Science and Mathematics Education Centre

The Interaction of Achievement Goal Orientations, Self-Regulated Learning and Learning Environment in High School Science Classrooms

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This thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University of Technology

August 2007

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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ACKNOWLEDGEMENTS

Thanks to those researchers whose work I have read throughout my years of study. This research is a mere extension of what they have done. Thanks to my supervisor, Professor Darrell Fisher whose patience, prompt and constructive feedback I have valued over the years. I also need to acknowledge the assistance of his colleague, Dr Beverly Webster, for her advice on statistical analyses. I am grateful to the ACSPRI teachers especially Dr David Gow and Dr Ken Rowe for their inspired teaching of relational statistics. Thanks to my family, friends, work colleagues and my students for their patience with me over the years. Finally, this work is dedicated to the students and teachers that volunteered to be involved in the studies I have conducted. I hope that my work will assist them in some form in the near future.

ABSTRACT

Despite the substantial amount of education research on "teaching for understanding" and "learning for understanding" processes that has occurred in the fields of achievement goals, constructivist-based pedagogy, motivational beliefs and self-regulated learning there is little research that considers in unison the pillar constructs of these fields. Three studies comprised the present research which was designed to address the proposal that important social- and personal-based constructs associated with achievement goals, constructivist-based pedagogy, motivational beliefs, and self-regulated learning act in an interdisciplinary fashion to influence learning in the high school science classroom. All the large-scale quantitative studies presented a single-level structural equation model that was applicable to the general high school science student, controlling for the variance associated with age, gender, and student type (regular or selective high school student). Results from the two large-scale trait-level correlational studies of Study 1 (n = 655) and Study 2 (n = 617) using the Achievement Goals Questionnaire (Elliot & Church, 1997), Constructivist Learning Environment Survey (Taylor, Fraser, & Fisher, 1997) and the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & McKeachie, 1991) as the main quantitative instruments found support for the hypothesis that a perceived emphasis on the constructivist-based pedagogical dimensions of personal relevance and student negotiation in science classrooms promotes the adoption of mastery-approach and intrinsic value. These analyses also showed the importance of self-efficacy in promoting mastery-approach, performance-approach and the use of regulatory strategies, and that test anxiety had positive associations with mastery-avoidance and performance-avoidance goals. Study 3 comprised of two mini-studies that investigated the associations of competence perceptions, achievement goals and self-regulated learning in two science classroom learning contexts: teacher-led discussion (n = 451) and group work (n = 476). Using specifically developed context-level questionnaires, the results of these studies affirmed current theories concerning the interactions of self-efficacy, achievement goals, self-regulated learning (regulatory strategy use) and maladaptive strategy use. Students interviewed in Study 3 mostly reported the adoption of their achievement goals depended upon personal reasons that were commensurate with current achievement goal theory (Elliot, 1999) rather than specific classroom practices. The present research was also significant in that it tested the empirical stature of two frameworks by which social/cognitive research affiliated with learning environments, achievement goals and self-regulated learning may be conducted. Firstly, the results of the construct validity measures generated across Studies 1, 2 and 3 found support for the existence of the hypothesised 2 X 2 achievement goals framework (Elliot, 1999; Elliot & McGregor, 2001; Pintrich, 2000a). Secondly, the research introduced the tenets of a "context" hypothesis and found support for this perspective throughout the context-level studies. Adjunct multilevel multiple regressions were used in all the quantitative studies to examine the impact of subpopulation variables (age, gender, regular or selective high school student) and multiple goal interactions upon response variables, and to assess the variance attributed to the response variables at the class-level. Implications for the research disciplines studied are presented in terms of teaching practice, theory, future research and research methods.

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Chapter 1

INTRODUCTION

1.1 PURPOSE AND SIGNIFICANCE OF THE RESEARCH

Recent advances in educational research have focused on the interplay of social and cognitive factors in attempting to illuminate both “teaching for understanding” and “learning for understanding” processes. The research affiliated with “teaching for understanding” has focused on the usefulness of social constructivist-based pedagogy, acknowledging that the learning environment features that accompany social constructivist settings compliment the cognitive constructions employed by students as they learn (Andre & Windschitl, 2003; Blumenfeld, Marx, Patrick, Krajcik, & Soloway, 1997; Hatano & Inagaki, 2003; Vosniadou, 2003). However, over the past two decades a substantial amount of education research on “teaching for understanding” and “learning for understanding” processes has also occurred in the fields of achievement goals and self-regulated learning. The fields of inquiry associated with each of these research disciplines have convergent research aspirations in that they consider in some form the impact of environmental/social and personal factors on the quality learning processes employed by students. Although the fields of research associated with achievement goal theory and self-regulated learning have been interdependent, both these fields have evolved in a relatively insular fashion with respect to the field of constructivism in science education. Yet the perspectives proffered by each of these constructs when examining the learning practices of high school science students have the potential to be complimentary and perhaps provide a more thorough and revealing picture of the forces at play when students learn a conceptual-based subject such as science. Achievement goals are a subset of achievement motivation and thus represent the “why” in learning, while constructivism and self-regulated learning are associated with the “how” of learning. While constructivism has been most prominent in science education, research on achievement goals and self-regulated learning has been ubiquitous in nature, with research transcending domain and even cultural arenas of inquiry. However, there is little research that considers in unison the constructs of achievement goal theory, social constructivist-based pedagogical features and self-regulated learning in high school science classrooms. The present research seeks to address this issue. Consequently, one of the prime purposes of the present research is to examine the interactions of these constructs in high school science classrooms.

Achievement goals represent the specific objectives, reasons, targets or purposes a person fosters during a competence-based situation such as a classroom (Ames, 1992; Dweck, 1992, 1996; Locke & Latham, 1990). In most competence-based situations two referent contexts exist: one's own internal standards of competence achievement and an external standard of competence achievement such as one's peers, a teacher's judgement or an exam result. The former context is labelled mastery while the latter is labelled performance. As a result of these orthogonal contexts, achievement goal theory is concerned with two major forms of achievement goals: mastery goals and performance goals. Each of the two fundamental achievement goals has been explored – theoretically and empirically – in terms of approach and avoidance dimensions in the academic arena (Elliot, 1999; Elliot & McGregor, 2001; Karabenick, 2004; Pintrich, 2000a, 2000b). According to this perspective, a student having a mastery-approach goal has the intent of mastering the task before them. A mastery-avoidance goal relates to the student giving up on or avoiding a task when they feel they are not achieving the desired level of accomplishment with respect to their own internal standards and has been associated with students that have set very high levels of personal standards or older people that do not wish to face losing previously acquired skills such in sport (Elliot, 1999; Elliot & McGregor, 2001). In contrast, a performance-approach goal implies tendencies for the student to attain positive competence effects with respect to external, normative standards (beating other students or displaying that one is better than others) while a performance-avoidance goal exists when the student focuses on avoiding situations that may display the student as being incompetent, of low ability or failing in front of others (Dweck & Elliott, 1983; Elliot & Harackiewicz, 1996; Middleton, Kaplan, & Midgley, 2004; Middleton & Midgley, 1997; Midgley & Urdan, 2001; Wolters, 2004).

Adopting a goal approach in studying students in achievement situations is important. By studying achievement goals, researchers have found that the achievement goals of students influence their cognitive processes, affect, behaviour and perception in a situation (Ames & Archer, 1988; Anderman & Maehr, 1994; Dweck, 1996; Elliot & McGregor, 2001; Urdan & Midgley, 2003) and may also help understand how cognition, affect and behaviour interact or co-ordinate to bring about behaviour (Ames, 1992; Dweck, 1992). An analysis of students' achievement goals may also be useful in examining students' perception of their class learning environment since goals may be mediators of students' engagement in the classroom (Ames & Archer, 1988; Anderman & Midgley, 1997; Church, Elliot, & Gable, 2001; Meece, Blumenfeld, & Hoyle, 1988; Midgley & Urdan, 2001) and adaptive behaviour such as help-seeking (Karabenick, 2004; Newman, 1998; Ryan, Pintrich, & Midgley, 2001).

Constructivism is a theory of learning (and ontology) has many variants although it is usually categorised into two streams of thought, social and psychological (Duit & Treagust, 1998; Lerman, 1996; Matthews, 1994; Phillips, 2000), the latter being the most commonly studied form of constructivism in terms of pedagogy-related issues (Richardson, 2003). Psychological constructivism is based upon the supposition that students build or construct their knowledge and understandings given appropriate phenomena (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Osborne, 1996). The emphasis is on the student constructing their understanding rather than adopting a passive learning stance that so often characterises a transmissive didactic approach to learning (Anderson, Holland, & Palincsar, 1997; Bodner, 1986). For example, von Glasersfeld (1995), from a radical constructivist theory viewpoint, emphasised the importance of the teacher questioning the type of cognitive conceptual structuring and re-structuring processes that arise in a learner irrespective of who or what is external to the learner. On the other hand, the Vygotskian theory of the social aspects of psychological constructivism is based on the influence of social interactions upon the learner (Driver & Scott, 1995; Hodson & Hodson, 1998). Constructivism has received much attention in science education over the past few decades (Matthews, 1994; Osborne, 1996; White, 2001). Just like models of self-regulated learning may lead to teaching strategies to foster the use of self-regulated learning in the classroom (e.g., Papaleontiou-Louca, 2003) constructivist theories lead to classroom practice issues and constructivist-inspired pedagogical practice. Constructivist theories of learning offer an epistemological-based framework that science students and their teachers can work in developing understanding and knowledge, particularly in a conceptual-based subject such as science. Constructivist pedagogy is based upon several key tenets of constructivism: (a) the student enters a learning situation with prior ideas and understanding; (b) the student is able to construct or develop their learning given suitable conditions such as scaffolding and testing, and via the processes of metacognition and cognition; (c) social and internal discourse is essential for the student to gauge their understanding and to foster reflectivity; and, (d) the learning experience must be authentic, particularly in a personal context for the student (Applefield, Huber, & Moallem, 2001; Brophy, 2002; Shymansky, Yore, Henriques, Dunkhase, & Bancroft, 1998; Staver, 1998). Hence, although constructivism is a theory of learning, it has been established that a distinctive style of pedagogy is affiliated with a constructivist approach to teaching and learning.

Self-regulated learning is a multifarious construct that has been utilised to describe the myriad of processes that students utilise as they go about their learning; self-regulated learning involves the cognitive processes and self-directed actions that are employed by a student when they are engaged in the process of learning (Schunk, 1990; Zimmerman, 2000b). Researchers have encapsulated self-regulated learning as meaning "…students' self-generated thoughts, feelings and actions, which are systematically oriented toward attainment of their goals" (Schunk & Zimmerman, 1994, p. ix) or as a condition that "…emphasizes autonomy and control by the individual who monitors, directs, and regulates actions towards goals of information acquisition, expanding expertise, and self-improvement" (Paris & Paris, 2001, p. 89). Researchers use the terms such as "autonomous, reflective, and efficient learners" (Wolters, 2003, p. 189), "personally initiate" (Zimmerman, 1989a, p. 329), and "comprehensive engagement" (Corno & Mandinach, 1983, p. 88) to state the attributes of a self-regulated learner. Students who are proficient at self-regulated learning have an array of cognitive processes that they can utilise effectively in order to accomplish the goals they associate with a task (Wolters, 1998). The self-regulation of one's learning thus involves processes such as monitoring, checking, directing, controlling, persistence, and seeking; it is a form of self-regulation that is oriented towards the attainment of adaptive or positive results in the learning environment context (Elliot & Church, 1997).

Despite focusing on different pedagogical-associated constructs associated with “teaching for understanding” and “learning for understanding” perspectives, the fields of achievement goals, constructivism and self-regulated learning as research disciplines have several aspects in common. Firstly, the research in each discipline has revealed the importance of the relevant constructs they tap into as playing an important role in effective learning and teaching. Constructivism, for instance, has established that students come to a science class with models or theories about phenomena and students tend to refer to these when learning; they also retain these substantive models after being taught science (Eylon & Linn, 1988). Constructivism has also been an influential referent for guiding curriculum reform efforts (Haney & McArthur, 2002; Kim, Fisher, & Fraser, 1999; Schneider, Krajcik, & Blumenfeld, 2005; Singer, Marx, Krajcik, & Chambers, 2000). Achievement goal theory has established that competitive learning environments promote students’ avoidance behaviour. Research on self-regulated learning has shown that metacognition is an important process of regulating one’s learning and students who are skilled at self-regulating their learning attain better grades than naïve learners (Zimmerman & Martinez-Pons, 1990). Secondly, the constructs of each discipline are social-cognitive in nature, being affected by environmental characteristics such as pedagogical factors, the school climate and peers. Personal or cognitive factors such as perceived competence, epistemology beliefs, prior experience and other temporal or historical aspects also impact. Thus, these disciplines have shown that the teacher can have some influence on the impact of these constructs in addition to the personal influences of the student. Thirdly, there has been a substantial amount of research on these fields over the past two decades and this work has resulted in the operationalising of the constructs associated with each field. This has shown the constructs to exist across many domain and cultural settings as well as occurring in males and females irrespective of age. This research has subsequently yielded reliable and valid quantitative and qualitative means of measuring the constructs associated with each discipline.

It is proposed here that another feature in common amongst these constructs is that they influence each other in an interdisciplinary fashion. While there has been a substantial amount of research on the interaction between achievement goals and self-regulated learning, scant attention has been made between the interaction of constructivism, particularly constructivist-based pedagogy ("social constructivism"), with achievement goals and self-regulated learning. The present research is designed to address this proposal that these constructs act in an interdisciplinary fashion to influence learning in the high school science classroom. Constructivist pedagogy, with an emphasis on mastery of learning concepts, has much to offer the fields of achievement goals and self-regulated learning, and in a reciprocal fashion, each of these fields informs constructivist theories of learning.

Several intradisciplinary issues are also addressed by the present research. The first issue concerns the existence of constructivist-based pedagogical dimensions, achievement goals and self-regulated learning in the context of high school science students and their classrooms. Two distinct school types exist in the New South Wales (Australia) public education system, academic selective high schools and comprehensive high schools. Most of these schools are co-educational and have students from year 7 (12 to 13 years) through year 12 (17 to 18 years of age). Academic selective high school students are usually labelled "gifted and talented" due their academic prowess. To be accepted into an academic selective high school, most students sit for a selective high school entry test in year 6 at primary school. The selective high schools then send letters of invite to the students who place; the offers of acceptance generally in line with the ordinal ranking of students. Thus, these schools represent a select group of academically elite children. Not much research has been done in comparing these students with comprehensive school students ("regular" students) in terms of the "teaching for understanding" practice they experience in their science classroom, their achievement goals and self-regulated learning skills. Other subpopulation variables investigated in the context of the present research included the impact of high school age (senior or junior) and gender on achievement goals and self-regulated learning; much of the research in achievement goals has focused on middle school students (years 6-8) and university students.

A second intradisciplinary focus area of the investigation concerns achievement goals. The mastery-avoidance goal has been under-researched and it may be prominent in selective high school students, who are generally high achievers. This investigation would thereby test Elliot's and colleagues' 2 X 2 goal theory (Elliot, 1999, Elliot & McGregor, 2001) which expands the contemporary trichotomous achievement goal model (mastery-approach, performance-approach and performance-avoidance) to four types of achievement goals by inclusion of the mastery avoidance goal (also see Pintrich, 2000a). One prominent area of conjecture with achievement goals in recent years has been the debate on the adaptive aspects of the performance-approach goal (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002; Midgely, Kaplan, & Middleton, 2001). It may be useful to study the motivational and cognitive features of selective high school students who, on the basis of anecdotal observations, have an emphasis on performance. Traditionally goals have been studied from a normative goal model, in which students are classified as being either a "mastery" or "performance" type. Contemporary goals research, however, now considers a multiple goal perspective, which considers the combined effects of mastery and performance achievement goals students may have. For example, it has been postulated that students having high mastery-approach and high performance-approach goal orientations will have the optimal profile for academic achievement and learning processes (Meece & Holt, 1993; Pintrich, 2000c; Wolters, Yu, & Pintrich, 1996). While there is a good deal of research based on the normative goal model, one of the next steps for contemporary achievement goal research is concerned with how students utilise their achievement goals in terms of multiple goal models (Harackiewicz et al., 2002) and this is one of the topics addressed by the present research. Perhaps these areas may be clarified through a focus on regular and gifted students.

The present research also attempts to extend these fields by examining the constructs at the micro-level in addition to the traditional trait-level analysis. In so doing, the present research utilises a “context” hypothesis. A context hypothesis contends that:

> (1) constructs such as achievement goals, competence perceptions and self-regulated learning are as functional in micro-learning events/contexts such as small group work as they are at trait-level analyses;
> (2) viable relations exist between such constructs in micro-learning events;
> (3) the salience of these constructs and their sub-constructs depends on the type of context; and,
> (4) the calibration-associated issues with students’ reporting of constructs will be improved.

With regards to the last point, ascertaining constructs in contexts such as group work or a teacher-led discussion will improve the validity of students’ reporting of constructs such as goals and self-regulated learning in several ways. Firstly, students will have a better chance of remembering their goals and learning behaviour due to the proximity of the context. Secondly, self-reporting is specific to the episode and hence students will be better able to report on their behaviour (e.g., self-regulated learning strategies) instead of remembering a mixed array of behaviours which may occur when asked in trait level analyses. Thirdly, reporting on a context may improve students’ reporting of their efficacy and perceived ability for a task. Perceptions of competence are the basis of many achievement goal theories and the calibration of perceptions about efficacy and ability can be improved by students reporting on a finer grain of context. This approach may assist in more accurate reporting of the consequences of goals as compared with using the outcomes of exams as the sole consequence of goals. For example, do students who report to have high performance-approach goals implement adaptive learning behaviours such as self-regulated learning? Are these mediated by the student’s mastery-approach goal and efficacy beliefs? Rather than depending on exam results to answer these questions the present research also investigated the self-regulated learning of students. Finally, a context focus also enables an examination of achievement goals and self-regulation of learning in constructivist-pedagogy contexts. This pedagogy is affiliated with distinct activities that vary in terms of the amount of teacher- and student-regulation. A context focus may reveal the influences of students' motivational and self-regulated learning qualities in constructivist-based settings.

Finally, some adjunct variables were investigated in light of the issues raised above. The motivational beliefs of intrinsic value, test anxiety, self-efficacy and perceived ability have been shown to be antecedents of goals and self-regulated learning (Pintrich, 1989; Pintrich & De Groot, 1990; Wolters & Pintrich, 1998) and therefore were also measured in order to assimilate the social cognitive nature of learning and teaching in high school science classrooms.

1.2 RESEARCH QUESTIONS

As a result of these issues the present research addresses the following research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?
>
> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?
>
> Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Research Question Seven: What are students' perspectives with regards to the impact classroom activities have upon the adoption of achievement goals?

1.3 ORGANISATION OF THE THESIS

The purpose of this thesis is twofold. Firstly, it presents literature reviews for achievement goals and self-regulated learning in terms of hierarchical relations – that is, in terms of the antecedents and consequences for these constructs. Adopting an interdisciplinary approach to studying learning environments is complex; by reviewing the relevant research from the fields of constructivism, achievement goals and self-regulated learning in a hierarchical fashion provides a logical framework of analysis of the work and situates the present research. Chapters 2 to 5 are concerned with the literature reviews and presenting the research questions and hypotheses of the present research. The second aim of this thesis is to report the research. Three studies comprise the research and these are presented in Chapters 6 to 12. Due to the contextualised nature of these studies, a specific discussion and the limitations of each study are presented within the relevant chapter. A general discussion, implications for research and conclusions form Chapter 13.

Chapter 2

OUTLINE OF THE LITERATURE REVIEWS

Achievement goals, constructivist pedagogy and self-regulated learning serve as the foci of the present research. Research conducted in the fields of achievement goals and self-regulated learning has generally been multi-dimensional, with the constructs being considered in terms of hierarchical relationships composed of a variety of antecedents and consequences, these variables being socially or personally situated in nature. Applying this framework of analysis to the present inquiry is relevant for several reasons. Due to the multidisciplinary nature of the present research, classifying variables as influences or consequences presents a logical framework for situating the objectives of the current research with respect to the literature associated with the fields of achievement goals, constructivism and self-regulated learning. It also assists in reviewing and presenting the literature with respect to the objectives of the present research, and for presenting the paths of analysis for the present research. Consequently, the achievement goals' review (Chapter 3) examines the influence of social (constructivist learning environments, classroom achievement goal structure, micro-learning environments) and personal (competence perceptions) factors on students' personal achievement goals, and examines the consequences of the achievement goals in terms of academic achievement. The self-regulated learning review (Chapter 4) focuses on the influence of social (constructivist learning environments, classroom achievement goal structure, micro-learning environments) and personal (personal achievement goals, competence perceptions) factors on self-regulated learning, and examines the consequences of self-regulated learning in terms of academic achievement. Gender and ability issues are also treated in each section. Chapter 5 sums the literature review findings in the context of the intentions of the present research and in so doing presents the research questions and hypotheses.

Chapter 3

LITERATURE REVIEW: RESEARCH ON ACHIEVEMENT GOALS

3.1 ACHIEVEMENT GOALS: THEORETICAL CONSIDERATIONS

Students' achievement goals are widely acknowledged as important mediators of purposeful learning and achievement in classrooms (Church et al., 2001; Dweck, 1996; Elliot & Harackiewicz, 1996; Meece et al., 1988). Achievement goals stem from the omnipresent set of motivational characteristics that exist in all types of classrooms and have been considered as one group of several social cognitive constructs that have been considered to have a major influence on the motivation of students in the classroom (Pintrich, 2003). These other social cognitive constructs include self-efficacy, attributions and control, interest, and value (Pintrich, 2003). The rationale behind the focus on achievement goals is that they are formed in competence-based situations such as the classroom and influence a student's behaviour, such as how they self-regulate their learning and engage in tasks. As such, a significant body of research related to achievement goals, both theoretically- and empirically-based, has accumulated over the past twenty years (for reviews see Ames, 1992; Dweck, 1986; Dweck, & Elliott, 1983; Elliot, 1999; Harackiewicz et al., 2002; Midgely et al., 2001; Nicholls, 1984; Pintrich, 2003; Rawsthorne & Elliot, 1999; Thorkildsen & Nicholls, 1998). While achievement motivation is concerned with the impetus of behaviour in order to achieve success and avoid failure (Atkinson, 1980; Franken, 1998; Heckhausen, 1967; McClelland, Atkinson, Clark, & Lowell, 1953; Weiner, 1972), achievement goals are used to represent the specific objectives, reasons, targets or purposes a person fosters during a competence-based situation (Ames, 1992; Dweck, 1992, 1996; Locke & Latham, 1990).

In recent time each of the two fundamental achievement goals, mastery and performance, has been explored – theoretically and empirically – in terms of approach and avoidance dimensions in academic settings (Elliot, 1999; Elliot & McGregor, 2001; Karabenick, 2004; Pintrich, 2000a, 2000b). A student having a mastery-approach goal has the intent of mastering the task before them. This involves being engaged in learning, attempting to understand, achieving competence (Ames, 1992; Church et al., 2001) and improving their ability (Elliott & Dweck, 1988; Kaplan & Midgley, 1997; Nicholls, 1984).

A mastery-avoidance goal relates to the student giving up on or avoiding a task when they feel they are not achieving the desired level of accomplishment with respect to their own internal standards and has been associated with students that have set very high levels of personal standards or older people who do not wish to face losing previously acquired skills such as in sport (Elliot, 1999; Elliot & McGregor, 2001). This may also be associated with the development of a false set of standards in order to avoid feelings of personal failure (Pintrich, 2000b). Pintrich (2000a) suggests that the adoption of a mastery-avoidance goal, that is, having a high mastery-avoidance orientation, fosters some maladaptive or negative processes. These may be cognitive (e.g., altering internal standards in order to avoid failing to understand), affective (e.g., increasing anxiety), or motivational (e.g., lower self-efficacy and lower intrinsic motivation) in nature. The mastery-avoidance goal has hardly been studied in the context of high school classrooms (although see Karabenick, 2004) let alone in gifted education or high academic performance contexts where it may be expected to be salient. Thus, one of the objectives of the present research is to investigate the presence and relations of this under-explored construct, particularly with respect to self-regulated learning in high school students.

In contrast, a performance-approach goal implies tendencies for the student to attain positive competence effects with respect to external, normative standards (performing better than other students or displays of superiority) while a performance-avoidance goal exists when the student focuses on avoiding situations that may display the student as being incompetent, having low ability or failing in front of others (Dweck & Elliott, 1983; Elliot & Harackiewicz, 1996; Middleton et al., 2004; Middleton & Midgley, 1997; Midgley & Urdan, 2001; Wolters, 2004).

Perhaps the main area of conjecture in achievement goal theory presently concerns the patterns of affect, behaviour, cognition and academic performance that arise with performance goals (Harackiewicz et al., 2002; Midgley et al., 2001). According to one line of research, the performance goal focus is on effort and ability comparisons with others (trying to be the best), whereas the focus of the mastery goal is on one's ability to master a task, that is, achieve improvement (Ames & Archer, 1988; Dweck & Elliott, 1983; Dweck & Leggett, 1988; Elliott & Dweck, 1988). According to this research [which is underpinned by Dweck's personal theory of intelligence (Dweck & Leggett, 1988) and Covington's theory of self-worth (1992)] a focus on performance goals makes students vulnerable to negative patterns of learning processes since students make judgements about their ability that are mediated by perceptions of effort and ability. For instance, if a task requires a lot of effort then it is inferred by the student that they have low ability; a perception whether success or failure results. The inverse occurs for low-effort tasks: success in a low-effort task infers high ability ["You only know you're good at something when it comes easily to you." (Dweck & Leggett, 1988, p. 401)]. As a consequence of this theory, adoption of a performance goal construes negative learning processes such as adopting superficial learning strategies since these require the minimal amount of effort. On the other hand, according to this theory, mastery goal-focused students attribute failure not to ability but to effort; they simply increase their effort in the face of failure.

While there is agreement on these effort attributions – they are echoed in the literature (e.g., Archer & Scherak, 1998; Bandalos, Finney, & Geske, 2003; Karabenick, 2004; Pintrich, 2000b) – there was discrepancy with respect to the consequences of the performance goal on areas such as academic achievement and interest (Harackiewicz, Barron, & Elliot, 1998) and the motivational motives of the performance goal (Elliott, 1999; Wolters et al., 1996) and this was the impetus for the divergence of the performance goal into approach and avoidance references (Elliot & Harackiewicz, 1996). For example, it was found that adopting a performance goal would lead to superficial learning processes such as rote learning and taking short cuts in learning since the goal is to display superior ability rather than improve ability (Ames, 1992; Meece et al., 1988; Nolen, 1988). On the other hand, Dweck and Leggett (1988) contended that it is the ability perception of a performance goal-focused student that influences their affect, behaviour, and cognition in the classroom: the perception of high ability endears a mastery-type of orientation (seeks challenge and has high persistence at the task); the perception of low ability ensues a "helpless" orientation (giving up easily and low persistence). Evidence of adaptive performance goal orientations occurred in some studies (Midgley et al., 2001; Pintrich & Garcia, 1991). For example, Meece et al. (1988)

found a performance goal orientation to be positively related to task engagement but to a lesser degree than the mastery goal. Other studies found no relation between performance goals with performance and motivational variables (Urdan, Pajares, & Lapin, 1997). Thus, the reports of the consequences of the performance goal orientation were inconsistent (Elliott, 1999; Midgley et al., 2001). The bifurcation of the performance goal into performance-approach and performance-avoidance has resulted in clarifying the nature of the performance achievement goal somewhat, especially in terms of avoidance behaviour (Elliot & Church, 1997; Elliot & Harackiewicz, 1996; McGregor & Elliot, 2002).

