CTEHP, 1994). For this, the results of the present factor analysis could
assist in identifying new topics to investigate as well as informing hypothesis development
(see the tables in the section on Applied Theoretical points). Another direction is to test
and refine the study’s proposals of four different learning dimensions with specific
configurations of dynamics, which is theorized as “Incentives-Values-Exchange” theory. A
final suggestion is expanding on the present research’s theorising of there being a social-
psychological system. For example, existing sociological social-reproduction theories such
as Bourdieu and Passeron (1977)’s theory of cultural capital may be integrated with
psychological information to define and build a theory of “social-psychological capital”.
Such a theory would attempt to explain the maintenance of ability levels amongst groups of
students due to specific psychological reactions of particular group dynamics.
The thesis has met many of the research aims. The first aim of furthering understanding of the mechanisms underlying cooperative learning is met by explications of how particular peer dynamics affected by a range of learning dimensions can potentially be either detrimental or advantageous. The second aim of identifying conditions for eliciting optimal outcomes in relation to academic performance has been partly met, especially in the findings for MWPS and Peer-Self-concept Study 2a. The third aim of the research was to develop a theory of cooperative learning that integrates learners’ cognitive, social and affective domains, and this has been achieved through the explorations of Individual- and Cooperative-learning factors and development of an affective measure, the “SLQ-Alone-&-Partnered”, the findings of which were synthesized into a proposed theory of Incentive-values–Exchange.
CHAPTER 7

CRITIQUE OF ALL STUDIES: 1, 2A, 2B AND 2C

7.1 Strengths of Research

The present research took place in schools in Singapore. While it has not been designed as a cross-cultural study, it is notable that it included studies that ran mathematics programmes from which the mathematics learning outcomes were not significantly greater in the individual conditions compared to the cooperative conditions – and therefore begins to address some researchers’ doubts about the applicability of cooperative learning methods in Asian or non-Western countries (Chan, 2000). A paucity of research outside of Western countries on the social-emotional outcomes of cooperative learning has previously been identified (Chan, 2000; Lee, Lim & Ng, 1997), but the present research has shown that cooperative learning can make crucial differences, and there is potential to develop strategies in the structuring of specific ability compositions in dyadic pairs and approaches to rewarding learning behaviours to enrich the social and affective outcomes of students’ learning experiences.

Conceptual advances were made in relation to discovering a contradiction to the hypothesised concept that positive-interdependence was the key to successful cooperative learning, particularly in Study 1’s clarification of the importance of individual accountability that allows retaining of control over learning tasks that are essentially cognitive. Another conceptual advance was made in Study 2b’s questioning the false dichotomy of individual/social of what are termed “individual” and “cooperative” methods of learning (Damon & Phelps, 1989; Karmiloff-Smith, 1995; Rogoff, 1990). The advance was applied to the development of learning scales, not only for cooperative-learning but also for individual-learning, and a factor analysis demonstrated how both types of learning
are a combination of individual and social endeavour. A further conceptual advance was made in combining the dual cognitive and social tasks by operationalising measures of “learning maths with a partner” (or alone), and these were applied in a questionnaire developed together with input from children as an original measure of affective outcomes for each of the learning factors.

Other strengths include the use of rigorous research standards. For example, in the studies with quasi-experimental designs, rigour included high-quality standards for controls and learning condition sample sizes, and the use of reliability measures, e.g. Rasch Analysis. Furthermore, the present research has strengths from its use of multiple-methods which have led to the study achieving several conceptual and methodological advancements – and the need for these is recognized in the field of cooperative learning as essential for going beyond experimental research designs in order to understand the mechanisms of its successes and problems (Bossert, 1988; Good, Mulryan & McCaslin, 1992; Knight & Bohlmeyer, 1990). Tashakkori and Teddlie (1988) describe the importance of “pushing theory” which is achieved by incorporating fresh perspectives or discovering paradoxes or contradictions.

Methodological advances were made in the combined use of rigorous quasi-experimental designs and exploratory studies that allowed additional dimensions of analysis for theorizing within-dyad effects in cooperative learning. Paradoxically, within-dyadic effects and dyadic interactions require a level of investigation typically avoided in most psychology research because experimental designs cannot address how each subject’s behaviour is reciprocal; that is, the behaviour is “at the same time a response to the past behaviour of the other and a stimulus to the future behaviour of the other”, and therefore unable to be clearly separated into dependent and independent variables (Thibaut & Kelley, 1959, p. 2). This pointed towards using exploratory studies to specifically investigate the
dynamics within dyadic pairs. One method used to address this issue was in the exploratory studies’ comparisons of the effects of high, medium and low levels of ability. This was achieved by re-analysing the main data outside of the constraints of the experimental conditions, thus adding another dimension of dependent variables that could be used to extend and refine the main analyses. An additional exploratory method used in the studies was in the theorizing, by the studies’ openness to moving beyond the hypotheses to investigate the losses associated with cooperative learning, theorizing them as vulnerabilities. Much research has been criticized for treating cooperative learning as a panacea (Anderson et al.,1997; Bossert, 1988; CTEHP, 1994) and ignoring findings of no differences or losses in outcomes. The present study has recognised such findings and applied them in its theory-building by reviving relevant aspects of social exchange theories as well as linking them to the children’s expressions of loss of motivation and frustration in dyadic learning. A further method used in the exploratory studies added a third dimension to the analysis in the correlations of specific losses and gains on the learning outcomes for students with specific ability-compositions. In particular, negative correlations in the analyses allowed for detection of various types of trade-offs amongst the individual and cooperative learning factors, which were central to speculative theorising that mapped out the dynamics of an integrated social-psychological system.