Even with the performance goal dichotomy, there are still debates about the consequences of the performance-approach goal. Harackiewicz et al. (2002) and Midgley et al. (2001) in their reviews cite numerous studies displaying the positive (Church et al., 2001; Elliot & Church, 1997; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997; Pajares, Britner, & Valiante, 2000; Skaalvik, 1997; Wolters et al., 1996) and negative consequences (Pintrich, 2000c) of adopting a performance-approach goal for the areas of achievement, affect, attitudes, effort, and task value. In addition, some studies report that the utilisation of the performance-approach goal has a null effect on learning processes (Middleton & Midgley, 1997; Wolters, 2004). Wolters (2004) suggests that disparities between the studies with respect to the learning setting (university, school) and the students' age groups (secondary school versus university) studied may affect the results obtained for the performance-approach goal. It has also been suggested that some of the research affiliated with performance-approach goals has not been valid with some researchers using a mixture of performance-approach and performance-avoidance or unspecified generic performance-based scales – the bifurcation of performance goals occurring relatively recently in achievement goal research (Harackiewicz et al., 2002). Furthermore, performance-approach goals are underpinned by external referents that may interact with personal-based variables such as fear of failure and the need for achievement (Elliot, 1999) and hence lead to more inconsistent research findings compared to mastery and performance-avoidance goals which are more clear in terms of their valence and referents (Harackiewicz et al., 2002). The performance-avoidance research is more clear-cut, showing that a performance-avoidance goal fosters negative consequences since students with this goal are concerned about how they are perceived by others and failing, by means of gaining poor results, is what they are trying to avoid since failing equates to incompetence (Church et al., 2001; Elliot & Church, 1997; Middleton & Midgley, 1997; Wolters, 2004). Accordingly, the dichotomous nature that pervaded achievement goal research has been expanded to one that is quadruplicate in nature although Elliot (1999) prefers to use the term "2 X 2 achievement goal framework" (see also, Elliot & McGregor, 2001) to encapsulate the quadruplicate nature of the two achievement goals, mastery and performance with their approach and avoidance valences. Furthermore, these goals are distinctly orthogonal (Pintrich, 2000c) with students holding variants of each, leading to a multiple goal effect that may impinge upon the learning processes of students.

Because of differing referents, the use of achievement goal constructs is predicated on the view that the goals a student adopts are orthogonal to one another (Ames & Archer, 1988; Turner, Thorpe, & Meyer, 1998). In other words, these goal orientations are separate constructs that impinge upon a student's motivation in the classroom (Ames & Archer, 1988; Anderman & Maehr, 1994; Elliott & Dweck, 1988). Furthermore, each achievement goal can be measured in a continuous numerical linear scale format and hence the use of the term "orientation" to describe the amount of a particular goal present in a person (Nicholls, 1989). For example, a student may have a high mastery goal orientation or a low mastery goal orientation.

Elliot and his colleagues' hierarchical model of achievement goals has been the instigator for the bifurcation of performance goals and mastery achievement goals (Elliot & Church, 1997; Elliot & Harackiewicz, 1996). Elliot's (1999) review of the achievement goal literature presented the hierarchical theory on achievement goals. This theory contends that there are two influential antecedents towards achievement goals. The first antecedent pertains to the achievement motives of students: students have an innate need for achievement and they also have a fear of failing. According to the valence of these two motives, approach behaviour results from the need to achieve, while avoidance behaviour is a result of the need to avoid failing. The second influential antecedent is concerned with perceptions of competence, perceptions students have about their ability with respect to the context and the tasks required. Students having high competence perceptions will adopt approach behaviour whilst students that perceive they have low ability will tend to employ avoidance behaviour. These two cognitive antecedents, the underlying achievement motives of success and fear of failing, and the perception of ability, can interact and moderate each other such that multiple pursuits of achievement goals can occur. This theory has been supported by the experimental and field research of Elliot and his colleagues (Elliot & Church, 1997; Elliot & Harackiewicz, 1996; Elliot & McGregor, 2001; McGregor & Elliot, 2002). Thus the hierarchical nature of this theory provides a framework for the pursuit of multiple achievement goals by students. However, there is not much research done on high school students in terms of the 2 X 2 goals framework espoused by Elliot and colleagues (Elliot, 1999; Elliot & McGregor, 2001), a topic addressed by the present research.

One important point concerning the assessment of mastery-approach, performance-approach and performance-avoidance goals needs to be highlighted. Elliot and his colleagues (Church et al., 2001; Elliot, 1999; Elliot & Church, 1997; Elliot & McGregor, 2001) viewed achievement goals from a hierarchical perspective (Elliot & Church, 1997), one that encapsulated the motivational rationale behind the reported behavioural goal. According to this theory, the motivational rationale for the mastery-approach goal is the need to achieve, the rationale for the performance-avoidance goal being the fear of failing, and the performance-approach goal has the need for both achieving and not failing. Thus, their items integrated not only the symptomatic tendencies of each goal but also an emotive-based motivational rationale ("fear of failure"). For example, "My fear of performing poorly in this class is often what motivates me" (performance-avoidance goal item). In contrast, Midgley and her colleagues (Midgley et al., 1998; Midgley & Urdan, 2001; Middleton et al., 2004; Middleton & Midgley, 1997), using the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1997), have espoused the use of items that reflect the symptomatic tendencies of achievement goals with some emphasis on comparative ability concerns rather than emotive-based concerns as used by Elliot et al. For example, "One reason I would not participate in class is to avoid looking stupid" (performance-avoidance item). One weakness in using the Midgley et al. model seems to be the amount of correlation between performance-approach and performance-avoidance scales, a result of comparative ability emphasis as the underlying rationale (Midgley et al., 1998). Studies using the PALS, for instance, have obtained relatively high inter-scale correlations for the performance-approach and performance-avoidance scales. The Middleton et al. (2004) study obtained 0.58 and 0.62, and the Middleton and Midgley (1997) study obtained a correlation of 0.56. Studies using the hierarchical perspective have obtained correlations of 0.31 (Elliot & Church, 1997), 0.40 (Elliot & McGregor, 2001), and 0.32 (McGregor & Elliot, 2002). It should be pointed out, however, that the Elliot-associated studies have been on university students whereas the Midgley-associated work has been with secondary and elementary students – perceptions of the motivational rationale of items may be affected by the age and environment of the students studied. One of the purposes of this study is to explore the mastery-avoidance goal in the high school context, building on the seminal work of this construct by Elliot and McGregor (2001). In concordance with that work, this study adopts the hierarchical model of achievement goals, incorporating a symptomatic and emotive-based motivational rationale to achievement goal items via the use of Elliot and Church's (1997) achievement goal items in order to differentiate the approach-avoidance dimension for both mastery and performance achievement goals.

Another step in achievement goal research has been to view achievement goals from a multiple goal perspective instead of the normative goal perspective – in which students are classified as being either mastery or performance-orientated - that permeates much of the achievement goal literature (e.g., Ee, Moore, & Atputhasamy, 2003; Meece et al., 1988; Middleton & Midgley, 1997; Pintrich, 2000c; Young, 1997). A multiple goal perspective contends that students hold variants of mastery and performance goals simultaneously and this impacts upon learning and achievement (Barron & Harackiewicz, 2001; Kaplan & Midgley, 1997; Meece & Holt, 1993; Midgley & Urdan, 2001; Miller, Behrens, Greene, & Newman, 1993; Pintrich, 2000c). For example, some researchers suggest that the performance-approach goal orientation may be beneficial in terms of fostering initial engagement and being an external motivator for doing the task while the mastery goal orientation promotes adaptive learning processes. Hence students who have a high mastery approach orientation and a performance-approach goal orientation would have the most adaptive achievement motivational outlook (Linnenbrink & Pintrich, 2003). However, the role of performance-approach goals in learning is not clear. In congruence with contemporary approaches to studying achievement goals (e.g., Harackiewicz et al., 2002), both single goal and multiple goal perspectives are utilised in the present research.

Crucial to the study of achievement goal theory is the notion that a person is cognisant with the achievement goals they hold; in other words, these goals are consciously intentional and recognisable (Locke & Latham, 1990). This feature of achievement goal theory is important for it assumes that researchers can measure the goals that people construe in achievement-based environments and it has implications for the validity and reliability of measures (Pervin, 1992). Other cognitive underpinnings of achievement goal theory include the person's perception of the historical, immediate and impending contexts, and their emotions, beliefs and thoughts (Stipek, 1998). Like other theories related to achievement motivation (e.g., Franken, 1998; Weiner, 1972), achievement goal theory is social cognitive in nature: behaviour and goals are mediated by the thoughts and beliefs of the individual, which in turn are dependent on situational factors such as the learning environment fostered by the teacher (Ames, 1992; Middleton et al., 2004; Schunk & Ertmer, 1999). These areas will be addressed in the review of empirical-based achievement goals research below.

Adopting a goal approach in studying students in achievement situations such as high school science classrooms is important. By studying achievement goals, researchers have found that the achievement goals of students influence their cognitive processes, affect, behaviour and perception in a situation (Anderman & Maehr, 1994; Ames & Archer, 1988; Dweck, 1996; Elliot & McGregor, 2001; Urdan & Midgley, 2003) and may also help understand how cognition, affect and behaviour interact or co-ordinate to bring about behaviour (Ames, 1992; Dweck, 1992). An analysis of students' achievement goals may also be useful in examining students' perception of their class learning environment since goals may be mediators of students' engagement in the classroom (Anderman & Midgley, 1997; Ames & Archer, 1988; Church et al., 2001; Meece et al., 1988; Midgley & Urdan, 2001) and adaptive behaviour such as help-seeking (Karabenick, 2004; Newman, 1998; Ryan et al., 2001). These considerations have important implications for areas such as science education in which the dominant pedagogical focus has been on constructivism and its affiliated constructs such as conceptual change. These areas have focused on pedagogical issues related to instruction and students' cognition and have tended to neglect or not address the motivational, self-regulated learning and affective characteristics that may also factor in learning (Linnenbrink & Pintrich, 2003; Pintrich, Marx, & Boyle, 1993; Sinatra & Pintrich, 2003a). Subsequently, the present research is intended to examine the relations between achievement goals, self-regulated learning and constructivist-based pedagogy in high school science classrooms.

3.2 SOCIAL/ENVIRONMENTAL INFLUENCES OF ACHIEVEMENT GOALS

3.2.1 Classroom Achievement Goal Structures

Classroom achievement goal structure refers to the achievement goals perceived by students of their classroom. These are to be differentiated from personal achievement goals, goals that individuals pursue. Generally, classroom achievement goal structures have been explored in a normative context with the focus being on mastery and performance goal structures (Anderman & Midgley, 1997; Ames & Archer, 1988; Midgley & Urdan, 2001; Newman, 1998; Nolen, 2003; Urdan & Midgley, 2003; Young, 1997). Accordingly, a high mastery goal structure represents an emphasis on understanding and acquiring knowledge, with a low emphasis on ability-related issues. A classroom with a high performance goal structure emphasises ability competence. For example, highlighting who comes first, indicating class means, focusing on test preparation and frequently highlighting test results (Midgley & Urdan, 2001). Three types of classroom achievement goals have been investigated in terms of approach-avoidance dimensions: a mastery goal structure, a performance-approach goal structure and a performance-avoidance goal structure (Ames & Archer, 1988; Anderman & Midgley, 1997; Kaplan, Gheen, & Midgley, 2002; Karabenick, 2004; Urdan & Midgley, 2003; Wolters, 2004). Since classroom achievement goal structures may reflect the teacher's mastery and performance ideologies, which conjointly may impact upon the learning environment (Ames, 1992; Prawat, 1985; Turner, Meyer, Midgley, & Patrick, 2003; Urdan & Midgley, 2003), they are investigated in the present research especially in light of constructivist learning environment dimensions. These types of goals are part of the social factors influencing students' personal achievement goals and the consequences of these thus need to be considered. There has been scant research on the implications of multiple goal structures (Patrick, Anderman, Ryan, Edelin, & Midgley, 2001; Turner et al., 2003). However, it has been found that teachers who foster a learning environment having a high mastery goal structure have similar classroom practices despite having differences in their performance goal structures (Patrick et al., 2001) therefore demonstrating that these goal structures are independent (orthogonal) in nature. Classroom achievement goal structure also should be distinguished from the goals that are at the school level, which lead to the school culture.

It is acknowledged that the main influence on the classroom achievement goal structure is the teacher for several reasons (Kaplan et al., 2002). Firstly, the teacher's personal achievement goal focus may transfer to their classroom organisational and pedagogical practices. Teachers who think it is important for students to get good grades and perform well on tests and tasks will emphasise ability and foster performance goals at the classroom level. Others may be more concerned with the development of understanding rather than ability-associated issues and thus nurture a high mastery goal structure. For example, a substantial body of research has shown the type of learning environment in high school becomes more objectivist or teacher-controlled compared to elementary school practice (Anderman & Maehr, 1994; Eccles et al., 1993a; Neber & Schommer-Aikins, 2002; Penna, Baird, White, & Gunstone, 1992) and students have been found to lose interest (Baird, Gunstone, Penna, Fensham, & White, 1990; Eccles et al., 1993b; White & Mitchell, 1994). This could be attributable to the teacher focus on performance in high schools. Alternatively, teachers may exhibit multiple classroom goal structure tendencies, although research has not addressed classroom achievement goal in a multiple goal framework. Secondly, the achievement goal structures emphasised by the teacher may be a result of curriculum perspectives. A crowded curriculum may force some teachers to resort to using a performance goal style such as using a transmissive approach instead of exploring ideas about the topic and encouraging rote learning since there is not enough time to get through the curriculum. In this context it is a matter of survival of the fittest for the students with respect to knowledge attainment and dealing with competence perceptions (Nolen, 2003). Thirdly, school level goals may impinge upon the classroom and thus the teacher's goal structure (Anderman & Maehr, 1994; Roeser, Midgley, & Urdan, 1996). Selective high schools, schools that cater for academically gifted students, may have an emphasis on achieving high marks thus maintaining a school's reputation for achieving high marks in university entrance exams. Teachers may feel it important to emphasise performance in this type of school culture environment. There has been considerable research on the differences between elementary, middle and high schools with respect to goal structures, with elementary schools being more oriented towards the mastery goal structure than other school types (Anderman & Midgley, 1997; Midgley, Anderman, & Hicks, 1995; Urdan & Midgley, 2003). Teachers also report these differences (Midgley et al., 1995). Fourthly, hegemony-related reasons could affect the classroom achievement goal structure. The learning environment fostered by a teacher may in part be influenced by the teacher's historical-based experiences such as the type of learning environment they experienced at school and university (Taylor, 1992). Another factor influencing the goals of the classroom could be a result of reciprocal relations between students' personal achievement goals and the teacher's achievement goals. Teachers may emphasis certain goals as a result of the achievement goals they perceive of the students that comprise the class (Turner et al., 2003). It has been shown that students gain awareness of achievement goals by grade 5 (Meece & Miller, 1999; Thorkildsen & Nicholls, 1998), these goals continue through high school and university and may be influenced by their perceptions of the other students in the class, especially with respect to competence perceptions. For example, if a class contains a number of students who persistently ask questions through sheer interest rather than towards performance-related issues then the teacher may focus more on mastery approaches. On the other hand, if students are of high ability and confidence, and focused on exam performance, then the teacher may resort to using performance approaches. Finally, teacher style may also impinge on the classroom achievement goal structure. Teaching in a particular pedagogical style (e.g., constructivist pedagogy, metacognition programs, conceptual change approaches) may cause the teacher to adopt a particular achievement goal orientation. Constructivist approaches emphasis learning and understanding and thus teachers who adopt this approach may lean towards a mastery classroom achievement goal structure at the demise of the performance goal structure (Blumenfeld, 1992; Patrick et al., 2001).

Studies that have attended to classroom goal structures have appeared only relatively recently in achievement goal research. This has been a result of an increased interest in the role of social and environmental contextual factors and their interaction with cognitive factors such as efficacy on students' personal achievement goals. It may also be partly due to the operationalisation of these constructs. The motive behind this type of research is to examine the relationship of teacher-related variables with students' personal achievement goals and other constructs such as affect (Kaplan & Midgley, 1999; Urdan & Midgley, 2003), self-handicapping (Midgley & Urdan, 2001; Urdan, 2004), self-regulated learning (Ames & Archer, 1988; Ryan & Patrick, 2001; Wolters, 2004; Young, 1997), seeking help (Karabenick, 2004; Newman, 1998), and academic efficacy (Anderman & Midgley, 1997).

Like much achievement goal research, empirical studies affiliated with goal structures are multidimensional in nature, treating goal structures as influences of personal achievement goals and other constructs such as self-regulated learning and self-handicapping. Most of these studies use students' perceptions of their classroom environment as a measure of the achievement goal climate fostered by the teacher. This method is in contrast to two other methods of ascertaining classroom goal structures: (a) using the students' personal achievement goals as the unit of analysis – collectively this represents the motivational character of the class (Nolen & Haladyna, 1990; Thorkildsen & Nicholls, 1998), and (b) asking the teacher to report their goal emphasis (Anderman & Young, 1994). Two types of study designs have been utilised: longitudinal and one-off administration of quantitative instruments. Longitudinal or transition studies have the advantage of measuring students' personal achievement goals and their prior classroom goal structures before encountering a particular classroom on a temporal basis. This enables the researchers to gauge the impact of the new environment as perceived by the students. Most of the longitudinal-based studies have focused on the change from elementary to middle schools. Urdan and Midgley (2003) conducted one such study, examining the relations between classroom goal structures, personal achievement goals (mastery, performance-approach, performance-avoidance), self-efficacy, affect and academic achievement as students moved from grade 5 through grade 6 in elementary school and then to grade 7 in middle school. While students in elementary school had the one teacher for all subjects, in the middle school students had different teachers for their subjects and thus the researchers focused on the math domain for grades 6-7. Students were surveyed throughout their schooling using items from the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1997). The mastery goal structure scale items from this questionnaire asked students questions such as "My (math) teacher thinks mistakes are okay as long as we are learning" and "My (math) teacher wants us to understand our work, not just memorise it". Performance goal structure scale items included "My (math) teacher tells us how we compare to other students" and "My (math) teacher lets us know which students get the highest scores on a test". Using a repeated measures analysis of covariance (ANCOVA) enabled the researchers to see if there were significant differences between the grades in terms of the variables while controlling for gender, ethnicity, and academic achievement at the end of grade 6. This study found that students varied in their perceptions of both mastery and performance goal structures of their classes: some perceived increases in these goal structures, some perceived a decrease, and some reported no change. In terms of the relations between goal structures and personal achievement goals, students who perceived their classroom as having an increase in the mastery goal structure from one class to the next also reported to have an increase in their personal mastery achievement goal, self-efficacy, positive affect and achievement; those that perceived a decrease in the mastery goal structure had a decrease in their personal mastery goal as well as a decline in positive effect and self-efficacy. This occurred for students moving from grade 5 to 6, and from grade 6 to 7. Students that perceived an increase in the performance goal structure reported increases in personal performance-approach goals and negative affect, but this was only observed in the grade 5 to 6 transition. Consequently, this study found greater effects associated with changes to the perceived classroom mastery goal structure than with the performance goal structure: students are more sensitive to changes to the mastery goal structure features of the classroom environment. The weak pattern of results for the performance measures may be attributable to the failure of the researchers to distinguish between performance-approach and avoidance classroom goal structures in their survey although they suggest that the classroom performance goal structure is a unitary construct that is interpreted differently by students.

Anderman and Midgley (1997) examined the achievement goal structures and personal goals of students making the transition from grade 5 to grade 6 in math and English classes. Scales from the PALS (Midgley et al., 1997) were administered to students in grade 5 and then in grade 6 and the data subjected to a repeated measures multivariate analysis of variance (MANOVA) to determine the changes over time for the variables. This study also differentiated students into two ability-based groups, high-ability and low-ability on the basis of their results in a state-wide assessment. Both mastery goal structure and personal mastery goals decreased when students changed from grade 5 to grade 6. Grade 6 classes were also perceived as having a greater performance goal structure than grade 5 classes and this was associated with an increase in the personal performance achievement goals but only for females. These results also found there was a decline in perceived academic competence in the transition with high ability students' perceptions of their academic competence substantially declining more than that of the low ability students. The suggestion is that high ability students are more susceptible to ability-related classroom practice, which is experienced more in grade 6 (middle school) than in grade 5 of elementary school.

The results of the above transition studies were based upon analysis of variance and thus no causality can be attributed to the relations between classroom goal structures and personal achievement goals. Hence, changes in the goal structure reported by students and the corresponding changes to students' personal achievement goals could be a result of either the classroom-level goals influencing personal goals or students' personal goals changing over time and these changes influence their perception of class goal structures. The transition study conducted by Young (1997) addressed the causality issue by using hierarchical multiple regression analyses, which enabled her to see the effects of goal structures on personal goals after controlling for personal and classroom goals from previous classes and grades. Subsequently, this study found the mastery goal structure positively predicted personal mastery and personal performance-approach goals when students made the transition from grade 6 into grade 7 for both their English and math classes. Perceptions of the performance goal structure positively predicted personal performance-approach goals only in the English classes; they also positively predicted in English and math an extrinsic-focus goal, a second type of personal performance goal that Young (1997) was investigating.

Nolen (2003) used a longitudinal study design to investigate the impact of classroom learning environment factors such as achievement goal structure in ninth-grade high school science classrooms on students' personal achievement goals, satisfaction and science achievement. However, she examined two similar but slightly different classroom goal-related structures: a "science-learning focus" goal, which is akin to a mastery goal structure, and an "ability-meritocracy" goal, which combined performance-approach aspects of the classroom with some epistemological beliefs aspects such as the emphasis on obtaining correct answers and a competitive climate. Students (*n* = 377) completed questionnaires at the start of the school year, in order to measure, amongst other characteristics, their dispositional personal achievement goals, and at the end of the school year in order to see how much the science classroom climate they had experience throughout the year affected their personal achievement goals, satisfaction and science achievement. At the start of the school year, students in the high ability classes had a higher mastery goal orientation and a lower work avoidance goal than students in the mixed-ability classes. High ability students also perceived their classrooms as less performance-based. However, by the end of the school year there was no difference between high ability and mixed-ability classes in terms of their classroom goal structures, and the high ability students were more performance-focused, similar to students of the mixed ability classes. Nolen suggests this could be due to the use of assessment protocols throughout the year that emphasised rote learning. She also found the ability-meritocracy goal structure to have a negative correlation with the mastery goal structure. A mastery goal structure emphasis positively related to the personal mastery goal and performance-approach goal orientations (she did not examine performance-avoidance goals) whereas an ability-meritocracy goal structure was negatively associated with a mastery goal orientation and had no relation to the performance-approach orientation. Using hierarchical linear modelling analyses, this study also found the mastery goal structure to be a positive predictor of personal mastery goals and satisfaction with the learning beyond students' dispositional personal achievement goals and other characteristics.

The studies of Young (1997) and Nolen (2003) have provided causal-associated data with regards to the impact of classroom goal structures on students' personal goals and other features. This work supplements the work of other transitional studies that have not controlled for prior-contextual achievement goals demonstrating that the context of the classroom may affect students' perception of goals and subsequent behavioural and cognitive outcomes. Single-administration questionnaire study designs have found similar relations between classroom goal structures and personal achievement goals. These studies have used some form of multiple regression to gauge the relation between classroom-level goals and personal-based goals based on students reporting their perception of the classroom goal structures. This body of research has found the mastery goal structure to be a positive predictor of students' personal mastery goals in high school classrooms (Ee et al., 2003; Kaplan et al., 2002; Midgley & Urdan, 2001; Urdan, 2004; Wolters, 2004) and tertiary settings (Karabenick, 2004). These studies have also found classroom performance goals to positively predict both personal performance-approach and avoidance goals (Midgley & Urdan, 2001; Wolters, 2004), or for classroom performance goals to be positive predictors of personal performance-avoidance goals (Kaplan et al., 2002; Urdan, 2004) or positive predictors of performance-approach goals only (Karabenick, 2004). On the other hand, Ee et al. (2003) studied high ability Singaporean grade 6 students and found the mastery goal structure to positively predict the students' personal performance-approach goals – a similar result to that found in Young's (1997) study. Two studies that measured the teachers' perceptions of their classroom goal structure found these positively correlated with their students' classroom level goal perceptions (Kaplan et al., 2002) and teachers that reported to use ability-focused practices (akin to a performance-approach goal structure) lowered the mastery goal orientation of their students (Anderman & Young, 1994).

3.2.2 Pedagogical Structures

Another body of research that has examined the influence of classroom-level characteristics on students' personal achievement goals focuses on specific teacher practice. Defining teacher practice in terms of classroom-level achievement goals generally utilises the framework first espoused by Epstein (1988, cited in Ames, 1992) and then explicated by Ames (1992), Maehr and Anderman (1993), and Midgley (1993) in their reviews of classroom learning environment structures and achievement goals. This framework classifies goal-related teacher practice in terms of various learning environment or pedagogical structures. These structures, which may act individually or interact with one another to impact upon the achievement goals of students, are categorised as:

- *Tasks:* this structure is concerned with the design of learning tasks. Are tasks designed to generate interest and have a focus on learning and acquiring skills?
- *Authority-related aspects:* this relates to the amount of autonomy provided to students and the amount of teacher-control experienced in classrooms.
- *Recognition:* are students recognised on the basis of effort and skill attainment or on the basis of normative-based criteria?
- *Grouping:* the use of group work to foster learning and developing a cooperative climate.
- *Evaluation:* the emphasis placed on normative evaluation practice.
- *Time:* are students provided with enough time to accomplish tasks or are tasks rushed?

The acronym TARGET has been used to represent this framework of analysis of teacher-related classroom goals (Tasks, Authority, Recognition, Grouping, Evaluation, and Time). The TARGET perspective represents more specific mechanistic-type pedagogical characteristics that teachers and students can identify with and this may increase the validity of research that addresses the relations between teacher practice and students' achievement goals. For example, research has shown that students are able to distinguish between the goal-intentions of the teacher from the actual pedagogy and motivational support utilised by the teacher (Turner et al., 2003). Furthermore, students in the same classroom may vary in their perception of classroom achievement goal structures (Urdan & Midgley, 2003); using the TARGET framework may help identify learning environment structures that cause these differences.

Quantitative research designs addressing TARGET dimensions of classrooms have been single-administration types with students reporting their perceptions of the TARGET dimensions using a variety of questionnaire scales (e.g., Greene, Miller, Crowson, Duke, & Akey, 2004). Church et al. (2001) adopted a TARGET approach when they studied university students' perceptions of lecture engagement, the focus of evaluation procedures, evaluation type (absolute or normative standards) and the harshness of evaluation practice as influences of personal achievement goals, intrinsic motivation and course grade. Path analysis revealed lecture engagement and evaluation type (absolute) to positively predict mastery goals, evaluation focus to negatively predict mastery goals but positively predict performance-approach and performance-avoidance goals, and harsh evaluation to positively predict performance-avoidance goals. Mastery and performance-approach goals positively predicted grade, performance-avoidance goals negatively predicted grade and intrinsic motivation. Gender, perceived competence and prior achievement scores were the controlled variables in this study.

Greene et al. (2004) focused on the TARGET dimensions of motivating tasks, the type of autonomy or support provided and the type of mastery evaluation perceived by high school English students. Their path analyses found the personal mastery goal to be positively predicted by an emphasis on motivating tasks, autonomy and a mastery evaluation. Performance-approach goals were positively predicted by motivating tasks and mastery evaluation. This study did not investigate the performance-avoidance goal. The increase in performance-approach goals could be a result of students becoming more confident with their understanding due to the emphasis on tasks that are interesting and relevant. This could increase their self-esteem thus demonstrating the adaptive nature of mastery-focused classroom dimensions.

One distinct advantage of the TARGET research paradigm is that it establishes a framework for analysing classrooms using qualitative means. Although these study types may not directly measure personal achievement goals and their consequences, they may provide useful information that is not measured using quantitative-based instruments, which tend to be prescriptive. Patrick et al. (2001) incorporated a qualitative analysis of four fifth-grade classrooms that were classified on the basis of their classroom goal structure as reported by their students via a questionnaire. Consequently, the classrooms were classified, on the basis of a multiple goals model, as having: high mastery/low performance goals; low mastery/low performance goals; low mastery/high performance goals; and, high mastery/high performance goals. Classrooms were observed with regards to behaviours and speech related to TARGET classroom features such as task type, locus of authority, recognition, grouping, evaluation, time use, social interactions and students' help-seeking behaviours. Both the class teacher and students were monitored in terms of these parameters. Teachers observed to foster a high mastery goal structure emphasised understanding, interaction and recognised effort rather than ability. Teachers classed as low mastery had a transmissive teaching style with more emphasis on rote learning in their classes than high mastery teachers. This study also found evidence for the independence of performance and mastery goal structures. That is, in terms of a multiple goal structure analysis, teachers with high mastery goal structures had similar practices with regards to mastery-associated classroom dimensions irrespective of their performance goal structure.

Another qualitative-based study that attended to TARGET-related dimensions was conducted by Turner et al. (2003). They analysed two sixth grade math classrooms for which students had reported having similar goal structure orientations: both had high mastery and high performance goal structure orientations. (Mean split measures were used to categorise the classes involved in the study as having high or low goal structures.) Observations were made throughout the year of the two classes with a focus on the type of teacher discourse provided by each teacher in terms of instructional discourse that supported or did not support autonomy and understanding, and supportive and non-supportive teacher discourse for organisational and motivational aspects. Students reported their approach behaviours (self-regulated learning and positive coping) and avoidance behaviours (self-handicapping and negative affect) by completing questionnaires. Despite the two classes having teachers of similar experience, having similar achievement levels, experiencing the same curriculum and having similar multiple goal structures, there were differences between them in terms of the amount of supportive discourse used by the teachers and the amount of negative affect and self-handicapping reported by the students. One teacher was found to use discourse that was higher in autonomy and motivational support and this facilitated students' use of self-regulated learning, positive coping behaviour, cooperation and intrinsic motivation. This classroom featured more adaptive patterns of behaviour than the other classroom in which the teacher was less consistent with supportive discourse and students reported having higher avoidance behaviours. Thus, even though both teachers had high mastery/high performance goal structures, the instructional and motivational character of the classrooms were influential on students' approach and avoidance behaviours.

The TARGET research paradigm highlights the potential impact of classroom-level pedagogical structures on students' achievement goals and the subsequent consequences of these achievement goals. This has implications for the field of science education, in which much research over the past few decades has been focused on the pedagogy associated with constructivism although scant attention has been paid to achievement goals at both the class and student levels. Constructivism is a theory of learning and not a theory of pedagogy or teaching practice (Haney & McArthur, 2002; Richardson, 2003; Staver, 1998); it is a belief about how a learner comes to know or learn (Taylor, 1998; Tobin & Tippins, 1993; von Glasersfeld, 1993). Consequently, constructivism as an epistemology operates at two levels in a classroom: the teacher and the student. From the teacher's level, constructivist theory contends that if a teacher has the belief that students learn via the tenets of constructivist theory then the teacher will attempt to create a learning environment that enables learning to occur via the elements of constructivism. That is, there will be an emphasis on the processes associated with students constructing their understanding, using various activities to create opportunity to experience the concept, and, from a social constructivist view, using discourse from teacher and peers for learning purposes. At the student level, according to constructivism, students learn by constructing upon existing understanding as a result of personal experiences involving actions such as questioning, evaluating, reflecting and analysing (Applefield et al., 2001). These constructions of learning may be either "subject-centred", in which the individual constructs their own understanding as a result of interacting with the environment (Cobb, 1994; Paris & Byrnes, 1989), or "social", in which knowledge is acquired via the processes of social experience with the phenomenon and encountering the language that accompanies such social contexts (Davis & Sumara, 2002; Duit & Treagust, 1998; Nuthall, 2002; Roth, 2002; Tobin & Tippins, 1993). The former is known as cognitive constructivism, the latter social constructivism, with each form representing the two main divisions that result in the bifurcation of the field of psychological constructivism. [The term "social constructivism" used here is associated with psychological constructivism, not the social constructivism, or social constructionism as it is also called, that is a proposition about how knowledge has accrued throughout history as a result of being influenced by social and cultural disciplines such as values, ideologies, religion and so on (Phillips, 2000)]. This is to be contrasted with other learning beliefs such as behaviourism and cognitivism, both based upon the objectivist ideal of knowledge attainment (Applefield et al., 2001; Davis & Sumara, 2002). An objectivist epistemology is associated with the realist ontological view that knowledge and understanding is objective, stable and subsists independently outside the head of the learner and therefore may be transmitted to the learner given appropriate experiences such as the teacher carefully and methodically describing phenomena (Hargis, 2001; Simpson, 2002). This type of learning philosophy is also known as naïve objectivism (Coborn, 1993). Although there is debate about how well constructivism reflects how students learn (Cobb, 1999; Matthews, 2000; McCarty & Schwandt, 2000), constructivism as an epistemological ideological stance fosters a pedagogical framework which constitutes the teacher emphasising students' understanding and relevant experiences; the assumption being that students construct a personal meaningful “conceptual framework” (Coborn, 1993; Driver, 1981, 1989) as they learn and that students will learn given appropriate guidance and experiences (Mellado, 1998; Simpson, 2002). For example, it has been suggested that psychological constructivism is a “…set of views about how individuals learn (and about how those who help them to learn ought to teach)” (Phillips, 2000, p. 7). Whether constructivism is a sound theory of learning or its pedagogical practice is supposed to foster engaged classroom learning, it has been a major program of research in many domains and educational reforms (Haney, Czerniak, & Lumpe, 2003; Haney & McArthur, 2002; Hickey, Moore, & Pellegrino, 2001; Matthews, 2000).

Constructivist pedagogy is based upon two tenets that are parallel to constructivism as a theory of learning: (1) teachers must consider the understanding or knowledge and experiences of students, and (2) the teaching and learning must include activities that will enable students to interact their experiences with their understanding so that construction of understanding will occur (Driver et al., 1994; Howe & Berv, 2000; Tobin, 2000). Perhaps one of the most important considerations of constructivist pedagogy is the teacher’s epistemological beliefs: it is of no use employing constructivist-based pedagogy unless the teacher supports some variant of constructivist philosophy (Brooks & Brooks, 1999; Coborn, 1993; Haney & McArthur, 2002; Howe & Berv, 2000; Prawat, 1992; Tabachnick & Zeichner, 1999; Tobin, 2000). For example, Ball and Bass (2000) conducted a qualitative investigation of constructivism in a third-grade math class. They interviewed students about the nature of their learning and the teaching experienced, audiotaped and videotaped lessons, examined students’ written work and recorded the structure of the lessons. Ball and Bass found three elements of the pedagogical climate that related to the teachers’ constructivist beliefs about learning. The first element concerns the role of reasoning of justification, whereby students should be given scope to examine their and others’ views via justifying why they think that way. The teacher is also part of this reasoning process, justifying to students their views. The second element relates to the acknowledgement of a publicly shared knowledge base in the classroom: convergence of conclusions should be highlighted and explained. Using language for reasoning purposes, even in the context of math lessons, is the third element. Hence the constructivist teacher must be aware of how and what students are thinking and this necessitates the teacher to constantly be dynamic and reflexive in their teaching. In contrast, a teacher aligned with objectivist views would tend to have the following classroom practice features: the teacher is seen as an authoritative source of knowledge to which students defer; knowledge is a fixed body of information gleaned from either the teacher or textbook; the teacher is responsible for managing students' learning by providing information and leading students through activities and assignments (Good & Brophy, 2000). Social constructivist teaching, therefore, is to be contrasted with the transmissive approach. In the former, knowledge is co-constructed through discussion, particularly sustained dialogue that enables construction of shared understanding, whereas in the latter knowledge is treated as a commodity that can be transmitted from teacher or text to students accumulated (Good & Brophy, 2000).

There is no one step-by-step protocol that will transpire to the classroom becoming constructivist in nature (Driver et al., 1994; Nuthall, 2002; Scott, Asoko, Driver, & Emberton, 1994). Rather, it is the beliefs about student learning that the teacher holds that will dictate whether the classroom is constructivist or other (Nuthall, 2002; Wells, 2002) - constructivist theories lead to constructivist-inspired teaching practice (Appleton, 1997). Constructivist pedagogy offers a framework that a teacher can base their lesson sequence on but it is the language and the actions of the teacher as they go about their teaching that will convey the impact of constructivism on students' learning.

There is a dearth of research that has explicitly investigated the role of achievement goals in constructivist contexts let alone considered the approach-avoidance dimensions of achievement goals, multiple goal perspectives and the role of classroom achievement goal structures in such pedagogical contexts. The focus of constructivist perspectives in science education has been on cognitive processes such as concept misrepresentation, concept development or change and on the pedagogical aspects of fostering learning environments conducive for conceptual understanding (Sinatra, 2005; Tobin, 1993; White, 2001). Hence much of the attention of this research has been on the relationship between conceptual change approaches and self-regulated learning constructs such as metacognition. Another reason for the lack of research on achievement goals from a constructivist pedagogical perspective could be related to methodological issues. Training teachers to teach in a constructivist fashion may be difficult particularly if there are misaligned epistemological issues between curriculum, teachers, researchers and research protocols. Furthermore, measuring statistical relations between quantifiable constructs such as achievement goals and self-regulated learning in constructivist and non-constructivist settings is essentially confined to intra-class analysis unless the amount of constructivism a class experiences can be quantified and thereby be used for interclass comparisons. One instrument that has been designed to measure constructivist-pedagogical dimensions is the Constructivist Learning Environment Survey (CLES) (Taylor & Fraser, 1991; Taylor, Fraser, & Fisher, 1997). While this instrument can be used to ascertain the effectiveness of constructivist reforms (see Burnet, 2003) it may also be effective for quantifying science classrooms in terms of constructivist dimensions and thus enable valid statistical analyses encompassing achievement goals and self-regulated learning to be conducted. In turn this may enhance the generalisability of research findings since constructivist dimensions can be measured and compared from one class to the next even if no constructivist reforms are underway. However, there is scant research on the use of this instrument in the context of contemporary achievement goal and self-regulated learning perspectives and hence one of the primary aims of the present research is to examine the relations between the constructs associated with achievement goals and self-regulated learning with those measured by the CLES in high school science classrooms.

The few studies that have focused on the role of achievement goals in constructivist learning environments have found that constructivist-type teaching fosters a personal mastery goal orientation and a decrease in personal performance goals. Classroom achievement goal structures have not been studied in the context of constructivist learning environments. Lee and Anderson (1993) (also see Lee & Brophy, 1996) studied the goals of twelve middle school sixth-grade students when encountering science pedagogy that was based on conceptual change principles. Conceptual change is considered a subset of constructivist approaches in which the teacher, using constructivist pedagogy principles and procedures, attempts to provide students with opportunities to alter their original incorrect or naïve conceptual understanding. Specifically, the researchers measured targeted students' task engagement, knowledge and achievement, personal achievement goals in science and attitudes toward science. In this study, a personal mastery goal orientation was categorised as "task orientation", and this was divided into an understanding goal and a fact acquisition goal; personal performance goals were classed as "ego-social"; the researchers also focused on the work-avoidance goals of students. A variety of data sources such as interviews with students, classroom observations of targeted students, class work and self-report questionnaire results comprised the corpus of data; these being measured before and after the conceptual change intervention. The small number of case studies that resulted from this research format revealed the students to have an array of personal achievement goals before and after the intervention and the goal-task-engagement patterns were in accordance with normative goal theory: students with understanding goals were engaged while those students whose primary goal was ego-social or work-avoidant failed to engage in the class work. One student reported having both understanding and ego-social goals thus illustrating a multiple goals effect was salient for this student. However, this study did not use the approach-avoidance framework; partitioning the performance orientation into approach/avoidance goals may have been useful in ascertaining the intentions and behaviours of students who reported ego-social goals as their main science goals. Perhaps these students had a performance-avoidance orientation thus explaining their tendency to avoid being involved in the class work compared to those that were classed as have understanding goals. This multi-method study therefore showed that students have a variety of achievement goals despite encountering a constructivist environment.

Kroesbergen, Van Luit, and Maas (2004) compared the influence of constructivist-based instruction with explicit instruction on low achievers in mathematics for students that had a mean age of 9.7 years (grades 2 and 3). This study incorporated an experimental design in which students where allocated to one of three groups: a control, which experienced normal math teaching; a constructivist group that experienced constructivist-based teaching; and, an explicit instruction group, which experienced direct instruction with regards to how and when to apply particular math strategies. Pre- and post-intervention self-report measures where made of achievement goals (ego and task orientations), beliefs in learning mathematics and attributions towards success and failure with respect to effort and external factors such as the perceived difficulty of the task. Using multivariate multilevel regression, the researchers found the explicit instruction condition to positively predict ego orientation (akin to a performance-approach goal) and the constructivist condition to negatively predict the ego orientation. No relations where found with respect to the conditions on the task orientation. However, the explicit instruction was more effective at improving students' problem solving ability.

Hickey et al. (2001) examined the influence of a constructivist-based computer-based teaching strategy for mathematics, *The Adventures of Jasper Woodbury*, on grade 5 students' motivation. Using a quasi-experimental design, 19 classrooms were configured to receive either the constructivist-based teaching strategy or remain as the comparison condition. In order to assess students' motivational experiences throughout the courses, teachers asked their students to complete a motivational experiences survey during or immediately after each activity in order to assess students' task specific motivation. This questionnaire, which was administered six times, included scales that measured a learning goal (akin to mastery approach orientation), performance/ego goal, two work avoidance goals ("make it easy" and "get it over with") and subjects' perceived competence. Subjects' trait-level motivational beliefs were ascertained by the administration of a survey at the start and end of the school year. This survey measured students' self-efficacy in math, interest, achievement goals and work avoidance goals. Math achievement was gathered from a state exam that included a math section. The data were analysed using ANOVAs to determine differences between the classes in the conditions. The study found the program did enhance math problem solving skills for classrooms whose teachers tried to adopt the themes of the teaching program, this occurred for both advantage and disadvantaged classes. The motivational beliefs of students, however, did differ significantly. It was suggested the motivational beliefs of the students were influenced by the classroom learning environment fostered by the teacher and that the implementation of the constructivist lessons was very much dependent on the teacher's ability to foster a constructivist learning environment. This actually led to the authors categorising the classrooms as being more-consistent or less-consistent in terms of the curriculum reforms; the less-consistent classrooms were more along the lines of normal teaching practice. Students did report lower performance orientation in the constructivist-based Jasper lessons compared to other activities. Student interviews revealed some students were concerned that the participating in the constructivist program would hamper their progress through the cumulative performance levels of the existing mathematics curriculum. Students were also feeling less competent in the constructivist settings due to the more challenging and novel activities they experienced compared to the normal mathematics activities.

Another experimental study was conducted by Nicholls, Cobb, Wood, Yackel, & Patashnick, 1990), who studied the achievement goals, work avoidance goals, beliefs about success and perceived ability in second grade math students. Questionnaires measuring these variables were administered at the end of the year to classes that were taught in the normal fashion and to one class that experienced constructivist-based pedagogy throughout the year. Using standard and Dunnett *t*-test analyses, the study found the class that experienced constructivist pedagogy had higher scores than the other five classes on personal mastery orientation and on beliefs that success depends on efforts to understand and cooperate with others. The constructivist class also had lower scores on the performance-approach orientation. The authors suggest that constructivist classrooms have as their educational goal effort directed "…at the making of meaning." (p. 120) and that this particular goal can be addressed by the teacher as compared to traditional cognitive constructs such as ability comparisons and effort to achieve high test results. However, this study did not control for students' dispositional goals. That is, students' goals before they encountered the constructivist intervention.

The experimental studies described above show that constructivist-based pedagogy has had desirable effects in terms of its influence on promoting adaptive goals in students, namely promoting a mastery goal orientation and decreasing the students' performance goal orientations. However, these studies did not consider contemporary achievement goal theory dimensions of approach and avoidance nor did they consider the distinction between personal goals and class goal structures. Finally, the research was conducted on elementary or middle school students. In high school, the learning environment becomes more objectivist or teacher-controlled compared to elementary school practice (Anderman & Maehr, 1994; Eccles et al., 1993a; Neber & Schommer-Aikins, 2002; Penna et al., 1992) and this environmental factor may impinge upon students' achievement goals. Furthermore, this may be compounded by students becoming increasingly susceptible to performance-related issues.

Despite these limitations, the research on constructivism has much to offer achievement goal research. Firstly, constructivist-inspired teaching, with an emphasis on student understanding and associated pedagogy, emphasises a mastery goal structure and as such downplay performance-based issues such as ability comparisons (Blumenfeld, 1992; Nichols, 1989). Blumenfeld (1992), in comparing the fields of constructivism and achievement goal theory, explicates the view each field has with regards to a mastery achievement goal environment: It is assumed that there are no ability perceptions emphasised in the constructivist classroom since students will be motivated to learn since teachers "… stress meaningful learning and scaffold instruction …" (p. 277). Achievement goal theory stipulates that if the teacher operates a class with minimal focus on ability, students will have greater cognitive engagement and be willing to focus on acquiring skills and concept understanding; that is, they become increasingly mastery goal orientated. Constructivist-based teaching practice, therefore, may be of value in fostering the desired mastery goal orientation in students when it comes to learning a science concept.

A second offering from constructivism is that it explicates a pedagogical framework so that the implementation of constructivist-based pedagogy is distinctly viable at the classroom level. Thirdly, cognitive-based research in science education has shown that students have pre-existing ideas about scientific concepts and these are often difficult to alter (Driver, 1981; Eylon & Linn, 1988). Moreover, students' epistemological views have also been found to be instrumental in influencing their approach to knowledge attainment and hence conceptual understanding (Duit &

Treagust, 1998; Duschl & Hamilton, 1998; Hewson & Hewson, 1984; Strike & Posner, 1992). Thus, students' epistemological views perhaps need to be also considered as a mediator of successful learning along with achievement goals and other factors. [These themes are somewhat addressed in intentional conceptual change models of learning (see Pintrich et al., 1993; Sinatra & Pintrich, 2003a).]

In a reciprocal fashion, achievement goal theory and its empirical findings have much to offer the field of constructivism. Firstly, research on achievement goals has shown the existence of positive (approach) and negative (avoidance) valences for both mastery and performance goals; these may exist in constructivist classrooms especially if activities are used by the teacher that challenge students' understanding about scientific concepts. Fear of failure and competence perceptions are central to achievement goal theory and there is evidence that constructivist classrooms can be challenging to students (Hickey et al., 2001). Some of the work that has examined student motivation in the context of the constructivist classroom has reported motivation in terms of task engagement (Lee & Brophy, 1996; Roth & Roychoudhury, 1994), students exhibiting deep processing (Appleton, 1997) and students being mentally active (Hand, Treagust, & Vance, 1997). However, the reporting of engagement should be interpreted with caution. For example, according to Lee and Brophy (1996), engagement can range from being superficial, where students are concerned with procedural matters, to cognitive and metacognitive, which requires deep mental processing. How studies of constructivism report students being engaged should therefore be taken into account. It has been found that not all students report constructivist-driven teaching engages them in thinking (Appleton, 1997; Hand et al., 1997). Osborne (1996) points out that not all individuals will adopt an active engagement since different students prefer to learn in different ways (this is an important point for it supports one of the tenets of critical constructivism), something others have found (Kempa & Martin-Diaz, 1990; Okebukola, 1985; Roth & Roychoudhury, 1994). Achievement goal theory may be of use to constructivism research. For instance, varying goal affiliations (performance, mastery and their valences) may be the reason for the discrepancy in engagement amongst students in constructivist classrooms amongst other factors.

Secondly, high school classrooms have a performance emphasis and according to goal theory this may influence students' adoption of performance-related achievement goals. This may lead to shallow learning during constructivist learning events. This is particularly applicable to senior students where exam performance is of increasingly importance. Thirdly, since goals are social cognitive constructs, teacher practice can impact on students' achievement goals. Thus, the teacher has a role to play in fostering adaptive classroom learning environments. Fourthly, achievement goal research may enrich models of learning by providing a motivational perspective (Pintrich et al., 1993). Peripheral and adjunct variables that accompany goal research such as self-efficacy and self-handicapping may also have roles in models of learning.

There is a degree of convergence with regards to the empirical research on pedagogical structures in the fields of constructivism and achievement goals. The aforementioned TARGET dimensions have been used by achievement goal researchers in order to ascertain the scope of classroom-level achievement goals in terms of pedagogical structures. The Constructivist Learning Environment Survey (CLES) has performed an analogous role in constructivism by quantifying the amount of constructivist-based pedagogical structures in science or math classrooms (Taylor & Fraser, 1991; Taylor et al., 1997). According to Aldridge, Fraser, Taylor, and Chen, (2000), the CLES is used to assess five types of structures or dimensions, each forming a scale:

- *Personal Relevance:* the extent to which teachers relate science to student's out-of-school science;
- *Student Negotiation:* the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas and to listen and reflect on the viability of other students' ideas;
- *Shared Control:* the extent to which students are invited to share with the teacher control of the learning environment, including the articulation of their own learning goals, design and management of their learning activities and determining and applying assessment criteria;

• *Critical Voice:* the extent to which a social climate has been established in which students feel that is legitimate and beneficial to question the teacher's pedagogical plans and methods and to express concerns about any impediments to their learning;

• *Uncertainty:* the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory dependent inquiry, involving human experience and values, evolving and non-foundational, and culturally and socially determined. (p. 39)

These structures have consistently been shown to exist in science classrooms across age groups and cultures (Aldridge et al., 2000; Cho, Yager, Park, & Seo, 1997; Churach & Fisher, 2001; Dorman, Adams, & Ferguson, 2002; Dryden & Fraser, 1998; Kim et al., 1999). Of relevance to the present research, however, is that these structures have considerable overlap with those addressed by the TARGET perspective in achievement goal research. The personal relevance scale in the CLES relates to Tasks (TARGET) in that tasks that are of personal relevance to students are recommended to assist in fostering a mastery goal orientation. Authority (TARGET) relates to shared control and critical voice scales in the CLES. According to TARGET theory, teachers that provide opportunities for students in the decision-making features (shared control) of their learning and to question the methods of learning (critical voice) will be making steps towards fostering a mastery orientation. Grouping (TARGET) is represented by the student negotiation scale in the CLES. Although both perspectives differ in terms of evaluation (TARGET but not in CLES) and uncertainty (CLES but not TARGET), there is considerable convergence between these two research paradigms with respect to measuring classroom learning environment structures and their impact. One of the aims of the present research is to examine the relations between the CLES structures with personal achievement goals.

3.2.3 Micro-Learning Environments

Most of the work in studying achievement goals is based on trait-level or aptitude analyses, with students reporting on their general goal orientation in a particular class for a domain. In reality, however, constructivist pedagogy, like mainstream science teaching, utilises a variety of micro-learning environments. In science, these environments typically include group work, teacher explanation, teacher-led discussion and perhaps some form of learning using information and communication technology such as using a computer simulation. For example, one of the initial processes in constructivist approaches involves students discussing their findings and resolving problems in a small group setting. After this, the teacher will conduct a whole-class discussion, drawing upon the ideas and suggestions the students have developed. This is in contrast to the transmissive approach, in which the teacher tends to transmit understanding with whole-class, teacher-explanation micro-learning environments. By focusing on micro-learning environments, measurements of students' goals, self-regulated learning, efficacy and other constructs can be made in situ. Most achievement goal learning environment research treats the learning environment as having a generic trait-like subsistence. A "context" hypothesis, however, contends that constructs such as achievement goals are context-based and as such should be measured in context. This has been referred to as "trait versus situational specificity of behaviour" (Pintrich, 1999).

There is good ground for applying a context hypothesis - achievement goals are dependent on micro-learning environments besides classroom goal structures - to achievement goal constructs. Firstly, according to achievement goal theory, students' dispositional tendencies may be overcome by the contextual or situational demands of the micro-learning event (Meece et al., 1988). Competence perceptions, an important mediator of goal orientation and valence, will be particularly susceptible to micro-learning environments. On the other hand, students' dispositional goals may become more salient in settings that have less teacher involvement such as small group work (Meece et al., 1988). A host of affective factors may come into play: the fear of failing may shift to perhaps fear of not getting on with peers, or failing to be acknowledged, or fear of not knowing. In a class-based discussion, students fear of failing or avoidance behaviour may be more pronounced since they may be inefficacious with respect to volunteering their knowledge in front of others or they are afraid to ask questions in order to clarify points (Rop, 2003). On the other hand, ability-focused students may ask questions to demonstrate their know-how and high mastery students may invoke help-seeking behaviour. In a computer-based activity, there is less teacher and peer regulation and thus the student may then be affected by dispositional tendencies. It may be advantageous for students to work in harmonious groups due to goal compatibility issues. On the other hand, incompatible student goals or ability levels may be more pronounced in a particular micro-learning environment such as group work. For example, Gijlers and de Jong (2005) found high achieving physics students working in heterogeneous dyads for a discovery learning task were not willing or not capable of scaffolding for the low achiever. There can be benefits and disadvantages to group work (Barbosa, Fófili, & Watts, 2004; Carter, Jones, & Rua, 2003; Cohen, 1994; Slavin, 1987).

Secondly, achievement goal research has classified classroom practice in terms of TARGET dimensions in order to describe holistically classroom practice in terms of what environmental features impact upon the achievement goals of students. In parallel, micro-learning environments are more proximal indicators of the pedagogy experienced by students than trait-like measures. Other researchers (Crawford, Krajcik, & Marx, 1999) have identified important components that compose science classrooms as being: authentic tasks, small-group work (as a means of fostering interdependency) and negotiation of understanding and public sharing. Crawford et al. (1999) investigated these components in eighth-grade science classrooms and found the important features to involve the authenticity of the driving question, the role of the teacher in terms of facilitating the cohesiveness and collaboration of students working in groups, and the time needed for the students to assimilate and establish effective relationships. Others have found teachers' discourse to be influential beyond that of the classroom goal structures their students perceive (Turner et al., 2003). Social constructivist pedagogy espouses the use of groups for argumentation, reasoning, etc, and this means micro-learning events exist in such classrooms (Hogan, 1999; Lumpe, 1995; Mortimer & Machado, 2000).