7.2 Limitations of Research

One of the limitations of the second phase of the study is that definitions of “Equals” or “Mixed” ability for individual students, dyads or cohorts of students are always arbitrary categories dependent upon the specific subject-sample size and ability-range. In Studies 2a, b and c, two methods of defining mixed-ability needed to be employed – one is dependent upon experimental condition and class ranking (i.e., for the Equals condition: the
class is ranked ordered and paired top-down; for the Mixed condition: the class is ranked ordered and rank split for pairing across each half), and the other is based on whole-sample rankings (first third: high-ability; second third: medium-ability; and final third: low-ability). Even though the results of both methods concur, the definition used in the findings was based entirely upon the subject sample. There were only a few categorization discrepancies between the two methods of pairings, and these can be accounted for, on the one hand, by the similarities between ability ranges in classes because the Singapore education system provides separate facilities to the mainstream schools for the highest- and lowest-achieving students after Grade-4 tests and, on the other hand, by the large sample size. Hence, since all of the participating schools in the study were from mainstream schools, the ability levels of students participating in the study may not have varied as widely from one another as might occur in mainstream schools in other countries. This would limit the ease with which teachers might apply the findings or at least points towards the need for maintaining close monitoring; and the study’s ability range also limits the probability of undertaking accurate replication studies or making accurate comparisons across studies in other contexts without progressing on the development of descriptive standards for research reporting, for example, using Mugny and Doise’s (1978) methodology to delineate ability using Piagetian stages, or preferably by using standardised psychometric tests that have suitable norms. However, such problems will persist in the research without a comprehensive measure of relative ability amongst dyadic members rather than relying on measures of individual students’ absolute abilities.

Study 1 compared the use of Positive Interdependence recommended by Johnson and Johnson (finding that too much was demotivating); and Study 2, in addition to using individual academic mastery rewards, employed the use of Learning Behaviour Rewards
(finding them mostly ineffective for individual learning and effective only in specific cooperative conditions).

However, it is notable that no claims can be made about the long-term or mainstay use of cooperative learning. It appears common-place in the field for researchers or commentators to use small scale studies over relatively short periods of time to then claim that cooperative learning should be used for a high proportion of time, but this is unfounded (Bossert, 1988). Those studies are not equipped to make the kind of informed judgment that projects what the outcomes of long-term cooperative interventions would be if used as the main approach to learning, for example if implemented as an across-the-school strategy for the majority of instruction time. The present Studies 1 and 2a were unable to meet the criteria for timing (20 hrs) and ideally being conducted over a period of four weeks in normal school time, which Slavin (1995) considers the bench-mark of high-quality studies. The 20 hour criterion was not met due to up to four hours was taken up in test administration. However, Slavin states that the average time for studies is 10 hours and such studies are useful for theory building. Therefore, although caution should be exercised in interpreting any of the specific results, the 16 hours of the present studies did produce some significant findings despite the shorter hours, and was relatively good for the purposes of this overall project.

A limitation of Study 2a is that using teachers’ observations in rewarding learning is that observations are difficult to standardize and subject to bias, and future research projects could provide training for inter-rater reliability and through the use of observational categories (e.g., Webb, 1993b; Farivar & Webb, 1994) that code behaviour for asking and levels of help received (to ensure the fidelity of implementation of rewarding).

Another limitation of Study 2a is that it was not possible to complete the comparison of both types of learning in relation to computer-based instruction. This was
due to unforeseen resource limitations and is possibly linked to the finding which cannot easily be analysed of differences in peer–self-concept outcomes across the two quasi-experimentally designed studies.

7.3 Directions for Future Research

Further research might explore different combinations of Learning Behaviour (LB-) Rewards, for example using methods from Slavin’s rewarding of Group Goals, or even re-investigating variations of employing positive interdependence in relation to LB-Rewards. This would be especially useful with regard to investigating the effects of Peer–self-concept for which the two main studies of the present research had somewhat discrepant findings.

Future research may directly compare the effects of Computer-Based Instruction and No-Computer-Based Instruction on peer outcomes (e.g. a measure of peer–self-concept or qualitative observations of peer social interaction for seeking and receiving help, etc.) to establish whether discrepant patterns of losses or gains for individual and cooperative conditions noted to occur across Studies 1 and 2a are an effect of games in relation to gains and no-games in relation to losses.

Future research could refine understanding of rewarding in learning motivation. For example, variations in Positive Interdependence could be directly combined with Learning Behaviour Rewards. It would especially be useful to the field to investigate how students view the reward structure (Bossert, 1988, p. 233), and this might be achieved using focus group or individual interviews, including questions about rewarding in future learning questionnaires that are similar to the SLQ-Alone-&-Partnered, seeking reflective free-responses about how children feel about rewarding, or using qualitative observations.
Future research into optimal rewarding of cooperative learning-behaviours could investigate effects of targeting particular cooperative–learning-factors, and additionally investigate effects of extinction or extension of target behaviour in programmes with longer durations in order to further test the Incentive-values–Exchange theory.

In concluding the thesis, the present research began by questioning the general optimism about cooperative learning. The findings suggest that with careful structuring so that individual control over the learning is not lost, cooperative learning has some worthwhile pedagogical merit. There does appear to be integration of academic, social and emotional domains, although how they affect each other in particular learning conditions is more complex than is typically recognized. This thesis has synthesized its findings to develop an overview of learning, theorizing the mechanisms underlying the motivations for four dimensions of learning: Individual endeavour; Companionate positive influence; Individualistic attitudes development, and Social-emotional endeavour. This study’s theory, “Incentives-values–Exchange” offers improved understandings of target learning outcomes that may be of interest to practitioners. It also clarifies the various benefits and risks to be considered when using cooperative learning methods, and had mapped future research directions that may develop this knowledge to assist in teachers’ strategic decision making.
REFERENCES