In terms of methodological factors, particularly those relating to validity and calibration issues, there are three broad reasons for focusing on micro-learning environments as goal contexts. Firstly, asking students to report on their achievement goals in a recent classroom event potentially increases the accuracy of reporting the valence of their achievement goals - actual approach and avoidance orientations - due to the proximity of the event. Trait-like reports may yield data that reflects dispositional tendencies rather than what students actually do in situ. Secondly, students may report more accurately on the peripheral influences and consequences of other factors that are associated with the achievement goals such as their perception of ability, efficacy and use of self-regulated learning strategies. This may be of benefit when examining the adaptiveness of performance-approach students (e.g., Meece et al., 1988). A third reason for pursuing an investigation of students' personal goals in micro-learning environments relates to multiple goal models, particularly the multiple goal perspective proposed by Harackiewicz et al. (2002) (see also, Barron & Harackiewicz, 2001; Pintrich, 2000c). Three goal patterns are proposed by this perspective. In the additive goal pattern, students having higher orientations of both mastery and performance-approach goals for a particular educational outcome will have a better result than students having lower orientations in both goals or a lower orientation for just one of these goals. Thus, the effects of both goals are additive since the goals are orthogonal, each goal may have adaptive effects, and the effects of pursuing performance-approach goals are not moderated by the level of the mastery goal orientation. In the interactive goal pattern, however, the goals moderate each other, with mastery and performance-approach goals interacting in a mastery X performance goals relationship for a particular educational outcome. According to their selective goal pattern model, students utilise particular personal achievement goals in different situations (see also, Barron & Harackiewicz, 2001; Wolters et al., 1996). For example, students may pursue performance goals in situations that promote competition such as exams and switch to pursuing mastery goals in situations associated with attaining skills such as understanding a science concept. Students having the highest orientations for the goals they pursue in situations will thus have the most adaptive outcomes. Investigating achievement goals in light of this theory may contribute towards understanding multiple goal models, a topic of contemporary goals research.

Meece et al. (1988) compared whole-class activities with small-group activities in terms of students' goal orientation and cognitive engagement during the second-half of the school year for fifth- and sixth-grade science students. Students completed a questionnaire (Science Activity Questionnaire) administered at the end of each of the six lessons that the researchers observed. This questionnaire measured personal mastery goals, personal ego/social goals (similar to performance-approach goal), work-avoidant goals and the cognitive engagement of the students. Factor analyses revealed the cognitive engagement items to be formed of two factors: an active engagement factor and a superficial engagement factor. Students were also surveyed at the beginning of the school year with respect to their attitudes towards science, intrinsic motivation and their perceived competence. Achievement of students was gathered by collecting the students' results from various broad-scale tests. The first finding of interest concerned the pattern of students' goal orientations and cognitive engagement: these were relatively consistent across the six science activities. There was consistency of the students' goal-orientations across the six lessons thus suggesting the students' values, interests and perception of their ability to have some influence on their goals in a learning situation. The authors, however, found that the strength of the impact of these inherent factors was dependent on the type of learning structure experienced by the students. In order to analyse the relationships students' goal and cognitive engagement patterns across the six lessons, they aggregated the mean scores the students provided for each of the motivation goal scales and the cognitive engagement scales. The mastery goal orientation had a significant positive correlation with the active cognitive-engagement whereas the ego/social correlated positively with the active cognitive-engagement and superficial cognitive-engagement scales. Students that emphasised a mastery goal orientation reported stronger active cognitive engagement than students that emphasised ego/social goals. However, this effect was mediated by the students' perception of their efficacy: students who reported themselves as low ability used more effort-minimising strategies in order to protect their self-worth than those of higher ability perceptions. Intrinsic motivation also had a positive correlation with cognitive engagement. Academic performance did not significantly relate to the students' goal orientations or cognitive-engagement patterns. Students' attitudes toward science had a significant influence on their goal orientations; there was a positive correlation with the mastery orientation and a negative correlation with the ego/social goal orientation. These relations were also found in the structural model developed via structural equation analyses. Meece et al. (1988) found students' science attitudes and intrinsic motivation to work were more salient in small-group activities than whole-class activities. They suggest small-group activities have less teacher control and structure compared to whole-class tasks and there is a greater demand on the students' self-regulation and a greater play of their motivational tendencies. This study did not measure performance or mastery avoidance goals.

The Meece et al. (1988) study focused on correlational relationships of attitude and motivational variables observed across six usual science class activities, finding that the context did not override students' general goals and beliefs; rather the context dictated the strength of the relationships amongst variables. In an experimental study, Gabriele and Montecinos (2001) examined the interactions of ability and personal achievement goals during peer dyad functioning in 35 pairs of fourth- and fifth-graders in elementary school during an unstructured collaborative math learning problem task. In this study, however, students were induced into learning- or performance-based contexts by the insertion of learning or performance emphasis before, during and just after the task instructions were read. Students completed a questionnaire assessing their goal orientations and assessed the learning of the students using math problems. Pairs were videotaped during the session. The low-achieving students who were given learning-goal instructions had significantly higher learning-goal self-report scores than those who experienced the performance-goal instructions task. Another finding of interest related to the status perceptions the low-achievers had of their high-achieving partners. Low-achievers given learning-goal instructions had less belief that their high-achieving partner was more competent and had a greater understanding than low-achievers given performance-goal instructions. Students who had the learning goals more salient learned more than low achievers who had performance goals salient. Gabriele and Montecinos (2001) suggest that students who endorse a performance goal have patterns of participation in groups different to those of students who have mastery or learning goals. Nicholls and Miller (1984) studied high school mathematics students, examining the effects of cooperative learning versus traditional learning styles on achievement goal orientations. Students in the structured cooperative learning group were found to be more learning goal orientated than those that experienced the traditional style. These two studies demonstrate the potential interactions of peers, competence perceptions and achievement goals in small group settings.

The present research also sought to investigate the achievement goals of students in a variety of micro-learning environments in order to measure the patterns of relations between these goals and behaviours such as self-regulated learning and competence perceptions such as efficacy-beliefs and ability perceptions. This may shed light on adaptiveness of the performance-approach goal and the usefulness of multiple goal models.

3.3 PERSONAL/COGNITIVE INFLUENCES OF ACHIEVEMENT GOALS

3.3.1 Ability and Self-Efficacy Perceptions

Perceptions of competence are central to achievement goal theory (Dweck, 1986; Elliot, 1999; Nicholls, 1984; Skaalvik, 1997) and in parallel with achievement goals can be considered to bifurcate into mastery-related and performance-related competence perceptions. The latter context, herein referred to as ability perceptions, may operate in terms of a student's perception of ability with respect to his or her peers at the classroom level. The mastery-related ability perception relates to the student's perception of his or her capability to complete tasks with respect to internal-based standards and is called self-efficacy (Bandura, 1986, 1997; Schunk, 1990; Zimmerman, 1989a; Zimmerman & Martinez-Pons, 1990), the label used in the present research. Self-efficacy is a contextual construct since it is a result of judgements based on historical events such as failures and success with respect to the task and is to be distinguished from more general affective-related perceptions of oneself such as self-esteem or self-concept beliefs (Linnenbrink & Pintrich, 2002). Self-efficacy is an important motivational construct itself and has been classified as one of four key families (attributions, self-efficacy, intrinsic motivation, goal orientations) that represent motivational beliefs (Linnenbrink & Pintrich, 2002). Hence self-efficacy and perceived ability are distinguishable perceptions of competence (Jagacinski, Madden, & Reider, 2001; Leach, Queirolo, DeVoe, & Chemers, 2003).

These constructs may interact to influence the motivational-associated behaviours of students in the classroom, particularly with respect to achievement goals. This distinction may especially be useful in light of the 2 X 2 achievement goals model of Elliot and colleagues (e.g., Elliot & McGregor, 2001). According to this model, competence perceptions are important antecedents of achievement goals, the other main variable being motive dispositions such as fear of failure (Elliot, 1999; Elliot & Church, 1997; Elliot & McGregor, 2001). According to this model, students with high academic self-efficacy perceptions would endeavour to persist with a task since they believe they have the capability to master it, leading to the adoption of a mastery-approach goal orientation. That is, there should be a positive relationship between efficacy and the mastery-approach achievement goal. For example, Schunk and Ertmer (1999) contend that mastery goals cause students to focus on learning and attempt to improve their skills or ability; as students acquire skills and enhance their learning they progress and this substantiates their self-efficacy; that is it is a volitional-type of process. Hence, the goal is to develop skill or task mastery. Students having low efficacy beliefs will be higher on the mastery-avoidance goal orientation since the intention of this achievement goal is to avoid incompetence with respect to internal standards (Elliot, 1999). However, this goal has been under-explored in terms of theory and empirical research associated with efficacy beliefs. According to this theory, performance goals should not relate to efficacy for learning since they are goals associated with the purpose of extrinsic pursuits such as ego superiority. That is, performance goals are concerned with the demonstration of ability rather than ability enhancement, which is the focus of mastery achievement goals. A focus on performance goals, therefore, will not substantiate self-efficacy (Schunk & Ertmer, 1999). Thus, mastery goals enhance self-efficacy since students perceive progress during their learning (Schunk, 1990, 1996). This means self-efficacy is intuitive and reciprocal in nature (Pajares, 2002).

There is substantial empirical evidence for these relationships. Correlation-based studies that have used regression-based analyses have found efficacy for learning to be positively related to mastery-approach goals (Ford, Smith, Weissbein, Gully, & Salas, 1998; Kaplan & Maehr, 1999; Kaplan & Midgley, 1999; Middleton et al., 2004; Middleton, & Midgley, 1997; Patrick, Ryan, & Pintrich, 1999; Roeser et al., 1996; Skaalvik, 1997; Turner et al., 1998; Urdan et al., 1997; Valle et al., 2003). A small number of studies have found significant regression-based relations between performance goals and self-efficacy: performance-approach goals were positive predictors (Skaalvik, 1997) or negative predictors (Ford et al., 1998) of efficacy, and performance-avoidance goals negatively predicted efficacy (Middleton & Midgley, 1997; Skaalvik, 1997). Hence, students having perceptions of high academic efficacy are more likely to adopt high mastery-approach goals and pursue adaptive learning behaviours associated with these goals. The mastery-avoidance goal has not been explored in the empirical research in terms of its relations to academic efficacy and the present research is designed to examine this relationship.

Some studies have grouped students on the basis of their efficacy beliefs in order to see if efficacy-based groups of students have particular motivational characteristics. A transitional study conducted by Middleton et al. (2004) examined the impact of the transition from sixth to seventh grade math with regards to academic self-efficacy and achievement goals. Hierarchical multiple regression analyses found math self-efficacy in sixth grade to positively predict mastery-approach goals in seventh grade, and self-efficacy in grade 6 math positively predicted self-efficacy in grade 7 math. The interaction of performance-approach goals and self-efficacy in sixth grade was found to positively predict performance-avoidance goals in seventh grade. Using a normative goal theory stance, they suggest that individuals who are generally oriented to demonstrate their ability adopt performance-approach or -avoidance goals depending on the situation and are thus prone to performance avoidance in order "to protect their image"; the avoidance goals become more salient when these students encounter a competitive environment – for example, seventh grade - and there is a greater chance of experiencing failure. This could have implications for selective high schools where students are highly efficacious upon entering and then encounter an environment that could test their experience with getting lower than normal ratings in tests. One of the purposes of the present research is to examine the academic efficacy beliefs of gifted and talented students in selective high schools. To test for the moderating effect of self-efficacy in predicting performance avoidance goals in seventh grade, Middleton et al. (2004) categorised students into high, medium and low self-efficacy groups on the basis of their scores on the self-efficacy scale (1-5), with similar size groups formed: high = equal to or higher than 4.6;

medium = scores higher than or equal to 3.6 and less than 4.6; low = less than 3.6. On the basis of structural equation model analyses, only the high self-efficacy group had a significant positive correlation between sixth-grade performance-approach goals with both seventh-grade performance-approach and -avoidance goals. Middleton et al. (2004) suggest that students with high self-efficacy respond differently to lower efficacy students when changing learning environments: students with high efficacy beliefs are more susceptible to changes in the environment. This result has implications for the mastery avoidance achievement goal - highly efficacious students may be more susceptible to a mastery avoidance goal orientation, which could in turn be influenced by the changing of learning environments. However, these researchers did not measure perceived ability of students (only academic self-efficacy).

Anderman and Midgley (1997) also grouped students on the basis of their academic self-efficacy for English or math in seventh grade. High and low ability academic competence groups were formed on the basis of a median split procedure. Students who had a predominant learning (mastery) goal orientation and high competence perception reported using more adaptive learning strategies than those who were lower in perceived competence. This occurred in both English and math classes. There was no difference untoward the relation of adaptive learning strategies with competence perceptions in the performance orientation group. Also, students in the predominant learning (mastery) goal orientation and high competence perception group reported using less maladaptive learning strategies than those who were lower in perceived competence. This occurred in only the English classes. In English, Anderman and Midgley (1997) found high competence performance orientated students to use less maladaptive strategies than those who were lower in perceived competence. Hence a moderating effect was found in the above cases for perceived competence on achievement goal orientation for adaptive and maladaptive learning strategies: the more efficacious a student is the more likely they will employ adaptive learning strategies. The researchers then used hierarchical multiple regression to investigate the interaction of perceived competence and achievement goal orientation. This statistical technique does not lose as much potential variable information as occurs when transforming a continuous variable into a dichotomous one which is the case in a median split analysis. Using regression, they found perceived competence and learning goal orientation to both significantly contribute to adaptive learning strategies in English. This was found for all students regardless of their goal orientation. In math classes, increase in mastery goals predicted a decrease in maladaptive strategies students. Moreover, this effect was greater in students of low perceived competence. Increase in performance goals predicted greater use of maladaptive strategies despite students' perceived competence. The results of this study thereby support the theory that mastery goals are more related to self-efficacy beliefs than performance goals. For example, Anderman and Midgley (1997) found perceived competence (self-efficacy) moderated the type of learning strategies used by students who are mastery-orientated; students having low perceived competence reporting more use of maladaptive strategies than those with higher competence perceptions. This could be explained by the former type of student having a greater mastery-avoidance goal orientation than the latter, a goal fostered by low competence perceptions.

The second competence-based perception, perceived ability, has interpersonal referents. Students with perceptions of high normative ability will tend to pursue performance-approach goals since there is a high chance of demonstrating competence to external referents such as peers and teacher. Perceptions of low ability result in performance-avoidance goals since the objective is to avoid demonstrating the lack of ability. Just like self-efficacy perceptions and performance goals have no relation, mastery goals should not relate to perceptions of ability since they are concerned with internal referents; in each case the competence referent of the student is different (Elliot, 1999). This theory has received considerable empirical support, both in laboratory and field studies. Dweck and her colleagues in a series of laboratory-based studies have experimentally manipulated students' goals and their perception of ability and shown the importance of ability perceptions on students' performance goals (Diener & Dweck, 1980; Dweck & Leggett, 1988; Elliott & Dweck, 1988). From a normative goal stance, mastery-oriented children were concerned with skill acquisition and improvement and not concerned about potential negative judgements of their ability; they chose a challenging task despite some having perceptions of low ability. The pattern of behaviour exhibited by students who were performance-oriented was dependent on their ability perception: students who perceived they had high ability chose tasks that would enable them to attain success or favourable judgements of ability from themselves and significant others; students who saw themselves as being of low ability chose easier tasks thus avoiding judgements of inadequacy. Perception of high ability may not correlate with the mastery approach or avoidance goals since it is dealing only with peers, a normative or interpersonal referent and not an intrapersonal referent. Those with low ability competence pursue performance avoidance goals since the goal is to avoid demonstrating low ability to others and oneself. This preserves self-worth.

Field studies using regression-based analyses have found perceived ability to positively predict mastery-approach goals (Church et al., 2001; Elliot & Church, 1997; Pajares et al., 2000). The mastery-avoidance goal has not been addressed in this context. These studies found perceived ability to positively predict performance-approach goals (Church et al., 2001; Pajares et al., 2000) and negatively predict performance-avoidance goals (Church et al., 2001; Elliot & Church, 1997; Pajares et al., 2000). However, the distinction between perceived ability and self-efficacy is not often made in the research. For example, the Motivated Strategies for Learning Questionnaire (MSLQ) includes a self-efficacy for learning and performance scale; the items that compose the scale being a mixture of ability ("Compared to other students in this class I expect to do well") and efficacy ("I am certain that I can understand the ideas taught in this class") items and hence researchers that have used this scale did not distinguish these dimensions (Bandalos et al., 2003; Greene et al., 2004; Malpass, O'Neil, & Hocevar, 1999; Neber & Schommer-Aikins, 2002; Pintrich, 2000c). Some of these studies found perceived ability positively related to both mastery-approach and performance-approach goals via path analysis or regression analyses (Bandalos et al., 2003; Greene et al., 2004; Neber & Schommer-Aikins, 2002; Wolters et al., 1996) whilst others have found no relations (Malpass et al., 1999; Pintrich, 2000c).

Self-efficacy and perceived ability have been considered as influences or antecedents of goals (Bandura, 1997; Elliot, 1999; Greene et al., 2004; Schunk, 1990). On the other hand, competence perceptions have also been considered as mediators or moderators of goals and their outcomes such as strategy use (Dweck, 1986; Dweck & Leggett, 1988; Kaplan & Midgley, 1997; Nicholls, 1989) while self-efficacy has been treated as an outcome of students' achievement goals (Anderman & Maehr, 1994; Middleton et al., 2004; Roeser et al., 1996).

Most competence-based studies, however, have assumed a normative goal perspective, with students being classified as either mastery or performance oriented (Pintrich, 2000c), whereas contemporary achievement goal theory [so called "revised goal theory" (Pintrich, 2000c)] suggests students hold multiple goals (Harackiewicz et al., 2002; Pintrich, 2000c). Pintrich (2000c) suggests a person-centred analysis is appropriate when considering analysing students over time (a longitudinal study) since the effects of the individual may accumulate over time. He investigated the relationship of multiple personal achievement goals on students' self-efficacy using person-centred analyses. Three waves of data collected from year 8-9 math students from one high school comprised the data. Students completed self-report questionnaires on their personal achievement goals, self-regulated learning, self-efficacy (MSLQ) and other motivational-related aspects such as interest and test anxiety. Students were categorised as high/low in mastery-approach or performance-approach goals on the basis of a median-split method. Hence students who attained higher than the median value in each category of personal achievement goals were classed as "high"; those below the median were "low". Four multiple goal groups were formed: high mastery/high performance, high mastery/low performance, low mastery/high performance and low mastery/low performance. On the basis of normative goal theory, the most adaptive pattern of motivational beliefs, affect, strategy use and performance would be for students belonging to the high mastery/low performance group. In contrast, multiple goal theory posits the most adaptive pattern existing for students belonging to the high mastery/high performance group (Pintrich, 2000c). Pintrich (2000c) found no differences between the high mastery/high performance and high mastery/low performance groups with respect to motivational beliefs (incorporating self-efficacy), affect, strategy use and performance over time. Thus, the adoption of a high performance-approach goal did not hamper the effects of a mastery goal orientation. In line with normative goal theory, Pintrich (2000c) found students who belonged to the low mastery groups significantly declined over time in their self-efficacy beliefs and students who belonged to these groups had more maladaptive outcomes and beliefs than those that belonged to the high mastery groups. No gender effect was found in this study. However, he did not distinguish between perceived ability and self-efficacy using MSLQ items.

Leach et al. (2003) also found performance-approach goals to be adaptive. However, this relationship depended on the efficacy beliefs of the student. Leach et al. (2003) studied first-year university students before they actually started their course by asking them to complete a mailed survey. Efficacy was defined in this study as the student's perception of their capability to do the course, as distinct from perceived ability perceptions. Learning goals (mastery) were positively correlated to self-efficacy while performance goals (approach) had no significant correlation. However, general linear model statistical analyses revealed significant interactions between academic results, performance-approach goals and self-efficacy: students having high mastery, low self-efficacy beliefs and high performance-approach goals achieved higher grades than students having the same mastery and efficacy beliefs but lower in performance-approach goals. Thus, performance approach goals predicted achievement when mastery goals were salient but students felt less efficacious. In contrast, higher performance approach goals tended to undermine the positive effects of mastery goals when efficacy was high.

Perceived ability and self-efficacy may be mediated by social or environmental factors that are distal or peripheral to the student such as the teacher creating a performance-focused classroom learning environment that has an emphasis on ability (Ames, 1984; Middleton et al., 2004). For example, a mastery-oriented learning environment may have greater influence on a learner than the learner's perception of their ability and hence nullify or buffer the negative effects of low ability perceptions (Ames & Archer, 1988). This ties in with attribution theory in which attributions of success and failure in achievement-related contexts depend on attributions towards relatively stable factors such as ability and task difficulty, and more variable factors such as effort and luck (Weiner, 1972). Thus, while the student's peers may be stable ability-referents, the learning environment activities or structures may be variable ability-referents. Some studies have investigated the effect of classroom goal structure on students' efficacy and found a positive correlation between the mastery goal structure and self-efficacy (Anderman & Midgley, 1997; Urdan & Midgley, 2003). Urdan and Midgley (2003), for example, studied the effects of the transition from grade 5 to grade 6 in terms of the relations between classroom goal structure (mastery and performance-approach) on personal achievement goals, self-efficacy, affect and grade achievement. Using analysis of covariance techniques with grade 6 academic achievement as the covariate, they found the most significant effect for the transition was that a decrease in the mastery classroom goal structure significantly decreased the self-efficacy of grade 6 students. There were no significant effects for the performance goal structure.

3.4 ACHIEVEMENT GOALS: GENDER EFFECTS

There are mixed results in terms of a gender effect operating for achievement goals. Some studies have reported gender effects across various ages, with females having more mastery goals than males. This gender effect has occurred in studies that have statistically tested for gender differences (Ablard & Lipschultz, 1998; Anderman & Midgely, 1997; Anderman & Young, 1994; Kaplan & Maehr, 1996; Meece & Holt, 1993; Nolen, 1988; Pajares et al., 2000; Thorkildsen, & Nicholls, 1998) and in regression-based studies (Bråten & Strømsø, 2004; Elliot & McGregor, 2001; Harackiewicz, Barron, Tauer, & Elliot, 2002). Some studies have found no differences between males and females in terms of mastery goals (Cavallo, Potter, & Rozman, 2004; Church et al., 2001; Meece & Miller, 1999; Middleton et al., 2004; Middleton & Midgley, 1997; Patrick et al., 1999; Urdan, 1997; Young, 1997). In terms of performance goals, males have been generally found to have higher performance-approach orientations in studies testing for differences (Anderman & Young, 1994; Anderman & Midgley, 1997; Cavallo et al., 2004; Middleton & Midgley, 1997; Midgley & Urdan, 1995; Pajares et al., 2000; Roeser et al., 1996; Thorkildsen, & Nicholls, 1998; Urdan, 1997; Young, 1997) and in studies based on regression analytic techniques (Bråten & Strømsø, 2004; Church et al., 2001; Urdan, 1997). Most studies have found no gender effect for performance-avoidance goals although Bråten and Strømsø (2004), in a study on trainee teachers, reported males have higher performance-avoidance goals than females.

Patrick et al. (1999) suggest that females receive more attention than males with regards to the "substance of their work" whereas males receive more feedback regarding their classroom management and procedural matters than females. This discriminatory nature at the classroom level may result in females being more mastery goal oriented than males. Also, Patrick et al. (1999) describe males as being more concerned about their social status and academic image. That is, they are more concerned than females about how they are perceived by their peers and significant others in the classroom. These gender issues may also be affected by the domain. For example, Anderman and Midgley (1997) reported females being more mastery goal oriented than males in English, but there were no differences in math. Young (1997), upon finding fifth-grade males having reported greater performance-approach goals, suggests males are more immune to the negative effects of classroom performance than females. Young (1997) also found fifth-grade females to perceive a greater classroom mastery goal structure than males. The fifth-grade males, however, perceived greater classroom performance-focus goals than females in English and mathematics. Anderman and Midgley (1997) also found males to have higher classroom performance goal structure perceptions than females.

No studies have examined gender effects for mastery-avoidance goals. It is predicted, however, that since females' efficacy in science decreases as they grow older (Cavallo et al., 2004) mastery-avoidance goals will be more prominent in females. Hence if girls do not understand a science concept they may give up, that is adopt a mastery avoidance goal. However, most of the studies that have investigated gender effects in achievement goals have been on students in university or grade 8 and below. Thus, there is limited research on gender effects for achievement goals for high school students. In general terms, it seems that females are more prone to mastery goals, both at the classroom level and the personal level than males, whilst males report more performance-approach goals (Middleton & Midgley, 1997).

3.5 OUTCOMES ASSOCIATED WITH ACHIEVEMENT GOALS

There are two main consequences studied with respect to achievement goals: the quality of students' self-regulated learning and their academic achievement. This section deals with research that has investigated the relations between achievement goals and academic achievement. Research examining achievement goals and self-regulated learning is dealt with in the self-regulated learning review (Chapter 4).

3.5.1 Academic Achievement Associations with Achievement Goals

Research has considered the academic consequences of personal achievement goals using either normative goal or multiple goal perspectives. Firstly, on the basis of normative goal theory, achievement goals are considered as orthogonal and disparate influences on achievement. According to this model, mastery-approach goals facilitate engagement and mastery of the task and consequently students with mastery-approach goals should do well on measures associated with skill and knowledge attainment: the mastery goal is a motivational component of "learning for understanding". In addition, these goals have been linked to exam preparation (McGregor & Elliot, 2002) and deep processing (Elliot & McGregor, 2001). Mastery-avoidance goals should foster weaker academic results compared with mastery-approach goals since they are associated with maladaptive behaviour such as giving up when high standards are not fulfilled. For example, these goals have been found to positively predict disorganisation (Elliot & McGregor, 2001). Performance-approach goals lead to success in tasks or tests since they represent desires to achieve with respect to normative assessment. These goals have been found to positively predict both challenge and threat appraisals, and time invested for exam preparation (McGregor & Elliot, 2002). They may be particularly salient in tasks or tests that have rote-learning components since they also associate with effort minimisation to achieve. Performance-approach students should not do well on tasks that examine deep understanding. Performance-avoidance goals should result in the weakest academic profile since they are associated with shallow cognitive commitment, perceived threats, procrastination in preparing for exams, test anxiety, the desire to escape during exams (McGregor & Elliot, 2002), and disorganisation (Elliot &

McGregor, 2001). However, there is laboratory evidence that students prone to performance-avoidance goals may work just as hard and attain equivalent results as other students since their desire is to avoid the lack of ability recognition (Elliot & Harackriewicz, 1996).

Single-administration questionnaire studies that have used regression-based analyses from a normative goal perspective have shown mastery-approach goals to positively predict course grade for university and school students (Church et al., 2001; Rao, Moely, & Sachs, 2000; Roeser et al., 1996; Urdan et al., 1997; Wolters et al., 1996). Research using structural equation modelling has also found mastery-approach goals to positively predict grade (Niemivirta, 1997; Valle et al., 2003). However, there has been considerable research using similar methods and regression analyses that has found null relations between mastery goals and grade (Ee et al., 2003; Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot, McGregor, & Gable, 1999; Greene et al., 2004; Harackiewicz et al., 1997; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Harackiewicz et al., 2002; Lopez, 1999; Skaalvik, 1997; Wolters, 2004). Patrick et al. (1999) found null relations between mastery-approach goals and academic grade for females in grades 7 to 8 but found mastery goals to positively predict grade for males in social studies. Thus, the empirical research base has yielded mixed results for the relations between mastery-approach goals with academic achievement. One reason for this could be that grades are also influenced by other constructs such as self-regulated learning which may not have been controlled for in the study. Another possibility is that exams and course grades are also dependent on performance-approach motivational characteristics, the impact of these being compounded if tasks or exams involve substantial rote-learning components.

In terms of the normative model, performance-approach goals have been positive predictors of academic achievement (Church et al., 2001; Ee et al., 2003; Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot et al., 1999; Harackiewicz et al., 1997; Harackiewicz et al., 2000; Harackiewicz et al., 2002; Skaalvik, 1997; Wolters, 2004; Wolters et al., 1996). Some studies have found null effects between performance-approach goals and grade (Lopez, 1999; Rao et al., 2000; Roeser, 1996). Urdan et al. (1997) found a negative effect for performance-approach goals on academic achievement but they used a scale that contained a mixture of performance-approach and avoidance items. Likewise, Niemivirta (1997) found a negative relation between performance-approach goals and grade using structural equation modelling analyses but his performance scale items were not provided; he may have used a mixture of approach and avoidance items for his performance scale as well. The research on performance-avoidance goals has been relatively clearer: performance-avoidance goals have been found to negatively predict grade (Church et al., 2001; Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot et al., 1999; Skaalvik, 1997; Wolters, 2004). Elliot and McGregor (2001) found no relation between mastery-avoidance goals and grade in university students.

That performance-approach goals lead to academic achievement is understandable in light of the normative model. Problems with this orientation arise, however, when considering its role in fostering deep understanding - an important consideration for constructivists in science education. If performance-approach students are successful because they memorise well then these students perhaps will not be satisfactorily learning science concepts. Proponents of the adaptiveness of performance-approach goals suggest this orientation may lead students to approach the task and then students may be coerced into deep understanding utilising their mastery-approach orientation if the learning experience is appropriate (Harackiewicz et al., 2002). Consequently, this theory has lead to the development of a multiple goal model. However, little research has considered the influence of mastery-avoidance goals in light of multiple goals and their relations to academic achievement. According to the theory, students with a high mastery-avoidance goal orientation give up when they realise they are not achieving satisfactory understanding (Elliot & McGregor, 2001). Although Elliot and colleagues (Elliot, 1999; Elliot & McGregor, 2001) suggest that this occurs in high achievers, I contend that this could occur in all learners irrespective of their ability and therefore has implications for constructivist approaches to science education. The thinking challenges that are part of constructivist-based pedagogy have the potential to invoke mastery-avoidance goals particularly if the teacher does not provide appropriate scaffolding. For example, students may adopt mastery-avoidance goals during group work due to the lack of communication with peers. Or, mastery-avoidance could be fostered when students lack particular skills such as observing and even procedural knowledge skills in terms of metacognitive processing. As a result, students may get confused or feel they are not able to generate satisfactory understanding thus give up or draw on their mastery-avoidance orientation.

The second way of examining the impact of achievement goals on academic achievement uses a multiple goal perspective. Research addressing this area has categorised the multiplicity of achievement goals on the basis of person-centred analyses such as median split and cluster analysis techniques or variable-centred analyses such as interactions between variables such as mastery and performance goals in multiple-regression analyses (Kaplan & Midgley, 1997; Pintrich, 2000c). Although there is general support for the adaptive nature of both mastery and performance-approach goals for students in terms of the additive goal pattern (see Harackiewicz et al., 2002), studies on high school and university students have found no significant interactive goal pattern effects on grades using regression-based analyses (Harackiewicz et al., 1997; Patrick et al., 1999; Urdan et al., 1997; Wolters, 2004; Wolters et al., 1996). Studies using person-centred analyses have also yielded mixed results. Pintrich (2000c) used a median split format and found high performance-approach goals in eight- and ninth-grade students to not hamper the effects of their mastery goals on achievement and other motivational beliefs (incorporating self-efficacy), affect and strategy use. Bouffard, Boisvert, Vezeau, and Larouche (1995), also on the basis of a median split format, reported university students having high mastery and high performance-approach goals to have greater academic performance than the other goal combinations. Meece and Holt (1993) used cluster analysis to reveal the highest grades for students belonged to the high mastery/low performance-approach cluster. However, this group and the high mastery/high performance-approach cluster reported greater use of self-regulated learning strategies than the low mastery/low performance-approach goal cluster.

The impact of achievement goals on academic achievement has been presented above in a unidimensional fashion. Another factor that impinges upon achievement is the student’s skill at regulating their learning. Self-regulated learning occurs inside and outside (e.g., at home) the classroom and, in concert with students' goals, may have a substantial role to play in learning and achievement. Indeed, constructivist research has shown that while students have a focus on learning, they are not good at it, with many students continuing to develop misunderstandings or resorting to their original understanding even though it is inadequate (Driver, 1981; Driver et al., 1994; Eylon & Linn, 1988; Novak, 2002). Perhaps students' self-regulated learning skills need be addressed when considering the role of constructivist approaches to learning in addition to the positive and negative valences of the mastery and performance achievement goals, the foci of the present review on achievement goals. An adjunct feature to this multidisciplinary consideration relates to addressing an important question that critics of constructivism often ask: How do students develop understanding if they do not have the appropriate phenomena in front of them? (Duit & Treagust, 1998; Kivinen & Ristela, 2003; Matthews, 1994; Osborne, 1996; Pea, 1993; Simpson, 2002). Perhaps understanding in science classrooms can be attained by students who have the necessary skills to self-regulate their learning and balance the positive and negative valences of their personal achievement goals.

3.6 SUMMARY

In sum, achievement goals have been identified as important motivational mediators in learning environments. While much of the research on goals in the past decade has utilised a trichotomous goal framework, contemporary achievement goal theory posits a quadruplicate set of goals - a "2 X 2" goals framework (Elliot & McGregor, 2001). According to this theory, mastery goals are associated with internal referents towards learning or mastering tasks and comprise of mastery-approach and mastery-avoidance goal orientations. Performance goals have external referents and comprise of performance-approach and performance-avoidance goal orientations. Currently, there is conjecture regarding the adaptiveness of performance-approach goals since these goals have theoretically been associated with inter-personal referents (demonstrating competence) and intra-personal referents, namely the need to achieve and the fear of failure (Elliot, 1999; Harackiewicz et al., 2002). The mastery-avoidance goal has been understudied. Although research on this goal may be useful for testing the theoretical aspects of the “2 X 2” goals framework, it is also justified for two other reasons. Firstly, mastery-avoidance may be salient in learning environments fostered by pedagogical styles such as constructivism that have an emphasis on challenging cognition. Secondly, mastery-avoidance is postulated as being characteristic of high-achievers (Elliot & McGregor, 2001) and thus may be prominent in gifted students attending selective high schools.

Much of the early goal research used a normative goal model, classifying students as either mastery or performance-oriented. Extant goal theory challenges this model, proposing that the interactions of mastery and performance goals mediate students' learning and behaviour in the classroom; this is referred to as a multiple goal model. Research from this perspective generally has found the mastery-approach goal to buffer any potential negative or maladaptive effects from having a performance-approach goal. Therefore, in a multiple goal model, performance-approach goals may serve as useful peripheral motivators for high mastery-approach students when they encounter mundane learning experiences and for exam preparation. However, more empirical research is needed to examine the various multiple goal models and their relations to other constructs such as academic performance and self-regulated learning.

Achievement goals are mediators of cognition and behaviours (e.g., help-seeking) in the classroom and thereby, in a hierarchical fashion, have distinct antecedents and consequences. This review presented theoretical and empirical research in light of several prominent influences of goals. In terms of social antecedents, research has found the classroom learning environment fostered by the teacher to exert a considerable influence on students' personal achievement goals. An emphasis on a mastery goal structure leads to an increase in students' personal mastery goals whilst fostering a competitive learning environment increases students' uses of performance-approach and performance-avoidance goals. In terms of pedagogical features, the TARGET literature has revealed absolute evaluation practice, instructional discourse, affective and supportive discourse to have positive effects in terms of enhancing the mastery goals of students. This has implications for pedagogical styles such as constructivism and its affiliates, namely conceptual change approaches. The limited research that has examined achievement goals in constructivist learning environments has found this approach to lower students' performance goals. However, these studies used a normative goal model in analysing the effects of constructivism. Some support for a "context" hypothesis was found in the literature: studies that have focused on examining goals in micro-learning environments have found the expected relations between goals and learning behaviours such as cognitive engagement. These studies have revealed the increasing role that motivational beliefs, such as self-efficacy and perceived ability, play as micro-learning environments become less teacher-regulated; in turn, these may influence the achievement goals adopted by students. This has implications for pedagogy that utilise distinct micro-learning environments such as constructivism.

In terms of personal antecedents, this review made a distinction between efficacy and ability perceptions; most studies have focused on one or the other of these competence perceptions. It was suggested that efficacy with its intra-personal basis would influence mastery goals and perceived ability, with its external standards of references, would influence performance goals. Thus, research should focus on measuring both these types of competence perceptions. However, while research has found efficacy to be a positive predictor of mastery-approach goals, perceived ability has been reported to positively correlate with both mastery and performance-approach goals, and to negatively correlate with performance-avoidance goals. There are mixed findings regarding gender effects on mastery-approach goals. Males, however, tend to report higher performance-approach goals. No gender effects have been found for performance-avoidance goals. No studies have examined differences between gifted and regular high school students in light of contemporary goal models.

The final section of the review presented research on achievement goals as influences of academic achievement. Mastery-approach goals have been found to have mixed effects on achievement whilst performance-approach goals are positive predictors. Performance-avoidance goals negatively correlate with achievement.

Chapter 4

LITERATURE REVIEW: RESEARCH ON SELF-REGULATED LEARNING

4.1 SELF-REGULATED LEARNING: THEORETICAL CONSIDERATIONS

Besides examining the influences of achievement goals on academic achievement, a substantial body of achievement goal research has focused on the relationships between achievement goals and the self-regulated learning processes of students. As a construct, self-regulated learning (hereafter referred to as SRL) attempts to assimilate the interactive processes that are associated with a student directing their own learning; these processes encompassing the praxis of quality learning. SRL is a subset of a self-regulation, a psychological phenomenon that encapsulates how a human regulates their day-to-day existence. As Zeidner, Boekaerts, and Pintrich (2000) suggest, SRL is a "narrower construct" whilst self-regulation is a "higher-order construct" (p. 751) and SRL involves "…cognitive, affective, motivational, and behavioural components that provide the individual with the capacity to adjust his or her actions and goals to achieve desired results in light of changing environmental conditions" (p. 752). Achievement goal researchers have measured various components of SRL such as active cognitive engagement (Meece et al., 1988; Ryan & Patrick, 2001; Stipek & Gralinski, 1996), optimal task engagement (Elliot & Harackiewicz, 1996), self-monitoring (Ames & Archer, 1988), deep processing (Bandalos et al., 2003; Grant & Dweck, 2003), active engagement (Ames, 1992), and deep strategy use (Turner et al., 1998) in order to distinguish consequential behaviours of mastery and performance goal orientations. Most investigators of SRL consider it as a set of social cognitive processes associated with the attainment of positive learning outcomes (e.g., Wolters, 2003; Zimmerman, 1989a). That is, SRL is adaptive in that the student is attempting to accomplish a learning task. Consequently, SRL has been one of the major areas of focus in achievement goal research and the present research continues with this focus especially in light of a multiple goal perspective.

Models of SRL describe some type of mechanism that is invoked by students when they self-regulate their learning (Boekaerts, 1996; Pintrich, 2000a; Winne, Jamieson-Noel, & Muis, 2002; Zimmerman, 1989a, 1989b). Central to this mechanism are the metacognitive components of SRL although Boekaerts (1996) proposed a metamotivational component in her model which she called “motivational self-regulatory strategies”. In his review of SRL, Wolters (2003) also describes the regulation of motivation as an inherent part of SRL. Metacognition refers to the processes associated with the regulation or “overseeing” of cognitive activities and involves actions such as planning, monitoring, and regulating, and is often confused with self-regulated learning (Baird, 1998; Borkowski, 1996; Georghiades, 2004; White, 1998; Wittrock, 1994). Metacognition is an overseeing process that requires the learner to be deeply engaged in their learning and to be cognisable with the way they are going about learning (Flavell, 1979, 1987; Papaleontiou-Louca, 2003), whilst SRL is a broader construct that attempts to relate the various mediators of a learning experience – behavioural, social, physical, emotional, motivational – with the use of metacognitive strategies utilised in the learning episode (Demetriou, 2000, cited in Zeidner et al., 2000). Metacognition is also to be differentiated from cognitive processes. Cognitive strategies are at a lower order to metacognitive strategies and involve strategies that are associated with organising, retrieving, relating and rehearsal of material (Borkowski, 1996; Flavell, 1979, 1987; Pintrich & De Groot, 1990; Pintrich, Smith, Garcia, & McKeachie, 1991). The higher order construct of metacognition involves the learner monitoring their selection and use of various cognitive strategies in order to regulate their actions towards attaining their learning goal and thus self-regulate the learning process.

It is generally agreed that SRL encompasses the “…cognitive, affective, motivational, and behavioural components…” (Zeidner et al., 2000, p. 752) a learner has and which are integral with respect to the learner mediating between their desired state of action, a component that is determined by some type of standard or criteria of reference, and what happens as a result of personal and environmental events (Puustinen & Pulkkinen, 2001). Hence major contemporary models of SRL consider SRL from a social cognitive perspective (Boekaerts & Niemivirta, 2000; Pintrich, 2000a; Zimmerman, 1989a). A social cognitive approach to the study of SRL acknowledges that the reciprocated dynamic interactions between the student’s personal attributes with the physical and social environments influence the SRL a student pursues (Bandura, 1986; Meyer & Turner, 2002; Zimmerman, 1995). As a result of its multifarious nature SRL is an expansive field - research on the metacognition component itself, for example, is considerably complex and multidisciplinary. Consequently, the present research is grounded in the SRL processes associated with achievement goal theory. The present research is also grounded in a social cognitive framework of understanding the factors that influence the self-regulated learning processes of students learning science by examining environmental factors such as classroom constructivist-based pedagogical factors, classroom achievement goal emphasis and classroom metacognitive demands, along with personal factors such as personal achievement goals, competence perceptions the motivational beliefs of test anxiety, self-efficacy and intrinsic value, perceived ability, gender, and global ability (gifted or regular). The model of SRL that has most resonance with the approach adopted in the research I have conducted is Pintrich's (2000a). This model of SRL subsumes students' achievement goals.

SRL is generally measured using self-report instruments (however, see Butler, 2002; Patrick & Middleton, 2002, for qualitative means). One of the more established inventories used by researchers is the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991), which contains scales measuring motivational components and self-regulated learning strategies. The self-regulated learning strategies section, for example, ascertains cognitive strategy use ("When I study for a test, I try to put together the information from class and from the book") and metacognitive self-regulation strategy use ("I ask myself questions to make sure I know the material I have been studying"). Other established inventories include the Learning and Study Strategies Inventory (LASSI; Weinstein, Zimmerman, & Palmer, 1988) and the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1997), although the relevant PALS scales are labelled "Adaptive learning strategies" (e.g., "After I write something the first time in English, I keep working on it to make it better") and "Maladaptive learning strategies" (e.g., "When I do my math, I sometimes skip the hard parts". Surveys are efficient, less costly than observational methods and they confine students to report on SRL strategies or actions thus narrowing the focus of the students and increasing the validity of the assessment of SRL. However, this assumes that the participants are conscious of their self-regulated learning strategies. In a developmental sense, it has been suggested that young students (under 13 years) are not able to be conscious of their learning style and thus have problems understanding what self-report questionnaire items are asking with reference to abstract items about cognitive and metacognitive strategy use, and students may not have stable SRL traits as compared to adults or older students (Boekaerts, 1999). A problem with using these established questionnaires in order to measure SRL processes like metacognitive strategy use is that they may worded in terms of trait-level features and thus students may find it difficult to report their SRL since it is a contextualised and complex issue (Patrick & Middleton, 2002). One of the aims of this study is to 'capture' the SRL students at the episodic level by wording the SRL questionnaire in the contextual frame of the learning task or episode. This will improve the validity of the reports of this construct. Winne et al. (2002) call this contextual consideration of questionnaires as 'conditions'.

Researchers from psychology have treated SRL as a continuous variable and have used questionnaires with Likert-type scales as the means to quantify the SRL exercised by students. Hence students may be classified somewhere along the poor-to-good self-regulated learner continuum (Eshel & Kohavi, 2003; Hong & O'Neil, 2001; Pintrich, 2000a; Wolters & Pintrich, 1998) or as simply having little SRL when they are involved in unproductive behaviour (Paris & Paris, 2001). Deci and Ryan's self-determination theory offers another approach to quantifying self-regulated learning: SRL is a continuum with the highest level of SRL manifested in students whose learning is intrinsically driven, students at the lowest level of SRL have extrinsic concerns dictating while students in the middle pursue behaviours that are a combination of the extremes of SRL (Deci, Ryan, & Williams, 1996). According to Zimmerman (1998), all learners self-regulate their academic learning but there is a range of skilled self-regulated learners from "naïve" self-regulated learners to "skilful" self-regulated learners (p. 6). To be consistent with previous SRL research, I will refer to the SRL attributes of students using the poor-to-good continuum structure.

The interplay of SRL control systems (e.g., processes of volition, emotion and metacognition) is still to be operationalised and researched (Boekaerts & Niemivirta, 2000) and consequently the present research considers the frame of reference for studying SRL in classrooms, like most studies of SRL, as being the behaviours observed and strategies reported by students in association with the self-regulation of students' learning. Further to this, I will utilise the construct of SRL as being indicative of the positive or adaptive behaviours that are commensurate with the procurement of learning in the classroom.

4.2 SOCIAL/ENVIRONMENTAL INFLUENCES OF SELF-REGULATED LEARNING

In the main, research addressing the influence of environmental factors on SRL may be categorised into three areas. Firstly, some research has investigated the influence of classroom achievement goal structures on SRL; this being cached in an achievement goal perspective. This line of research is based on the supposition that the learning environment may influence students' SRL above and beyond students' personal factors such as personal achievement goals and efficacy perceptions. Secondly, there is a body of research that has investigated the impact of pedagogical styles on SRL. A considerable amount of research in science education has focused on the impact of constructivist pedagogy or associated programs such as conceptual change teaching on students' SRL processes, particularly the metacognitive aspects of SRL. Thirdly, there is research associated on programs that explicitly teach components of SRL such as metacognition and cognitive strategies. Relevant issues to the present research of these three areas are presented below.

4.2.1 Classroom Achievement Goal Structures

In accordance with achievement goal theory, classrooms that emphasise a mastery-approach goal would foster greater use of self-regulated learning than classrooms that are more performance oriented. The limited amount of research that has investigated the associations between goal structures and self-regulated learning has found mixed results. Some regression-based studies have reported the mastery goal structure to be a positive influence on middle to junior high school students' use of metacognitive and cognitive strategies (Wolters, 2004; Young, 1997). Ee et al. (2003), studying high achieving sixth-grade students, found the mastery goal structure to be a weak negative predictor of students' knowledge of SRL strategies and to have null relations with SRL usage. Studies have found the performance goal structure to have no influence on students' SRL (Ryan & Patrick, 2001; Wolters, 2004). Young (1997) found a weak positive effect for performance goal structure on SRL in English but not in math. Ee et al. (2003) found this goal to have a null relation with usage of SRL and to be a weak negative predictor of knowledge of SRL. However, there is a substantial body of research that has found the performance goal structure to be associated with negative behaviours such as an increase in help-seeking avoidance behaviours (Karabenick, 2004; Newman, 1998; Ryan, Gheen, & Midgley, 1998) and self-handicapping (Urdan, 2004; Urdan & Midgley, 2001; Urdan, Midgley, & Anderman, 1998).

4.2.2 Pedagogical Styles: Constructivism

Constructivism is to be contrasted with self-regulated learning. Constructivism is a belief about learning and the associated pedagogical practice that ensues; SRL is a multifarious construct that encapsulates the cognitive, motivational, and behavioural processes that are employed by a student as they go about their learning (Boekaerts & Niemivirta, 2000; Pintrich, 2000a; Schunk, 1990; Zimmerman, 1989a, 1989b, 1994). SRL refers to the set of processes that are utilised when a student is regulating their learning; unlike constructivism, it is not an epistemological belief. However, some models of self-regulated learning contend that the epistemological beliefs of students is a component of SRL, interacting with student's motivational beliefs, prior knowledge and experience, social interactions, motivational goals, volitional processes, metacognitive and cognitive processes (Butler, 1998a; Winne, 1996). A constructivist belief in learning may perhaps play a role in influencing how a learner goes about their learning in a science classroom, that is, how they self-regulate their learning. For example, compatible teacher and student learning goals have been shown to be influential in fostering harmonious learning environments. Hence, students that have constructivist epistemological beliefs may find a teacher with similar epistemological beliefs to foster a desired learning environment (Roth, 1997; Wallace, Tsoi, Calkin, & Darley, 2003; Windschitl & Andre, 1998). However, according to a social cognitive view, SRL is also mediated by behavioural, environmental and personal factors (Schunk, 1989, 1998; Zimmerman, 1989a, 1995). Thus, both constructs are complimentary.

Constructivism subsumes students self-regulating their learning. For example, Paris and Byrnes (1989) noted six components or tenets of constructivist approaches that are immanent with the principles of self-regulated learning in the context of academic achievement and learning environments:

(1) Students are intrinsically motivated to seek information; hence students interact with their environment in a reciprocal fashion rather than just being a passive observer.
(2) Students try to make sense of their experiences.
(3) Knowledge and understanding may be gradually altered.
(4) Understanding is never final according to constructivists.
(5) Constructivists acknowledge that there is some type of constraint imposed upon students when engaged in the process of learning and the teacher is required to guide or assist the student to overcome learning impediments. Vygotsky (Howe, 1996; Leach & Scott, 2002; Vygotsky, 1978), for example, used the term “zone of proximal development” to describe the type of scaffolding that a learner needs in order to advance from being able to do a task with assistance to being able to do it independently.
(6) The learner has some autonomy with respect to how they go about reflecting and reconstructing their learning. Hence constructivism, like any theory of learning, depends on the regulation of one’s learning (Paris & Byrnes, 1989).

Self-regulated learning is not new to the ideas of constructivism. The social constructivist perspective of learning, for example, highlights facets of SRL as integral in learning. In order to make meaning, there must be some type of collaboration between the learner and the social environment (teacher and peers) with the learner using their mental functioning to make sense of their learning, particularly in relation to Vygotskian theory's "zone of proximal development", in which an expert scaffolds the learning experience while the learner attends to the perturbations until they have accomplished the learning; this involves verbal regulation, verbal guidance and language integration (Biemiller, Shany, Inglis, & Meichenbaum, 1998; Henderson & Cunningham, 1994; Roth, 1993, Vygotsky, 1978; Wells, 2002). Thus, a student is required to be self-regulating when constructing their learning; the presence of others fostering an "other-regulation" (Biemiller et al., 1998, p. 208) event. Vygotsky's theory of cognitive development encompassed much of the contemporary work on metacognition (Bråten, 1991, 1992; Brown, 1987; Papaleontiou-Louca, 2003). Emanating from this theory is a Vygotskian theory of self-regulated learning, which considers various environmental or social factors as influential on the self-regulation of the learner. These factors include socialisation processes at school, involving peers and teachers, and socialisation processes at home, including parents, siblings and peers; these social influences interacting with the intrapersonal experiences of the student (Rohrkemper, 1989). Thus, it is the interplay of intra- and inter-individual circumstances that impact on learners as they engage in learning. Of import in the Vygotskian view of SRL is the role of language. It is the sequence of events from when language is initially encountered from outside the learner – external sources – to the language becoming integrated by the learner so it becomes intrapersonal and with a sense of direction ("self-directed" Rohrkemper, 1989, p. 147) – inner speech - that typifies Vygotskian SRL. This sequence has been labelled as "emergent interaction" (Rohrkemper, 1989, p. 147). There are two types of inner speech: self-involved and task-involved. The former involves control of self, the latter involves control over the processes utilised when doing a task. Hence the regulation of one's learning is an essential feature of the Vygotskian theory of learning (constructivism).

In a reciprocal fashion, constructivist-based pedagogy has much to offer with regards to fostering learning environments conducive to SRL. Firstly, constructivist-inspired teaching and learning environments supposedly allow more scope for the implementation of SRL processes by students since the learning environment is not confined to teacher-regulated events that exhibit great control over the students (Hickey, 2003; Paris & Paris, 2001; von Glaserfield, 1995). Traditional classrooms do not offer much scope for students to self-regulate their learning (Boekaerts, 2002). Secondly, the teacher focuses on students' understanding in contrast to transmissive approaches that tend foster minimalist activity from students (Paris & Byrnes, 1989) or direct instruction approaches that offer students no chance to utilise their metacognitive thinking skills and that offer students no basis for explicating the relevant learning mechanisms (Palincscar, 1998). Thirdly, a constructivist-based pedagogy develops general skills of communication and learning with others, typical of real-life ventures. The focus of the present research is on the pedagogy espoused by constructivism and if this is a facilitator, amongst others, towards the implementation of SRL processes. For example, teaching programs that foster SRL are based on social constructivist principles (Rozendaal, Minnaert, & Boekaerts, 2003).

Two fields of research are affiliated with the impact of constructivist-based pedagogy on SRL. One of these concerns constructivist-based interventions, the other is associated with conceptual change approaches. In both fields the focus has been on the metacognitive aspects of students' SRL. This could be a result of the methodology employed, with most studies employing mixed-method approaches, using a mixture of quantitative and qualitative means rather than depending on traditional quantitative instruments from psychology such as the MSLQ. It also reflects the disciplinary focus of the researchers with most of these studies nested in the field of science education – the interest being on how students learn rather than measuring motivational-related constructs that are usually the domain of psychologists. First, there is a body of research that involves intervention studies in which a constructivist-based teaching sequence is used. Research based on constructivist interventions has yielded mixed results with respect to the effectiveness of constructivist interventions on fostering SRL in students

(Appleton, 1997; Conner, 2004; Hand et al., 1997; Mason & Santi, 1994; Roth, 1997; Thomas & McRobbie, 2001). Hargis (2001) found no difference between constructivist, control and objectivist groups in terms of SRL. Conner (2004) also found a range of student intentions during a constructivist-based set of lessons in senior biology high school students. In this study, some students reported they expected the teacher to tell them what to do and to monitor their work; this external regulation trait of students (Boekaerts, 2002) also being reported in other studies (Roth, 1997; Thomas & McRobbie, 2001).

In an attempt to enhance students' metacognition and learning processes, Thomas and McRobbie (2001) employed a program of science lessons based on social constructivist principles in a co-educational high school chemistry classroom, involving twenty four year 11 students (15-16 years). Specifically, the intervention consisted of a periodic sequence of lessons that required students to employ a metaphor "learning is constructing" as a frame of reference for their learning. During the 12-week intervention phase, the teacher assisted students in developing an approach to their learning of chemistry in line with the metaphor "learning is constructing". This involved activities such as students constructing three-dimensional concept maps, comparing views, reflection, and the teacher altering his discourse in order to exemplify the intent of the metaphor as a referent for students' learning ("Where does this concept fit in your present construction?"). Data were collected on students' metacognitive and learning processes, their interpretation of the classroom learning environment and on their role as a student in the classroom prior, during and after the intervention. Six students, representing a range of learning approaches and metacognitive abilities of the class, were focused upon as case studies, these students were interviewed and their multiple-source data correlated. Of import was the finding that all students in the class could relate to the metaphor and the approach was conducive to beneficial learning. The data analysis revealed three groups of students: students that increased their level of metacognition; students that did not alter their metacognitive level; and, students that had no change to their metacognition apart from improving their vocabulary associated with describing their metacognition and learning approaches. Another finding from this study was the influence of students' future goals on their use of strategies (see Wentzel, 1999). Students reported they saw the classroom as a vehicle for their goal of going to university and this confounded the adoption and integration of metacognitive training. The students identified, via interviews, a pedagogical hegemony of teachers getting students ready for exams, controlling students and monitoring students' progress. This type of external regulation fosters low cognitive effort (just knowing for the exam, as reported by the students about their other classrooms) from the students thus influencing their adoption of metacognitive strategies; it also reflected the values and norms of school culture. That is, the school is a workplace and assessment is of prime importance. Students also reported the teacher as being essential for metacognition implementation. Twelve students reported the changes resulted in improved learning outcomes; the remaining students reported their views about teaching and learning to be unaltered. Thomas (2002) suggests that if students have these views then they will be hard to modify. If effective interventions or programs are to be viable then there must be consideration of the education and learning values at many levels (see Fensham, 1988).

The second research field has examined the impact of conceptual change pedagogy on students' SRL. The majority of studies that relate constructivist pedagogy to self-regulated learning have been situated in the conceptual change field of research. This area has confined itself to examining the cognitive aspects and the concomitant regulatory processes as students experience conceptual change; the regulatory processes equating to metacognition. Conceptual change is acknowledged as a pragmatic form of constructivism (Coborn, 1993) in order to distinguish it from the more radical type of constructivism espoused by von Glaserfeld (1993, 1995). Conceptual change is pragmatic since it tries to alter students' existing conceptual frameworks so that they are aligned with the scientific one, one that is more plausible than the student's initially held representations. Therefore, this assumes some type of realist ontology with regards to the concept being learned – the aim being to foster understanding in congruence with canonical views. Thus, conceptual change is associated with changes in the beliefs that students have about phenomena (Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001; White & Gunstone, 1989). Radical constructivism, on the other hand contends that knowledge is empirically attained; there is no one set form of knowledge, it is confined to one's experiences (Matthews, 1994). From a conceptual change perspective it is contended that in order for students to construct their understanding they must utilise metacognitive processes (Baird, 1998; Beeth, 1998a; Georghiades, 2000; Gunstone, 1994; Hewson, Beeth, & Thorley, 1998; Thorley & Woods, 1997; White, 1998; Wittrock, 1994).

The focus in most conceptual change work has been on the attainment by students of the scientific view of the concept and consequently the emphasis has been on studying the effectiveness of this approach with regards to science conceptual attainment in areas such as diffusion and osmosis (Tekkaya, 2003), mass, volume and density (Hewson & Hewson, 1983, 1984), electricity (Chambers & Andre, 1995, 1997; Thorley & Woods, 1997; Wang & Andre, 1991), chemistry (Chiu, Chou, & Liu, 2002; Niaz, 1995), astronomy (Diakidoy & Kendeou, 2001) and physics (Newton's third law) (Savinainen, Scott, & Viiri, 2005). Most of these studies have found conceptual change approaches to successfully improve students' scientific conceptions beyond traditional approaches to teaching. These studies and their approaches implicitly imply that for conceptual change to occur students must regulate their learning and there is evidence for conceptual change teaching as increasing students' use of metacognitive strategies (Beeth, 1998b; Champagne, Gunstone, & Klopfer, 1985; Gunstone, Gray, & Searle, 1992; Hennessey & Beeth, 1993; Nussbaum & Sinatra, 2003; Schur, Skuy, Zeitsman, & Fridjon, 2002). Hence, for students to gain understanding they must utilise adaptive SRL strategies.

Paralleling the advantages tendered by constructivist learning environments in school science are the benefits of pedagogy that attempts to improve the SRL skills of students and in school science education these have come under the wing of metacognitive programs (see Lin, 2001 for a review). Although not the focus of the present research, these programs aim to develop inter- and intra-domain metacognitive skills via direct instruction or via an integrated approach blending the skills into existing teaching and learning practice. Thus, the teacher can impact upon one component of students' SRL, namely metacognition. Generally, experimental studies involving metacognitive programs have found an increase in students' metacognitive-related strategies (Adey & Shayer, 1993; Blank, 2000; Georghiades, 2004; Vosniadou et al., 2001). Other studies of metacognitive programs in high schools have also had some success in increasing students' metacognition (Baird, 1992, 1998; Baird & Northfield, 1992; Baird & Mitchell, 1986; Loughran & Derry, 1995).

Some work has been done on teaching or enhancing students' SRL via self-regulated learning programs. De Corte, Verschaffel, & Op'T Eynde (2000) report four experimental studies in mathematics in which interventions were designed to enhance SRL for primary school students (Cognition and Technology Group at Vanderbilt, 1997), seventh grade students (Lester, Garofalo, & Kroll, 1989, cited in de Corte et al., 2000), university level students (Schoenfeld, 1992), and fifth grade students (Verschaffel et al., 1999, cited in de Corte et al., 2000). Common to these studies was students learning to implement a metacognitive-based strategy towards complex problem-solving. This entailed students firstly developing a thorough understanding of the problem: this involved students visually presenting the problem (drawing), reading the problem more than twice, analysing the familiarity of the problem and gauging chances of success of solving the problem in particular ways. Next, students had to design some form of plan for solving the problem using strategies such as exploring the conditions of the problem, seeking patterns, doing the problem in a sequence of steps from easy to harder, monitoring their efforts as they go, and utilising heuristics. The final step involved processes such as evaluating the procedure employed to solve the problem. The studies incorporated constructivist pedagogy by utilising challenging tasks, using small-group and whole-class discussions, focusing on alternate solution strategies as well as familiar ones and encouraging reflection. Positive results were found for these studies in terms of the approach used by students towards problem solving skills and the self-regulatory mechanisms used by the students. One study, however, had no gains for both the experimental and control groups, this being attributed to weak "instructional methods" used for the intervention.

Other SRL programs have also been successful at improving students' SRL skills (Butler, 1998a, 1998b; Fuchs et al., 2003; Papes, Bell, & Yetkin, 2003; Paris & Paris, 2001; Perry, Vandekamp, Mercer, & Nordby, 2002; Skunk, 1989, 1998). Fuchs et al. (2003) found an improvement in the SRL skills of third-graders in math as a result of implementing goal-setting and self-assessment procedures with the students. Papes et al. (2003) also implemented a SRL-focused pedagogy in a seventh-grade math classroom. While students improved in terms of their knowledge of strategies and the use of strategies in solving problems, their volitional control skills were not appropriate to cause the SRL processes to be sustained over time.

A limitation of these studies is that they have not considered the impact of motivational aspects on SRL. Although contemporary models of SRL acknowledge the influence of motivational aspects on SRL (Pintrich, 2000a; Winne, 1996; Winne et al., 2002; Zimmerman, 1989a, 1989b,), defining the motivational components and determining their impact is ongoing. Pintrich (2003), in his review on student motivation, describes five factors with regards to what motivates students in the classroom: (1) self-efficacy and competence, (2) attributions to success and failure, and perceived control, (3) interest (situational motivation) and intrinsic motivation (personal motivation), (4) task value, and (5) achievement goals and goal orientation. Thus, achievement goals, in addition to competence perceptions, may be important influences on SRL.

4.2.3 Micro-Learning Environments

Little research has applied a "context" hypothesis to the self-regulated learning construct. However, it has been suggested that skilled self-regulated learners are somewhat immune to contextual influences since they have the ability to control their immediate environment and apply themselves using various cognitive and metacognitive strategies. Hence skilled self-regulated learners will be consistently adaptive across contexts (e.g., Wolters, 1998). On the other hand, some students may be vulnerable to peer- or teacher-regulated learning contexts. Hogan (1999) examined eighth-grade science students' sociocognitive roles during a twelve-week unit based on constructivist principles. There was an emphasis on collaboration during group work activities that involved students justifying, reasoning, hypothesising, explaining, discussing and making inferences. Eight groups of three students served as the focal groups of the study. The groups were of mixed ability with respect to academic achievement and students were grouped with at least one preferred partner. The groups remained unchanged throughout the twelve-week unit. Each focal group was audiotaped and videotaped several times throughout the unit, yielding 73 interactive discussion-based sessions for the groups. This formed the corpus of data for the study. Hogan observed two major categories of social cognitive roles: roles that had a positive effect on the group's reasoning (promoters of reflection, contributors of content knowledge, creative model builder, mediators of group interactions and ideas), and roles that had a null or negative effect on the group's progress throughout the unit (promoters of acrimony, promoters of distraction, promoters of simple task completion or unreflective acceptance of ideas, reticent participants in collaborative knowledge building). She found that the highest achievers were not necessarily the best collaborative thinkers or the most participatory group members. However, students' personal frameworks for learning science were also influential on their approach to learning: students that believed in a transmissive approach to teaching and learning were reticent in the group work whereas those that were aligned with mastery approaches were promoters of reflection.

A context hypothesis has been prevalent in the fields of conceptual change and metacognition, mainly due to the fine grain type of methodology employed by the researchers in these fields. In these fields the researchers focus on students' reporting out loud as they solve a problem and students' discussions in small group or whole-class settings. Research from the metacognition field has found the interactions of students in group work contexts to be influential on the metacognitive components of students' self-regulated learning. However, it must be kept in mind that metacognition is a sub-construct of SRL. Artzt and Armour-Thomas (1997) conducted an experimental study on seventh-grade students solving math problems in small-group settings. Students were videotaped and observed for metacognitive and cognitive behaviours while solving a math problem. Groups ranged from 51 – 26% in terms of the percentage of behaviours deemed to be metacognitive. Generally, the higher ability students in the group exhibited the highest percentage of metacognitive behaviours. However, having a high ability student did not necessarily equate to a fully functional group. Wide-ranged mixed ability groups had the highest percentage of metacognitive behaviours. Windschitl (2001) found academic assertiveness had a negative effect on the group learning processes. Gijlers and de Jong (2005) found collaboration in extremely heterogeneous dyads is difficult when the high achiever is not willing to work in the low achiever's zone of proximal development. Bianchini (1997) showed that high status students have greater access and influence in groups. Hogan, Nastasi, and Pressley (2000) studied the discourse, interaction patterns and reasoning complexity within peer and teacher-guided small group discussions. Teacher-guidance was more efficient at attaining higher levels of reasoning whereas the degree of peer-influenced reasoning varied from group to group. In a correlational study, Cantwell and Andrews (2002) found high school students who had a preference for group learning to have higher levels of metacognitive awareness than those who preferred individualised learning approaches. Using regression analytic techniques, Anderson et al. (1997) found previous peer relationships affected the working of a group. Thus, social relationships may hamper the "negotiation of meaning" (Palincscar, 1998, p. 359).

4.3 PERSONAL/COGNITIVE INFLUENCES OF SELF-REGULATED LEARNING

4.3.1 Achievement Goals as Influences of Self-Regulated Learning

As pointed out above, SRL is somewhat influenced by the motivational attributions of a learner and subsequently has often been used to ascertain the differences in the processes employed by students who have different achievement goal orientations (Ames & Archer, 1988; Meece et al., 1988; Schunk & Ertmer, 1999). According to the normative goal model, a mastery goal orientation fosters the use of self-regulatory strategies such as monitoring with respect to one's internal standards and regulating progress in attempting to find effective strategies that bring about learning and understanding

(Pintrich, 2000a). The impact of performance goals on SRL, on the other hand, is not so straight forward and is an area of contemporary discussion by investigators of SRL and achievement goal theory. Reviews of this area point out that performance-approach goals may generate adaptive or positive SRL strategies whilst performance-avoidance goals lead to the adoption of maladaptive SRL strategies such as not checking understanding and taking short cuts in trying to understand (Midgley et al., 2001; Pintrich, 2000a) since the standards are external and not internal. Early studies that investigated self-regulated learning-related strategies in the context of achievement goals did not consider performance goals in the dichotomous framework (performance-approach and performance-avoidance) and thus the analysis of SRL in this work is hazy (Pintrich, 2000a). Furthermore, there is no research on SRL in the context of the mastery-avoidance orientation espoused by Pintrich (2000a) and Elliot (Elliot, 1999; Elliot & McGregor, 2001). The present research examines the relations between the mastery-avoidance goal and SRL.

There is a substantial body of regression-based research that shows personal mastery goals to be positive predictors of self-reported SRL for school students (Ablard & Lipschultz, 1998; Ee et al., 2003; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Pajares et al., 2000; Patrick et al., 1999; Turner et al., 1998; Wolters, 2004; Wolters et al., 1996) and university students (Elliot & McGregor, 2001; Elliot et al., 1999; Ford et al., 1998; Greene & Miller, 1996). Studies utilising path analysis and structural equation modelling have also found positive relations between mastery goals and SRL (Bandalos et al., 2003; Greene et al., 2004; Meece et al., 1988; Niemivirta, 1997; Valle et al., 2003). Only one study found a null relation for mastery goals and SRL (Neber & Schommer-Aikins, 2002), this study focusing on high achieving students in a middle school. Performance-approach goals have been found to have null relations with self-reported SRL in school students (Bandalos et al., 2003; Ee et al., 2003; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Neber & Schommer-Aikins, 2002; Niemivirta, 1997; Pajares et al, 2000; Turner et al., 1998; Wolters, 2004) and university students (Elliot & McGregor, 2001; Elliot et al., 1999; Ford et al., 1998; Greene & Miller, 1996). However, some studies have found performance-approach goals to be positive predictors of SRL (Ablard & Lipschultz, 1998; Meece et al., 1988; Wolters et al., 1996). Pajares et al. (2000) found performance-approach goals to be positive predictors of SRL in eighth-grade English but to have null relations with SRL in sixth- and seventh-grades for English and science, although they used a scale that measured students' reporting on their capacity to use SRL rather than self-reported use of strategies. Many of these studies also found performance-approach goals to positively predict maladaptive strategies such as surface processing (Elliot & McGregor, 2001; Elliot et al., 1999; Greene & Miller, 1996; Kaplan & Midgley, 1997; Niemivirta, 1997). Studies that have utilised performance-avoidance goals have found these to have null relations with SRL (Elliot et al., 1999; Middleton & Midgley, 1997; Wolters, 2004) or to be negative predictors of SRL (Elliot & McGregor, 2001; Pajares et al., 2000). Some research has found performance-avoidance goals to positively predict surface processing (Elliot & McGregor, 2001; Elliot et al., 1999). Elliot and McGregor (2001) found null relations between mastery-avoidance goals with deep processing and surface processing strategies; however, they did find mastery-avoidance goals to positively predict disorganisation. Karabenick (2004) found mastery-avoidance goals to positively correlate with help-seeking avoidance behaviour.

In terms of multiple goal models, Meece and Holt (1993) used to two procedures to categorise fifth and sixth-grade science students on the basis of multiple goals. Employing cluster analysis techniques, they identified three clusters: cluster one composed of students who had high mastery goal orientation. Cluster two contained students having high mastery and high ego-social (equates to performance-approach goal) and cluster three composed of students having low mastery-low ego goals. Of significance, students of clusters one and two had no difference in terms of their reported use of active learning strategies and these clusters had greater use of these strategies than cluster three. On the basis of a median split procedure, there was no significant difference between the groups categorised as high mastery/ high ego and high mastery/low ego for active engagement strategy use. However, these groups had higher levels than the low mastery/high ego and low mastery/low ego groups. Interestingly, the high mastery/high ego group had significantly higher reports of superficial engagement compared to high mastery/low ego group. Bouffard et. al. (1995) also used a median split analysis and found university students' having a high mastery/high performance profile to have the highest use of SRL. Riveiro, Cabanach, & Arias, (2001) also used cluster analysis to identify three groups of university students. Using analysis of variance measures, they found the high mastery/high performance-avoidance/medium performance-approach cluster to have the greatest use of SRL strategies. Pintrich (2000c) in a longitudinal study of eighth and ninth-graders also used a median split procedure and found no differences between the high mastery/high performance-approach group compared with the high mastery/low performance-approach group in terms of SRL strategy use. Rather, the personal mastery goal predicted SRL (in accordance with normative goal theory). Ablard and Lipschultz (1998) found similar results in their median split study on seventh-grade students: the high mastery/high performance-approach group did not differ to the high mastery/low performance-approach group in terms of SRL strategy use. Midgley and Urdan (2001) used a median split strategy on seventh-grade math students and found high mastery/high performance-avoidance and low mastery/high performance-avoidance groups to report greater use of academic self-handicapping than groups having a low performance-avoidance profile. Apart from a study by Urdan et al. (1997), which found the interaction of mastery X performance-approach goals to positively predict self-efficacy for self-regulation for eight-graders, no significant regression effects have been found for the mastery X performance interaction on SRL strategy use (Patrick et al., 1999; Wolters, 2004; Wolters et al., 1996). Thus, there is evidence for the buffering effect of the mastery-approach goal on performance goals in terms of fostering SRL although the performance-avoidance goal may be somewhat influential (Midgley & Urdan, 2001). Having a high mastery-approach goal will lead to adaptive SRL, overriding any potential negative effects from the performance-approach goal orientation.

4.3.2 Motivational Beliefs: Self-Efficacy, Test Anxiety and Intrinsic Value

An array of motivational beliefs accompanies achievement goal and SRL research. The present research incorporates the SRL model used by Pintrich and his colleagues, a model adapted from the expectancy-value theory of motivation (Eccles, 1983; Pintrich, 1989; Wigfield, 1994). According to this model, the motivational belief constructs of self-efficacy, test anxiety and intrinsic/task value, have some influence on the type of SRL processes a student adopts (Pintrich, 1989; Pintrich & De Groot, 1990; Wolters & Pintrich, 1998). Self-efficacy refers to the beliefs a student has with regards to their capability to accomplish a task with respect to certain criteria (Bandura, 1986; Pajares, 2002; Zimmerman, 2000a). This is referring to academic efficacy and is to be contrasted with social efficacy, which refers to the beliefs a student has with respect to their relationships with peers and teacher (Patrick, Hicks, & Ryan, 1997; Ryan & Patrick, 2001). Besides influencing goal orientation and task involvement, self-efficacy beliefs are influential throughout all phases of self-regulated learning (Bandura, 1986; Pajares, 2002; Skunk, 1990; Wolters, 2003). According to self-efficacy theory, students with high self-efficacy beliefs tend to engage in learning tasks and engage in ways that are more adaptive with respect to psycho-emotional states such as having lower levels of stress and anxiety than those who are less efficacious (Pajares, 2002). During the task, highly efficacious students tend to persist when faced with difficulty, believing in effort attributions to success, and utilise self-regulatory learning mechanisms such as metacognitive and cognitive strategies (Skunk & Ertmer, 1999; Zimmerman, 1989a). To reiterate, SRL is a result of a student's own choice of strategies and procedures in endeavouring to be a proactive learner (Zimmerman, 2002). Students will participate in tasks if they have confidence in their ability and will sustain their participation in the task by self-regulating their learning if they remain efficacious. Gender differences have been found in terms of self-efficacy related to SRL (Pajares, 2002; Patrick et al., 1999) and self-efficacy related to subject (Wigfield & Eccles, 1994; Wolters & Pintrich, 1998) with girls generally being more efficacious for SRL and girls utilising more SRL strategies. Generally, self-efficacy has also been considered a moderator variable of achievement goals (Middleton et al., 2004; Midgley et al., 1998). Also, self-efficacy may be ascertained at the trait level or an event/domain (for example, self-efficacy in math, English or science) context (Bandura, 1986; Schunk, 1990; Wolters & Pintrich, 1998). Thus, efficacy perceptions are influential on self-regulated learning (Stone, 2000).

Empirical research has shown students who report high levels of self-efficacy to have high levels of SRL. Studies using regression analyses have found self-efficacy to be a positive predictor of SRL (Ames & Archer, 1988; Kaplan & Midgley, 1997; Neber & Schommer-Aikins, 2002; Wolters & Pintrich, 1998; Zimmerman, Bandura, & Martinez-Pons, 1992; Zimmerman & Martinez-Pons, 1990). Studies using path analysis or structural equation modelling techniques have also found positive relations between self-efficacy and self-regulated learning (Greene et al., 2004; Joo, Bong, & Choi, 2000; Malpass et al., 1999). Similarly, bivariate correlational studies have also found self-efficacy beliefs to be positively related to self-regulated learning (Pintrich & De Groot, 1990; Rao et al., 2000; Skunk & Ertmer, 1999). Meece et al. (1988), using structural equation modelling, found perceived competence to have no effect on active cognitive engagement. However, this could have been attributable to students' interpretation of intrinsic value and perceived competence, with these two variables sharing a substantial amount of variance (that is, having high multicollinearity) thus masking any contributing effect from the perceived competence variable alone.

Kaplan and Midgley (1997), using two techniques to partition students on the basis of achievement goals and efficacy interactions, found efficacy beliefs to moderate seventh-grade students' achievement goals and the use of adaptive and maladaptive self-regulated learning strategies. First, on the basis of a median split technique, students in the mastery/high efficacy group reported significantly higher use of adaptive strategies than those belonging to the mastery/low efficacy group for English and math. Students belonging to the performance-approach/high efficacy and performance-approach/low efficacy groups did not differ in their reported use of adaptive strategies. However, performance-approach/high efficacy students reported lower use of maladaptive strategies than performance-approach/low efficacy students. Second, using hierarchical multiple regression, no interaction effects were found for goals and efficacy for the adaptive strategies. However, there was a moderately significant interaction for the mastery X efficacy interaction for maladaptive strategy use in math. In terms of single-variable multiple regression analysis, self-efficacy was a positive predictor of adaptive self-regulated learning and a negative predictor of maladaptive strategy use in English and math. A limitation of this study was that students from different domains were analysed (English classes from one school and math classes from another school) instead of one group of students being analysed in their math and English classes. Furthermore, the ability level of the classes was not controlled: some students were in advanced classes and others in basic classes. Some studies have found no interaction effects between efficacy and achievement goals on self-regulated learning (Ames & Archer, 1988; Wolters, 2004).

Test anxiety is the second motivational belief of the self-regulated learning model considered here. This affective component of the model represents the amount of anxiety or feelings of emotional distress that are associated with a learning environment. It has been found that test anxiety is a pertinent motivational belief in classrooms and impacts upon SRL processes differently to self-efficacy and intrinsic value (Pintrich & De Groot, 1990; Wolters & Pintrich, 1998). For example, Wolters and Pintrich (1998) found students who reported higher levels of test anxiety to maintain their use of cognitive strategies but use less metacognitive strategies (regulatory) than students who were less anxious. The use of the lower order cognitive strategies by the more anxious students may have lead to their attainment of poor grades. The type of achievement goal held by the student may also moderate test anxiety: performance goals may foster test anxiety and this provokes evaluative cognition and a focus on the negative consequences such that the student's application is hampered (Middleton & Midgley, 1997; Turner et al., 1998). Test anxiety has been considered as a moderating motivational belief in Elliot and Church's hierarchical model of achievement goals (Elliot & Church, 1997). Hence, test anxiety is considered as a moderating variable of SRL and achievement goals in the present research.

Intrinsic value is the third motivational belief and refers to the student's reasons for doing a task (Pintrich & De Groot, 1990; Pintrich et al., 1991). These reasons are associated with the intrinsic value a student bestows upon a task or learning environment and consequently the intrinsic value construct has a positive relationship with a mastery-approach goal orientation and subsequent use of cognitive and metacognitive strategies

(Meece et al., 1988; Pintrich & De Groot, 1990; Wolters et al., 1996). Wolters et al. (1996) also found the performance-approach goal to have a positive correlation with intrinsic value, supporting Elliot's (Elliot, 1999) contention that performance-approach goals have a personal-based motive of the need to achieve.

4.4 SELF-REGULATED LEARNING: GENDER EFFECTS

There is mixed evidence for the effect of gender on school students' reported use of SRL. Using regression analyses, Wolters et al. (1996), in a longitudinal study on seventh and eighth-graders, found females to report greater cognitive strategy use than males at the beginning of the school year in English, math and social studies. However, there was no gender effect on regulatory strategy use. At the end of the school year, females reported greater cognitive strategy use for math only, while the absence of a gender effect still occurred for regulatory strategy use. The finding that females reported using more cognitive strategies with no gender differences for regulatory strategy use in English, math and social studies, also occurred in the study conducted by Wolters and Pintrich (1998), which was also based on regression analyses, although this used a single-administration questionnaire protocol. Regression-based studies have also found no gender differences towards self-regulatory learning (Pajares et al., 2000; Ryan & Patrick, 2001). There are also mixed results for studies that have statistically tested for gender differences. Some of these studies have found females to report higher self-regulatory learning strategy use than males (Ablard & Lipschultz, 1998; Joo et al., 2000; Pokay & Blumenfeld, 1990; Zimmerman & Martinez-Pons, 1990), while others have found no gender effect (Neber & Schommer-Aikins, 2002; Pintrich & de Groot, 1990; Rao et al., 2000), although these tests could not control the influence of other variables upon gender on self-regulated learning. For example, Niemivirta (1997) used *t* tests to find that learner-oriented females used more regulatory strategies than learner-oriented males, however, performance-oriented males reported using a higher level of detail memorising than performance-oriented females. There were no gender differences for the avoidance-oriented students in terms of self-regulated learning. Rozendaal et al. (2003) found high school males to have greater use of deep-level processing strategies than females, although the statistical test used to determine the difference was not stated. Studies using path analytic techniques have also found mixed results. Joo et al. (2000), complimenting their *t* test result, found females to have greater SRL strategy use. However, Malpass et al. (1999) found no direct or indirect effects of gender on self-regulatory learning strategy use.

One reason for the variation of SRL gender effects may be attributed to how other influential SRL factors such as motivation, anxiety, efficacy and achievement were controlled in the study. However, the studies reported above that used regression-based analyses in order to take into account the effects of other variables on self-regulated learning still found mixed results for the effect of gender. For example, the Rozendaal et al. (2003) study found females to overly represent the surface-level processing group; they were also found to have greater levels of anxiety than males. Thus, females may use less adaptive SRL strategies since they are more anxious than males. Another reason for variable gender effects in SRL is that females and males may utilise a different outlook with regards to the features of the learning environment (Kahle & Meece, 1998). Patrick et al. (1999) found gender as a predictor of regulatory strategy use in seventh and eighth-graders for social studies but not in English or math. In social studies, only females' mastery goals were significant positive predictors of self-efficacy and regulatory strategy use; males had no such effects for their mastery goals. However, only males reported their extrinsic goals for learning negatively predicted regulatory strategy use. It is suggested that females and males react differently to a subject – social studies in this case - that is not as prescriptive as math. Pajares (2002) suggests that females and males may also vary in their reporting of confidence and self-belief related items: females may deflate their responses whilst males may inflate their responses to self-efficacy and self-regulated learning items.

4.5 SELF-REGULATED LEARNING: GIFTED STUDENTS

From self-regulated learning theory it is expected that, compared to regular students, gifted students would be more skilled at using cognitive and regulatory strategies, respond more adaptively to environmental conditions and be more efficacious. However, research based in the SRL field has scarcely focused on the differences between gifted and regular school students. Most of the research on the influence of intellectual ability on SRL is situated in the metacognition field (e.g., Alexander & Schwanenflugel, 1996). Zimmerman and Martinez-Pons (1990) interviewed gifted and regular students from grades 5, 8 and 11, assessing their use of fourteen classes of self-regulatory learning strategies in a variety of educational contexts. Students' answers were categorised, tallied and then statistically analysed for differences and relations to efficacy. This study found gifted students reported using more SRL strategies than regular students. Gifted students also sought greater assistance from their peers. Ablard and Lipschultz (1998) found high achievers to report using the full spectrum of SRL and to also seek assistance from adults thus demonstrating their active involvement in learning. However, studies that have used regular students have also found SRL strategies to be used by students (e.g., Patrick et al., 1999; Turner et al., 1998; Young, 1997). Research from the metacognition field has, however, found differences between gifted and regular students but in terms of metacognition, a sub-construct of SRL. Chan (1996) compared the motivational orientations (beliefs about the causes for school successes and failures, and self-perceptions of competence) and metacognitive abilities (knowledge, reported use of learning and reading strategies) of seventh-grade selective high school students with average-achieving peers from comprehensive (regular) schools. Results revealed the gifted students perceiving themselves to be cognitively more competent and less likely to attribute failures to lack of ability. Gifted students also had greater confidence in their personal control over successes or failures in school tasks (control over the amount of effort and the use of strategies), demonstrated more knowledge of learning strategies and achieved higher levels of reading competence. Bouffard, Parent, and Larivée (1993) compared gifted and regular eighth-grade females in terms of their spontaneous self-regulation on a concept identification task. Cognitive and metacognitive strategies, metacognitive experiences and motivation were measured as aspects of self-regulation. Whereas both groups showed a similar frequency of metacognitive strategy use, the gifted students used cognitive strategies more consistently, expressed fewer metacognitive experiences with a negative valence, exerted greater efforts to solve the task, had more specific self-appointed goals and were more likely to perceive the task as challenging. Gifted students not only performed better than the average students but were more accurate in self-estimation of outcomes. These results suggest that the self-regulation of learning is a complex composite of cognitive, metacognitive and motivational factors that underlie sustained efforts to achieve high performance outcomes. Swanson (1992) in a finer grain study categorised students in fourth and fifth grade classes on the basis of their IQ, comparing gifted, high-average and low-average students on a problem-solving task. Compared to their peers, gifted children used fewer moves to solve the problem, worked more independently and exhibited higher metacognitive knowledge than their lower IQ peers. Thus, research has shown SRL and its metacognitive components to be one quality that distinguishes gifted from regular students.

There is also some research that has shown no differences between gifted and regular students in terms of more specific components of SRL, namely those associated with metacognition. In their review of metacognition in gifted and regular students, Alexander and Schwanenflugel (1996) cite work that has demonstrated gifted students to maintain their greater declarative metacognitive knowledge over regular students to grade 4 but then regular students begin to close this gap due to either a ceiling effect or a deceleration of declarative metacognitive knowledge for gifted students. This is somewhat in accordance with surplus capacity hypothesis. According to Biemiller, Shany, Inglis, and Meichenbaum (1998), finding a better match between task demands and individual students' current skills and planning abilities is influential on the type and amount of self-regulated learning employed. According to surplus capacity hypothesis, the cognitive load a student experiences during a task influences their self-regulated learning, which in turn is a result of the skills and strategies acquired some time in the past rather than on the skills and strategies just being learned. Hence less advanced students gain little in tasks that demand the use of skills and strategies that they lack and because they may have insufficient cognitive capacity available to self-regulate. Less-advanced students over time may become subordinate, getting less practice at regulating academic tasks. Thus, if the learning task is set at an appropriate level for the student, they will be able to adapt. Based on this hypothesis, Biemiller et al. (1993) conducted an experimental study designed to enhance young students' use of SRL in solving math problems. They were able to increase the task-regulatory language sentences per hour for low and middle-achieving students to be no different to that of the high-achieving students in the study. Prior measurements showed significant differences between the groups of children on regulatory speech.

4.6 OUTCOMES ASSOCIATED WITH SELF-REGULATED LEARNING

4.6.1 Academic Achievement Associations with Self-Regulated Learning

According to SRL theory, skilled self-regulated learners should obtain higher academic results than less skilled learners. However, there are mixed findings for the influence of SRL on academic performance. Greene et al. (2004) used path analysis to determine strategy use as a positive predictor of academic achievement for a range of high school students in English. Malpass et al. (1999) also used path analysis but found no significant effects for SRL on math achievement for gifted high school students. However, this study grouped metacognition, cognitive and effort items in order to provide for a higher order self-regulation factor and this may have hampered determining the relationships between the SRL strategies with grade. For example, there was a mild positive correlation in this study between SRL and math achievement. Niemivirta (1997), using structural equation modelling analyses, found deep processing to be a positive predictor of grade for seventh-grade males and females. Surface processing activities were significant negative predictors of grade, but for males only. However, two other studies that also utilised structural equation modelling found varying effects. Valle et al. (2003) found deep learning strategies to have no direct effect on achievement in university students. Bandalos et al. (2003) found a negative relationship between deep processing and achievement for university students in a challenging set of statistical-based activities. They attribute this result to some students being inefficacious in using higher order metacognitive strategies to gain knowledge. Pokay and Blumenfeld (1990) also found a negative relationship between metacognitive strategy use and math achievement but this could have been due to a suppressor effect. Studies based on regression techniques have also found mixed results for the impact of SRL on academic achievement. Pintrich and De Groot (1990) found self-regulated strategy use to positively predict achievement in classroom settings while cognitive strategy use did not predict performance. Urdan et al. (1997) found grade to positively predict self-efficacy for self-regulated learning. Kaplan & Midgley (1997) found no relations between basic skills test results and the use of adaptive or maladaptive strategies in fifth and sixth-grade students. Elliot et al. (1999) also found no relations for deep processing and exam performance for university students but this was only after controlling for prior exam performance, which construed controlling ability. In a correlational study, Sperling, Howard, Staley, and DuBois (2004) found no relationship between metacognition and achievement in university students. Ee et al. (2003), using multilevel modelling, found SRL usage to be a positive predictor of achievement for gifted students in grade six.

These inconsistent results could be due to several factors. First, the type of SRL researchers are measuring and the methods employed for ascertaining SRL vary. SRL is considered to be a higher order expansive construct (Sperling et al., 2004; Winne, 1996) and measuring it via the assessment of its sub-constructs may not be valid. For example, some of the research presented above has used students' reports on deep processing as being indicative of metacognitive strategy use; this assumes students are cognisant with their meta-level cognition and that they are able to report these accurately. Second, the academic performance measure may reflect skills or factors that are not fully accounted for by the SRL construct. For instance, an experimental study by Veenman, Wilhelm, and Beishuizen (2004) investigated whether metacognition and intelligence have independent or interdependent effects on learning for students ranging from grade 4 to university. In their review of related research, they concluded there is general support for a mixed model in which metacognition and intelligence interact to affect learning. Their research also supported the mixed model: learning performance was affected by metacognition and intelligence. These results were based on partial correlation analyses, controlling intelligence in order to determine the correlation between metacognition and learning. They also found metacognitive skills to increase with age. Another experimental study by Veenman and colleagues with university students found similar evidence for the mixed model (Veenman & Verheij, 2003). The Elliot et al. (1999) study controlled for ability and found null relations. Consequently, the relation of SRL with academic performance is not clear. Other variables such as intrinsic motivation, family orientation and achievement goal orientation, particularly performance-approach goals, may be important influences on academic achievement besides SRL.

4.7 SUMMARY

As a construct, self-regulated learning attempts to encapsulate the myriad of social and cognitive processes a student attends to when regulating their learning. This review distinguished SRL from the more narrow-focused construct of metacognition, which has received much attention in science education and psychology. Like achievement goals, SRL has a variety of social and personal influences; the present review addressed the SRL research in this format. There is some support for positive relations between a classroom mastery achievement goal structure and students' use of SRL although not much research has examined the role of classroom achievement goal structures on SRL. Performance goal structures have been found to have null relations with SRL suggesting that the teacher's practice at developing understanding is influential in fostering SRL in students. It was contended that a learning environment based on constructivist principles would be conducive towards students use and development of SRL. However, empirical support for this is lacking with many of the studies finding mixed results for the impact of constructivist-based pedagogy on SRL. This may be attributed to methodological issues such as the effectiveness of the constructivist practice, the measurement of SRL and the impact of variables like achievement goals, competence perceptions and students' proficiency at SRL. For example, programs specifically designed to teach metacognition or SRL have been relatively successful at improving students' SRL skills. Applying a "context" hypothesis to SRL research revealed similar findings to the achievement goals literature. Firstly, research that has examined SRL in micro-learning environments is lacking with most studies focusing on trait-like SRL characteristics of students. Secondly, associated research from peripheral fields of conceptual change and metacognition has found students' social interactions to be influential on their SRL.

Regarding personal influences of SRL, Pintrich's model of self-regulated learning (Pintrich, 2000a) contends that motivational aspects such as achievement goals, self-efficacy, perceptions of ability and intrinsic goals are important influences of SRL. Many of the studies in conceptual change and metacogntion fields do not consider the impact of these motivational aspects of learning; SRL as a construct is expansive, trying to encapsulate these important personal aspects. The considerable amount of research that has examined the interactions between achievement goals and SRL has found goals to be significant antecedents of SRL. While personal mastery-approach goals are positive predictors of SRL, performance-approach goals have been found to have inconsistent relations with SRL. Performance-avoidance goals have been shown to have negative relations with adaptive SRL. In relation to multiple goal models, evidence supports the salubrious nature of the mastery-approach goal with regards to it being the major positive influence on SRL, irrespective of the performance-approach orientation. Competence perceptions are also influential antecedents of SRL. Self-efficacy has positive relations with SRL. However, there is scant research on perceived ability and SRL. In terms of subpopulation effects, inconsistent findings have been reported for the impact of gender on SRL. Gifted students tend to report more use of SRL than regular high school students, although comparing gifted and regular students on the basis of SRL is rarely addressed. Finally, inconsistent findings have also been reported for the influence of SRL on students' academic achievement. This may be partly attributable to the type of achievement used in the study.

Chapter 5

A CASE FOR STUDYING THE INTERACTION OF ACHIEVEMENT GOALS, SELF-REGULATED LEARNING AND HIGH SCHOOL SCIENCE LEARNING ENVIRONMENTS

5.1 INTEGRATING THE RESEARCH ON ACHIEVEMENT GOALS AND SELF-REGULATED LEARNING IN THE CONTEXT OF HIGH SCHOOL LEARNING ENVIRONMENTS

An interdisciplinary perspective has much to offer the fields of constructivism, achievement goals and self-regulated learning. Constructivist research offers understanding about students' cognition, suggestions regarding pedagogical dimensions associated with learning and teaching, and contributes methodological issues to the fields of achievement goals and self-regulated learning. Most of the focus in constructivist research has been on the epistemological features of students' learning processes and this has yielded a substantial amount of theory, although sometimes provocative, and evidence as to how students come to understand or misunderstand. Much of these findings are applicable to the fields of inquiry that pertain to achievement goals and self-regulated learning. While achievement goals research considers students having high mastery-approach goal orientations as being adaptive, it does not address the epistemological properties and processes of learning employed by such students. Despite their favourable goal orientation, mastery students may develop misunderstandings or they may develop more appropriate understanding than students with less desirable goal orientations. These matters may also be applicable to the self-regulated learning capabilities of students. Constructivist research attempts to explicate the cognitive and metacognitive issues associated with these matters. Indeed, it already offers some theories as to why students understand and misunderstand (e.g., Driver et al., 1994; Windschitl, 1999). Some of the research methods utilised by constructivist researchers may also be of assistance to the motivational and self-regulated learning fields, which tend to be quantitative-based fields of inquiry. As described in the preceding chapters, constructivist-based pedagogy has some convergence with the adaptive learning environments proffered by research on achievement goals and self-regulated learning. Indeed, constructivist pedagogy in recent time has been subsumed in "teaching for understanding" programs (Andre & Windschitl, 2003; Blumenfeld et al., 1997).

As a theory of learning or rather an "epistemological position" (Duit & Treagust, 2003), constructivism potentially links the motivational and regulatory learning parameters of teaching and learning with curriculum implementation and reforms; theories of motivation or self-regulated learning do not form the basis for curriculum development. In recent time, some curriculum reforms in science education have been based upon constructivist theory, particularly social constructivist views (Applefield et al., 2001; Bell, 2005; Palincsar, 1998; Singer et al., 2000; Windschitl, 2002). However, according to the research emanating from the fields of achievement goals and self-regulated learning, students' goals and regulatory mechanisms are important influences of their learning. In addition, as presented in the preceding reviews, these fields have also demonstrated the role of competence perceptions such as self-efficacy in students' approaches to learning. Constructivist research tends to neglect the motivational, affective and self-regulated aspects of students' learning and this has been the impetus for the development of the field of intentional conceptual change, which attempts to address some of the interdisciplinary contentions of the present thesis. A relatively recent field of research, intentional conceptual change has emerged from conceptual change research and is characterised as "…the goal-directed and conscious initiation and regulation of cognitive, metacognitive, and motivational processes to bring about a change in knowledge" (Sinatra & Pintrich, 2003b, p. 6). This perspective proposes that learning is affected by the interaction of intrapersonal factors such as goals, intentions, developmental, metamotivation and metacognition with interpersonal and social factors. However, this field is in its infancy and the work that has examined achievement goals and self-regulated learning in conceptual change contexts has focused mainly on the self-regulated learning dimensions with scant attention applied to learner achievement goals.

One other important difference between the fields of achievement goals, self-regulated learning and constructivism concerns the roles of learning contexts, classroom pedagogical structures and the teacher. Research from the fields of achievement goals and self-regulated learning has demonstrated the impact of such social/environmental factors on students' goals and self-regulated learning; these constructs are social cognitive in nature. Although constructivism has spawned an associated pedagogy, its main focus has been on the intrapsychological dimensions of students. Similarly, intentional conceptual change theories have also been intrapsychologically situated with not much attention paid to the influence of social factors such as the learning environment fostered by the teacher or learning contexts (Hatano & Inagaki, 2003; Pintrich & Sinatra, 2003) or the interaction of these with personal-based factors. One of the contentions of the present research is that social constructivist pedagogy has the potential to foster adaptive learning environments that resonate with those recommended by the achievement goals and self-regulated learning research programs. This view is complemented by the suggestions of intentional conceptual change scholars that intentional conceptual change can be facilitated or assisted via a pedagogy based upon social constructivist principles (Andre & Windschitl, 2003; Hatano & Inagaki, 2003; Vosniadou, 2003).

One problem with studying constructivist pedagogy is due to its inherent nature as an epistemological position. Constructivist-based pedagogical practice is more a set of approaches or principles that teachers or curriculum planners utilise than a specific set of instructions that teachers can follow in order to effectively implement a distinct pedagogy (Blumenfeld et al., 1997; Richardson, 2003; Windschitl, 1999). Thus, in pedagogical terms, constructivism is contextualised, depending upon the teacher's epistemological position and the curriculum being implemented. This makes constructivist pedagogical studies questionable with regards to external validity and generisability issues (but are these issues themselves pertinent if "teaching for understanding" and "learning for understanding" are contextualised?). It seems plausible, therefore, to approach studying constructivist pedagogy not by focusing on the stepwise, mechanistic aspects of teaching practice but by examining the constructivist pedagogical dimensions of teaching practice commonly fostered by teachers whether they are implementing a constructivist-based program or not. This enables comparison of these dimensions across classrooms and domains and has the potential to integrate with measures of students' achievement goals and self-regulated learning. One instrument that serves this purpose is the Constructivist Learning Environment Survey (CLES) (Aldridge et al., 2000; Taylor et al., 1997), which is grounded in social and critical constructivism, the latter being a relatively unexplored development of constructivist practice. Critical constructivism offers one way of overcoming the shortcomings associated with the hegemonic principles that are inherent in teachers and students in contemporary classrooms; namely, teachers having to get the students through a certain amount of the syllabus which leads to students expecting the teacher to regulate their learning and students having to deal with exam expectations and other procedural issues of schooling (Taylor, 1992, 1998; Thomas, 2002). By promoting a critical perspective of these epistemological-limiting issues it is proposed that the teacher and students can learn in a more productive way by sharing a common philosophical framework that acknowledges the limitations of outside ideologies (Jofili, Geraldo, & Watts, 1999). The CLES has been used in several studies of high school science students and teachers (Dorman et al., 2002; Dryden & Fraser, 1998; Haney & McArthur, 2002; Kim et al., 1999; Thomas, 2002) and has consistently identified several constructivist pedagogical dimensions as perceived by students: perceived relevance, student negotiation, shared control, critical voice and uncertainty. Combined, these dimensions reflect a constellation of learning environment dimensions that represent the constructivist nature of the classroom as experienced by students. These dimensions, therefore, may also behave as measures of the “teaching for understanding” characteristics fostered by the teacher. Consequently, the CLES may be a useful means of ascertaining the interactions of constructivist pedagogical dimensions with students’ achievement goals and self-regulated learning. In this way a step can be made towards examining constructivism, achievement goals and self-regulated learning from an interdisciplinary perspective.

The preceding reviews have also identified several intradisciplinary issues that are addressed by the present research. Firstly, more recent achievement goal theory posits four types of achievement goals – mastery-approach, mastery-avoidance, performance-approach and performance-avoidance (e.g., Elliot, 1999; Pintrich, 2000b). However, the mastery-avoidance goal has been understudied in the context of regular and academically-gifted high school students. The present research has two purposes for incorporating the mastery-avoidance goal into its investigative framework. First, studying this goal provides a test of the “2 x 2” goals theory (Elliot, 1999) particularly the suggestion that these goals are associated with high achievers - gifted high school students in the context of the present research. Second, this goal may be salient in the context of teaching that emphasises understanding such as that fostered by constructivist approaches to teaching in which there is an emphasis on challenging students' ideas and understanding. The present research also examines both normative goal and multiple goal models in regards to the influence of goals on self-regulated learning and science achievement. This will contribute towards understanding about the interactive roles of achievement goals.

Another intradisciplinary focus for the present research concerns both achievement goals and self-regulated learning in light of a "context" hypothesis. According to the classroom situation categorisations of Meece et al. (1988), "whole-class" activities (e.g., teacher explanation and teacher-led discussions) are predominately teacher-regulated while "small-group" activities have much less teacher regulation. Their research has shown that students' individual motivational profiles are more salient in small-group activities than whole-class activities, which are controlled by the teacher. Thus, there could be a range of events in the classroom that affect the achievement goals and self-regulated learning of students in varying ways as a consequence of the type of teacher- and student-regulation of the event. These considerations warrant further investigations especially when considering that the bulk of research on achievement goals and self-regulated learning is conducted at the trait level and when utilising a constructivist-based approach to teaching science various types of learning episodes or events are assumed to foster the desired pedagogical processes (e.g., group work and class discussion). Shown in Figure 5.1 is a proposed classification of typical learning events in science classrooms on the basis of the amount of teacher- and student-regulation involved.

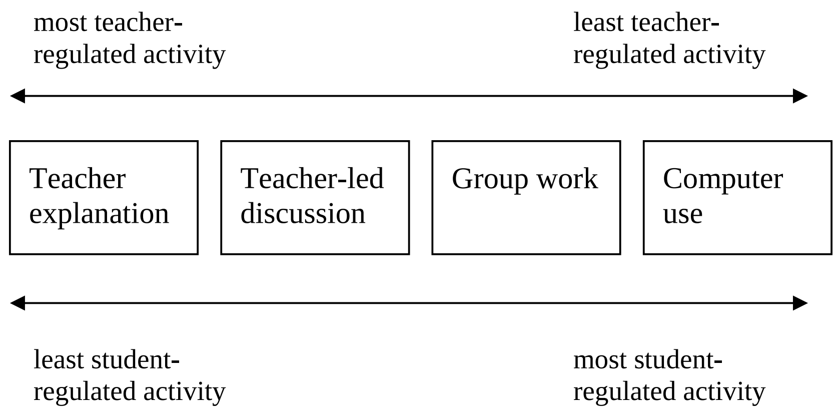

Figure 5.1. A proposed classification of learning events in science classrooms based upon the amount of student- and teacher-regulation associated with the learning event.

According to this classification scheme, teacher explanation is the event that has the most teacher regulation and the least student regulation, while the computer-use activity would have the least teacher regulation and the most student regulation. These learning events may impact upon the students' achievement goals. For example, in the teacher explanation event, the performance achievement goals may be nullified somewhat since the teacher does not offer avenues for the display of ability and avoiding failure. Conversely, the computer-use activity does allow the students' personal achievement goals to be highlighted – become more salient than in the teacher explanation event – since that event has the most student regulation and the least teacher regulation. A "context" hypothesis contends that:

(1) constructs such as achievement goals, competence perceptions and self-regulated learning functionally exist in micro-learning events or contexts;
(2) viable relations exist between such constructs in contexts;
(3) the salience of these constructs and their sub-constructs depends on the type of context; and
(4) the calibration-associated issues with students' reporting of constructs in contexts will be improved as compared with trait-level reports.

Context approaches to studying achievement goals have begun to receive attention (Barron & Harackiewicz, 2001; Harackiewicz & Sansone, 1991; Linnenbrink, 2002; Senko, 2002).

The impact of several subpopulation variables in the context of each of the above research topics was also examined. These variables included age (junior high or senior high), gender and global ability (gifted or regular). Of particular interest are the relations between global ability status with achievement goals and self-regulated learning.

5.2 RESEARCH QUESTIONS AND HYPOTHESES

The present research attempts to address the intra- and interdisciplinary issues discussed above and presented in the preceding reviews of the literature. Figure 5.2 exhibits the model that the present research uses in examining interactions of learning environment characteristics, achievement goals and self-regulated learning, and their consequences in high school science classrooms. According to the model, environmental and cognitive factors interact in order to influence students' personal achievement goals and other motivational components, self-regulated learning and their science achievement. The environmental characteristics addressed by the model include: the constructivist learning environment dimensions of perceived relevance, student negotiation, shared control, critical voice and uncertainty; classroom goal structures of mastery, performance-approach and performance-avoidance; and, classroom metacognitive structure. These are predominantly teacher-based variables and are predicted to influence students' personal achievement goals and their application of self-regulated learning processes of cognitive and metacognitive strategy use. Motivational beliefs of value (intrinsic value), affect (test anxiety) and competence perceptions (perceived ability and self-efficacy) may also influence goals and self-regulated learning. Motivational components and self-regulated learning affect academic achievement. The model also treats subpopulation variables of age, gender and global ability level (regular or gifted ability) as exogenous variables along with the classroom learning environment factors. This model is adapted from that used by Zusho and Pintrich (2003), who explored similar self-regulated learning and motivational beliefs dimensions but with a focus on other environmental factors and learning outcomes. Zusho and Pintrich also included feedback loops from achievement to self-regulated learning strategies and from achievement to environmental factors given that studies have shown prior experience (successes and failures) to be also influential on students' motivation and regulatory mechanisms.

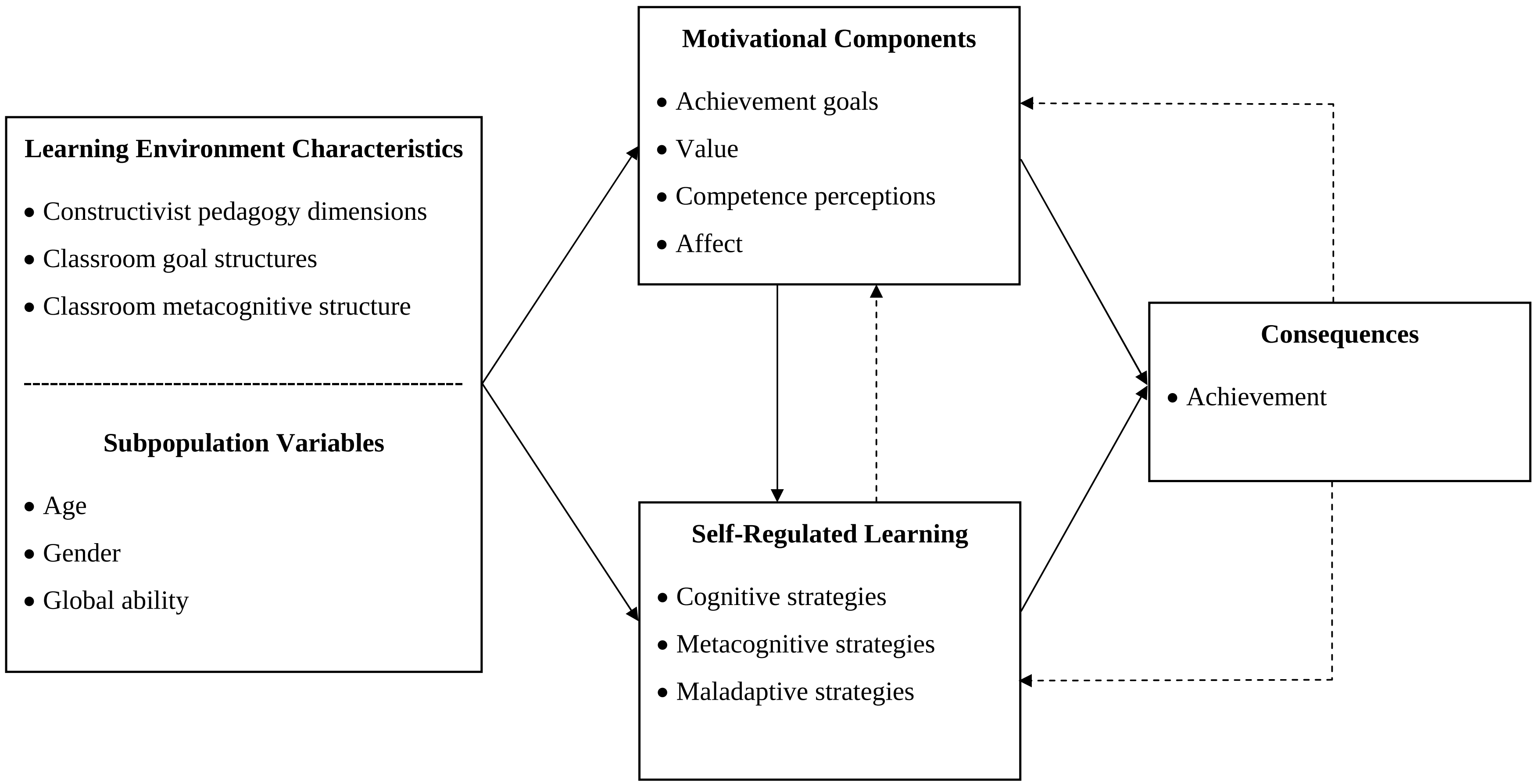

Figure 5.2. A theoretical model for the interactions of learning environment features, personal achievement goals, self-regulated learning, motivational beliefs, achievement and subpopulation variables.

The model used for the present research, however, contends reciprocal relations exist between achievement with the motivational components and between achievement with self-regulated learning. For example, perceptions of competence may have some historical achievement basis (Elliot, 1999). Reciprocality also exists amongst the motivational components. For example, perceived self-efficacy affects achievement goals (Schunk, 1990); test anxiety may have causal relations with performance-avoidance goals.

Specifically, the following research questions and hypotheses are addressed with regards to the interactions of learning environment dimensions, achievement goals, and self-regulated learning in high school science classrooms.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?

Trait-level and context-level achievement goals questionnaires were used in the present research. These questionnaires contained indicator items that tapped the four achievement goal constructs of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. It is expected that the factorial structure of these questionnaires will be upheld throughout the studies.

> Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?

It is expected that the constructs pertaining to achievement goals, competence perceptions (task efficacy, perceived ability) and self-regulated learning (regulatory strategy use, maladaptive strategy use) would be validated in a variety of micro-learning events or contexts and that the interdependent relations between these constructs would be commensurate with extant theories of achievement goals, self-efficacy and self-regulated learning.

> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?

Constructivist pedagogy dimensions were based on the pedagogical structures identified by the Constructivist Learning Environment Survey (CLES) and comprise of perceived relevance, student negotiation, shared control, critical voice and uncertainty. The personal relevance dimension is designed to represent how much a teacher makes science relevant to students' beyond-school existence ("real world"). Given the intrinsic understanding nature of mastery goals, it is expected the mastery-approach and mastery-avoidance goals would have positive and negative relations respectively with the personal relevance dimension. Since this dimension has a focus on making science interesting and relevant to students, it should have negative relations with both performance goals. That is, it should dampen students' perceptions of performance-based issues in the classroom. This dimension should have null relations with students' self-regulated learning strategies.

The student negotiation dimension relates to the amount of time and type of activities devoted towards students' discussion of their ideas. Since this entails a degree of peer interaction it is expected to be a positive predictor of students' performance-approach goals since students may have the opportunity to impress others with their ideas. It should also positively relate to performance-avoidance goals as some students may be uncomfortable with having to discuss something that they may not understand in front of their peers; they do not wish to be judged as failing to understand in front of others. Student negotiation should positively predict mastery-approach goals as the focus is on attaining knowledge through discussion. However, it is expected to also positively predict mastery-avoidance goals since students may not be as skilled at negotiating ideas as teachers and this could lead to some conceptual confusion amongst students. In this context, some students may be prone to avoiding not understanding. Student negotiation should positively predict students' adaptive self-regulated learning strategies.

Shared control refers to the degree of control students are given towards their learning activities and assessment. This dimension should positively predict the mastery-approach goal and have null relations with the mastery-avoidance and performance-avoidance goals. There may be a positive relationship with the performance-approach goal since performance-focused students are potentially given more opportunities to display their ability in assessment activities when given a greater say in the control of their learning and assessment. Shared control should also positively relate to students' use of cognitive and metacognitive strategies since these adaptive self-regulated learning strategies would be fostered more when students are given more control in their learning as compared to a restrictive teacher-dominated learning environment (Zimmerman, 1989a).

The critical voice dimension relates to the type of social climate fostered by the teacher that allows students to express their concerns about any hindrances to their learning and to question the pedagogy employed by the teacher. Since this dimension involves positive emotional and learning qualities it is expected to positively relate to the mastery-approach goal, negatively relate to the mastery-avoidance goal and to have null or negative relations with both performance goals. Critical voice should also foster adaptive self-regulated learning practices.

Uncertainty is concerned with the way in which the teacher presents the ontological-related aspects of scientific practice. This dimension, therefore, is expected to positively relate with mastery-approach goals. It may also positively relate to the mastery-avoidance goal since some students may find it difficult accepting the nature of science being a theory-based and evolving discipline. Null relations are hypothesised for uncertainty with both performance goals. This dimension is expected to have null relations with self-regulated learning.

Classroom goal structures were ascertained as being mastery, performance-approach and performance-avoidance in nature. Mastery goal structure represents the emphasis the teacher places on understanding and thus should positively predict mastery-approach and mastery-avoidance goals. Although a small number of researchers have found mastery goal structure to positively predict performance-approach goals (e.g., Ee et al., 2003; Young, 1997), most work has found the mastery goal structure to negatively predict performance-approach and performance-avoidance goals, the hypothesis used in the present research. Mastery goal structure should be a positive predictor of self-regulated learning.

Performance-approach goal structure represents the emphasis placed by the teacher on relative ability-associated issues in the classroom and therefore should negatively predict mastery-approach and mastery-avoidance goals. This goal structure should positively predict performance-approach and performance-avoidance goals. The performance-approach goal structure is predicted to have positive relations with cognitive strategy use and to have null relations with metacognitive strategy use. Metacognitive strategies represent deep processing whereas cognitive strategies (memorising, organising, etc) are at a lower order and are more suited for learning environments that have a performance emphasis.

The performance-avoidance goal structure has hardly been studied. It is thought to reflect the value "… on not demonstrating low ability" (Kaplan et al., 2002, p. 195) fostered by the teacher and as such be expected to positively predict performance-avoidance goals. It is expected that this goal structure would have negative relations with mastery-approach, mastery-avoidance and performance-approach goals. This goal structure should also have negative relations with students' self-regulated learning.

Classroom metacognitive structure represents the emphasis the teacher places on developing students' self-regulated learning, particularly regulating their cognition. This learning environment characteristic should positively predict mastery-approach goals and negatively predict mastery-avoidance goals since the focus of this structure is to develop students' skills at learning to understand. Null relations are hypothesised between this structure and both performance goals since this structure does not have a relative ability focus. Metacognitive structure is expected to positively predict students' self-regulated learning.

In terms of a normative goal model, mastery-approach goals should promote self-regulated learning while mastery-avoidance goals should negatively relate with self-regulated learning. Null relations are expected for both performance goals on self-regulated learning. From a multiple goal model perspective, however, it is expected there would be no differences between the self-regulated learning used by the high mastery-approach/high performance-approach and high mastery-approach/low performance-approach groups; self-regulated learning is primarily influenced by the mastery-approach goal orientation (e.g., Ablard & Lipschultz, 1998; Pintrich, 2000c). No interaction effect is expected for mastery goals and performance goals for self-regulated learning. The least adaptive profile for self-regulated learning would be the mastery-avoidance/performance-avoidance goals orientation. It is hypothesised that there will be some relations between the orthogonal achievement goal constructs. For example, if one is to adopt a multiple goal perspective that involves mediating and moderating associations amongst the achievement goals, a performance-approach orientation may have positive relations with mastery-approach and performance-avoidance while the avoidance goals may have positive associations with each other. However, the specific associations of achievement goals with each other are yet to be substantiated and thus no hypotheses are proposed for these specific associations.

Of the motivational beliefs investigated, the competence perceptions of self-efficacy and perceived ability are expected to affect achievement goals and self-regulated learning. Self-efficacy is expected to be a positive predictor of mastery-approach goals and performance-approach goals, and a negative predictor of mastery-avoidance and performance-avoidance goals. Perceived ability is expected to have null relations with the mastery goals since it has externally-based referents and therefore it is expected to have positive relations with performance-approach goals and negative relations with performance-avoidance goals. Both competence perceptions are expected to positively predict self-regulated learning (Pajares, 2002; Schunk, 1990). Test anxiety is predicted to have negative relations with self-regulated learning although it may also have a moderating effect on the goals-to-self-regulated learning pathway (e.g., Elliot & Church, 1997). Task/intrinsic value is expected to have positive relations with mastery-approach goals, negative relations with mastery-avoidance goals and negative relations with both performance goals. Task/intrinsic value should have positive associations with self-regulated learning.

Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

In accordance with a "context" hypothesis, it is expected that students will be able to identify their achievement goals, perceptions of efficacy and ability, and report their adaptive self-regulatory learning (regulatory strategy use) and maladaptive strategy use in a variety of learning contexts. The classroom learning contexts include teacher-led discussion and group work (although teacher explanation and computer use contexts were also studied but the findings for these contexts are not reported here due to space restrictions). Each of these, it is proposed, has differing degrees of student and teacher regulation (Figure 5.1) and thus influences the goals and self-regulated learning students use. Both competence perceptions are expected to positively predict self-regulated learning (Pajares, 2002; Schunk, 1990) and negatively predict maladaptive strategy use. However, the hypothesised relations between competence perceptions, achievement goals and self-regulated learning will be similar to those used in addressing Research Question Three. Mastery-avoidance and performance-avoidance goals should positively predict maladaptive strategy use.

Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Age was considered a variable in the present research since most work on achievement goals has focused on two types of students: university-level and middle high school (years 6-8). Hardly any research has examined senior (years 11-12) and junior (years 7-10) high school students in the context achievement goals, especially in terms of comparing juniors with seniors. One hypothesis is suggested for this study: senior students are more sensitive to the relative ability practices of the classroom than junior students. This could be a result of prior experiences (successes and failures) and by virtue of knowing their relative ability from prior exam results at the school. Of course, developmental effects may play a substantial role. For example, ego-centricity factors may cause seniors to be more conscious of ability- and affect-related factors than juniors. In addition, seniors may have higher self-expectations as they encroach upon career choices and major exams. Thus, senior students may report more avoidance goals than juniors. It is also expected that seniors should use more self-regulated learning than juniors, a result of developing adaptive learning strategies throughout school (e.g., from observing peers and experiencing different teachers).

Gender effects have been associated with achievement goals in previous research. Generally, females should be weakly prone to mastery goals, males should be prone to performance-approach goals and there should be no gender differences for mastery-avoidance (Elliot & McGregor, 2001) or performance-avoidance goals. Regarding the gender effects on self-regulated learning, some researchers have found females to use more cognitive strategies but to have similar use of regulatory strategies as males (Wolters & Pintrich, 1998). Generally, mixed results are found for gender effects on self-regulated learning and hence it is hypothesised for the present research that no gender differences will be found towards self-regulated learning in high school students.

Global ability in the context of the present research refers to the type of school the student attends – selective (gifted) or comprehensive (regular). Hardly any research has compared gifted and regular high school students in the context of achievement goals. Although it has been suggested that high achievers (gifted) are prone to mastery-avoidance goals (Elliot, 1999, Elliot & McGregor, 2001), based on goal theory, it is expected that global ability will not be a significant predictor of goals. However, global ability is expected to be a significant predictor of self-regulated learning, with gifted students expected to report using more self-regulated learning than regular students (e.g., Chan, 1996; Zimmerman & Martinez-Pons, 1990).

Research Question Seven: What are students' perspectives with regards to the impact classroom activities have upon the adoption of achievement goals?

The purpose of this question was to examine achievement goals in high school science classrooms from a qualitative stance with students being interviewed about their achievement goals and associated classroom factors. No hypothesises are necessary regarding the answers provided by students for these questions; rather the intention was to gather students' views and as such address some of the limitations related with the quantitative research conducted in Study 3 (Chapters 8 to 12). On the other hand, it is expected that students' answers will vary with each question and it is anticipated that the responses would be of particular interest in light of the nascent quantitative research employed in examining achievement goals in learning contexts (Study 3).

5.3 OVERVIEW OF THE RESEARCH

The primary intention of the present research was to investigate the relations between learning environment features, achievement goals and self-regulated learning in high school science classrooms. Several adjunct variables (subpopulation variables, motivational beliefs) were also addressed in order to provide a more valid picture of the social cognitive associations for students in learning science. Science was chosen as the focal domain on the basis of generally comprising a variety of micro-learning contexts and having been a focus for social constructivist, achievement goals and self-regulated learning research approaches. The present research was conducted on high school science students attending regular and academically selective co-educational state system high schools belonging to the New South Wales State Education system (non-private and non-independent) and thus covered the spectrum of students' academic ability. Both senior students (year 11) and junior students (years 7 to 10) were studied.

Three studies were conducted in order to accommodate the aims of the present research. Study 1 (Chapter 6) utilised a traditional correlational approach in examining the relations of most of the variables at the trait-level and consisted of a large-scale single-administration questionnaire protocol. Study 1 addressed Research Questions One, Three and Five. Science classes from randomly chosen schools participated in this study. Study 2 (Chapter 7) was a large-scale, trait-level analysis of the variables for the students that formed the cohort for the context-level analyses that comprised Study 3. In fact, Study 2 was almost identical to Study 1 excepting for the measurement of the classroom goal structures. Study 2, therefore, addressed Research Questions One, Three and Five. In so doing, Study 2 served to examine the reliability of the findings in Study 1. Study 3 (Chapters 8 to 12) investigated the relations amongst the personal-based variables during two separate micro-learning events experienced by students in their high school science classes (teacher-led discussion and group work) in situ. Context-level measures were achieved via administration of questionnaires designed specifically for each micro-learning context. This research was supplemented with student interviews about achievement goals in classroom contexts. Study 3 addressed Research Questions One, Two, Four, Six and Seven. Science classes from randomly chosen schools participated.

Chapter 6

STUDY 1

6.1 STUDY 1: AIMS

The first study was designed to address the following research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?
>
> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

The hypothesised relations between students' perceptions of their high school science learning environments, students' motivational components, their self-regulated learning, and subpopulation variables were presented in Chapter 5. Study 1 examined these relations at the trait-level and on a large scale. This study attended to the hypothesised path relationships displayed in the research model presented in Figure 5.2 (Chapter 5) with the exception of students' reported use of maladaptive regulatory strategy use, which is analysed in Study 3 (Chapters 8 to 12). In so doing, it also sought verification of the multitude of constructs represented in the research questions. Of particular interest were those constructs associated with learning environment characteristics - constructivist pedagogy dimensions (perceived relevance, student negotiation, shared control, critical voice and uncertainty), classroom goal structures (mastery, performance-approach and performance-avoidance) and classroom metacognitive structure. Personal level constructs that were of interest in terms of construct validity issues included the existence of the mastery-avoidance goal, the differentiation between perceived ability and self-efficacy, and the distinction between students' reported use of cognitive and metacognitive (regulatory) strategies.

6.2 METHOD

6.2.1 Research Design

The aim of the research was to measure high school students' perceptions of a collection of learning environment and personal constructs while experiencing a state education system science curriculum. This entailed the administration of a one-off trait-level questionnaire to the students during the second half of their school year (2005). This design accommodated an exploration of the associations amongst the constructs in situ - with respect to the implementation of the state science curriculum. Besides yielding embryonic baseline data on the associations amongst the constructs under focus, this design enabled a greater degree of participation in the study from schools, teachers and students, and an increase in the generalisibility of the findings compared with use of smaller-scale study designs such as case studies or interventions. Consequently, this approach did not necessitate the need for formal curriculum-based interventions or experimental-based protocols. Rather, it was expected that the nascent nature of the research would generate findings that could form the basis for future research that may utilise such methods.

6.2.2 Participants and Procedure

A sample of 655 high school science students (333 males and 322 females) was assembled from ten different New South Wales State education system high schools serving the Sydney metropolitan area. Each school was co-educational, catered for students from years 7 to 12, randomly chosen from state high schools in the Sydney area and invited to participate. Seven schools were classified as regular (384 students) and served as the sample from the regular high school sub-population. The regular students' sample comprised of 22 classes ranging in size from 7 to 28 students (mean class size = 17.5). Of this sample, 247 (139 males and 108 females) were in year 9, completing a general science curriculum and 137 (59 males and 78 females) were in year 11 completing a senior biology curriculum. Three schools were classified as selective (271 students) and served as the sample from the selective high school sub-population. The selective students' sample comprised of 16 classes ranging in size from 8 to 29 students (mean class size = 16.9). Of this sample, 156 (88 males and 68 females) were in year 9, completing a general science curriculum and 115 (47 males and 68 females) were in year 11 completing a senior biology curriculum. Senior students in NSW high schools have a choice regarding the type of science subjects they wish to study. Focusing on students enrolled in one senior science subject somewhat controls for unidentified variables associated with surveying students who are involved with different senior science subjects. For example, students participating in senior physics may differ on a number of unanticipated social/cognitive factors compared to those students who study biology. For the regular students' sample, students reported themselves as having the following ethnic backgrounds: Asian-Chinese (*n* = 28, 7%), Asian-other (*n* = 27, 7%), Caucasian (*n* = 308, 80%), Filipino/Indonesian (*n* = 14, 4%) and Indian/Sri Lankan (*n* = 7, 2%). For the selective students' sample, students reported themselves as having the following ethnic backgrounds: Asian-Chinese (*n* = 79, 29%), Asian-other (*n* = 23, 8%), Caucasian (*n* = 129, 48%), Filipino/Indonesian (*n* = 7, 3%) and Indian/Sri Lankan (*n* = 33, 12%). Written parental permission was required for students to participate in the study. Students were informed that participation was voluntary and their responses would be kept confidential. Despite providing written parental permission, a small number of students declined to participate in the study.

Students were asked to complete three questionnaires (see 6.2.2 Measures below) during the middle of the third term of the school year in one of their science lessons. By this time of the school year students' relationships with class peers and class teacher were well established. The questionnaires were administered at the same time to each class by the researcher who instructed students to provide responses that focused on the particular science class and course they were participating in. Although the class teacher was present, he or she was not involved with any part of the administration procedure. Students were encouraged to ask questions regarding the clarification of any items. It took approximately 30 minutes for students to complete the questionnaires.

6.2.3 Measures

Constructivist pedagogy dimensions. The Constructivist Learning Environment Survey (CLES; Taylor et al., 1997) was used to measure students' perceptions of the constructivist-based pedagogical features they experience in their science classroom learning environment. The CLES (labelled in this study as "Science Classroom Learning Environment Questionnaire") comprises of five six-item scales, each scale designed to tap into the following constructivist pedagogical dimensions: perceived relevance (e.g., "I learn about the world outside of school"); student negotiation (e.g., "I talk with other students about how to solve problems"); shared control (e.g., "I help the teacher to plan what I'm learning"); critical voice (e.g., "It's OK for me to question the way I'm being taught"); and uncertainty (e.g.,, "I learn that science is influenced by people's values and opinions"). Students indicated their responses on a five-point Likert scale ranging from 1 (almost never) to 5 (almost always).

Classroom goal structures. Three scales from the Patterns of Adaptive Learning Survey (PALS; Kaplan et al., 2002; Midgley et al., 1997) were used to measure students' perceptions of their classroom goal structures. The mastery goal structure scale consisted of five items (e.g., "My science teacher thinks mistakes are okay as long as we are learning"). The performance-approach goal structure scale consisted of three items (e.g., "My science teacher points out those students who get good grades as an example to all of us"). The performance-avoidance goal structure scale consisted of four items (e.g., "My science teacher says that showing others that we are not bad in science should be our goal"). Students indicated their responses on a five-point Likert scale ranging from 1 (almost never) to 5 (almost always).

Classroom metacognitive structure. One scale from The Metacognitive Orientation Learning Environment Scale-Science (MOLES-S; Thomas, 2003) provided a measure of students' perceptions of the metacognitive demands of their science classroom. This scale comprised of five items (e.g., "Students are asked by the teacher to think about how they learn science") and students indicated their responses on a five-point Likert scale ranging from 1 (almost never) to 5 (almost always).

Personal achievement goals. The Achievement Goals Questionnaire developed by Elliot and Church (1997) was used to measure students' personal achievement goals. This questionnaire comprised of three six-item scales, each scale ascertaining the following personal achievement goals: mastery-approach (e.g., "It is important for me to understand what is being taught"); performance-approach (e.g., "It is important for me to do better than the other students"); and performance-avoidance (e.g., "I just want to avoid doing poorly, compared to others, in this class"). Since the Elliot and Church (1997) questionnaire was developed for the trichotomous goal model, a six-item scale that assessed students' mastery-avoidance goal was added (e.g., "I focus on not making any mistakes at all during my learning in this class"). The revised Achievement Goals, Questionnaire (labelled in this study as "Science Classroom Motivation Questionnaire-Macro-Level"), now containing four six-item scales, was then piloted with a year 9 science class that did not take part in the final research. After students completed the revised questionnaire, the researcher held discussions with students regarding the readability and clarity of the items. This resulted in a small number of amendments to the items. Students indicated their responses to the final achievement goals questionnaire items on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Motivational beliefs. Three scales from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) were used to measure students' perceptions of their motivational beliefs. The intrinsic value scale consisted of nine items (e.g., "I prefer class work that is challenging so I can learn new things"). The self-efficacy for learning and performance scale consisted of nine items; three of these items measured students' perceptions of their efficacy (e.g., "I am certain that I can understand the ideas taught in this class") and six items assessed students' perceptions of their relative ability in their science class (e.g., "Compared to others in this class, I think I am a good student"). The test anxiety scale consisted of four items (e.g., "I am so nervous during a test that I cannot remember the facts that I have learned"). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Self-regulated learning. Two scales from the Motivated Strategies for Learning

Questionnaire (MSLQ; Pintrich et al., 1991) were used to measure students' self-reporting of their use of self-regulated learning strategies in learning science. The strategy use (cognitive) scale consisted of thirteen items (e.g., "When I study for a test, I try to put together the information from the class and from the textbook"). The regulatory strategy use (self-regulation) scale assessed the metacognitive elements students used and consisted of nine items (e.g., "I ask myself questions to make sure I know the material I have been studying"). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

6.3 RESULTS

6.3.1 Preliminary Analyses: Exploratory Factor Analyses and Confirmatory Factor Analyses

Exploratory factor analyses (EFA) were conducted on the items relevant to a priori construct predictions. Although all items, except the six formed for the mastery-avoidance goal scale, were from established questionnaires, exploratory factor analyses were utilised to test the factorial structure of the questionnaires using a sample composed of established high school students (older than year 8) since several factors proposed to be measured by the questionnaires contained items that had the potential to be interpreted by high school students as being representative of another factor or of cross-loading. Besides, much of the research using the MSLQ and the Achievement Goals Questionnaire has been on students younger than year 8 or on university students. With regards to these construct validity issues, the MSLQ had several scales of interest. The first of these concerned students' ability to distinguish between the competence perceptions of perceived ability and perceived efficacy. Six items on the MLSQ focused on perceived ability and another three were concerned with efficacy perceptions, although all of these nine items were labelled by the MSLQ as forming the "Self-efficacy for learning and performance" scale. It was hypothesised that students would be able to distinguish these two competence perceptions and thus two factors would occur amongst these items.

The second issue involved the items associated with the self-regulated learning constructs of cognitive and regulatory strategy use from the MSLQ. In this case it was hypothesised that students may not interpret the items in accordance with the designated scale. For instance, item 39 "When I am studying for a topic, I try to make everything fit together" is classified as belonging to the cognitive strategy use scale however this item could also be interpreted as being metacognitive in nature by high school students and thus may load onto the regulatory strategy use factor.

The third issue of interest related to the intrinsic value items of the MSLQ and the mastery-approach scale of the Achievement Goals Questionnaire. Several intrinsic value items were very similar to those associated with the mastery-approach scale and it was hypothesised that some of the items from both these scales would load onto the same factor whilst a small number of intrinsic value items would make up a genuine intrinsic value scale. The proposed four achievement goals were also a focus in this context, in particular the capability of students to distinguish between the mastery-avoidance and performance-avoidance goals. Examining such psychometric properties of the questionnaires using EFAs may help minimise the effects of collinearity and multicollinearity in relational statistical analyses that make use of these constructs.

The factor analyses employed by this study were, in the main, part of a two-step process applied to establish the construct validity properties of the scales associated with the questionnaires. Where appropriate, adjunct confirmatory factor analyses (CFAs) using LISREL 8.72 (Jöreskog & Sörbom, 2005) were also used to verify that any amendments to the relations between indicator items and their factors or scales provided a significantly better fit for the data in comparison with the original scales and thus justify any scale-item modification to the questionnaire. Principal axis factoring with an oblique rotation method was used throughout as the exploratory factor analysis method. Principal axis was chosen as the factor extraction method on the assumption that the data would have some deviation from being normally distributed. Oblique rotation was used on the assumption that there would be a degree of correlation between the factors (e.g., Elliot & McGregor, 2001). Finally, principal axis factoring was posited as producing a clearer picture of the latent variables' structure on the basis that it uses only the shared variance of the items for a factor, not the unique variance and error. Principal components, which has been the traditional "exploratory factor" analysis method used for the constructs investigated, uses both the shared and unique variance thus limiting the accuracy of the latent variables' structure (Costello & Osborne, 2005; Reise, Waller, & Comrey, 2000; Rowe, 2006).

Constructivist pedagogy dimensions. An EFA of the Constructivist Learning Environment Survey (CLES; Appendix A) items yielded seven factors with eigenvalues greater than 1 as well as satisfying scree test requirements for five factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. This factor solution analysis accounted for 55.2% of the total variance after the initial extraction for the unrotated solution (after oblique rotation, proportions of total variance cannot be made due to correlation of factors). (See the author for complete results of the final EFA solution.) The five factors represented the five hypothesised constructivist pedagogy dimensions of perceived relevance, student negotiation, shared control, critical voice and uncertainty. All items except for item 7 ("I learn that science cannot provide perfect answers to problems") and item 12 ("I learn that science is about creating theories"), loaded above 0.35 on their primary factor and none of the items crossloaded (> 0.32 on two or more factors).

Classroom goal and *metacognitive structures.* An EFA of classroom goal and metacognitive structures items (Appendix A) yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. This factor solution accounted for 64.1% of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) The four factors represented the hypothesised classroom-level goal structures of mastery, performance-approach, performance-avoidance and the classroom metacognitive structure. All items loaded above 0.35 on their primary factor and none of the items crossloaded (> 0.32 on two or more factors).

Personal achievement goals. An initial EFA of the Achievement Goals Questionnaire (Appendix B) items yielded five factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. After rotation, the five-factor solution provided a more creditable substantive-based model than the four-factor solution; the five factor solution accounting for 57.1% of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) Four of the five factors represented the hypothesised personal achievement goals of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance whilst the fifth factor identified with attitude-associated dispositions towards learning in addition to being comprised of reverse-coded items that were most likely misinterpreted by students: item 5 ("It is not important to me to do well compared to others in this class"), item 7 "I do not want to learn as much as I can in this class"), item 21 ("It doesn't worry me if I make mistakes when learning"), and item 22 ("I do not like to know that I am doing something incorrectly when learning"). Since it was suspected that students may have had trouble with the reverse-coded items, the fifth factor was labelled 'misinterpretation'.

Confirmatory factor analysis using PRELIS 8.72 (Jöreskog & Sörbom, 2005) and LISREL 8.72 (Jöreskog & Sörbom, 2005) was employed to determine which of three first-order models, three-factor (mastery-approach, performance-approach, avoidance), four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) or five-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, misinterpretation), accounted for more variance and thus provided the better fit of the data. CFAs also afforded the opportunity to examine the nature of the items associated with the fifth factor. It was suspected that since these were reverse-coded items they had greater potential for misinterpretation by students and subsequently may have very high measurement errors associated with them. Another advantage of testing the factorial structure of the achievement goals questionnaire using the CFA procedures of LISREL 8.72 relates to the measurement properties of the data. LISREL 8.72 caters for the statistical analysis of ordinal data as in the case of this study in which students report their perceptions of the social/cognitive constructs via Likert scales (see Jöreskog, 2002). Briefly, Likert scales do not generate continuous variables and hence when analysing the relations of ordinal with other ordinal variables, polychoric correlations should be computed rather than using traditional Pearson product-moment correlations. This is accomplished using PRELIS 2.72 which also generates the asymptotic covariance matrix of the correlations. The polychoric correlations and asymptotic covariance matrices are then analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation model (Jöreskog, 2002). Models are compared by use of goodness of fit indices (for examples of these procedures see Rowe, 2006; Voss, Müller, & Schermelleh-Engel, 2006). CFA has several advantages over EFA in determining the construct validity of questionnaire scales (Marsh, 1994; Rowe, 2002; Stevens, 1995).

The results of the first set of CFAs comparing the three first-order achievement goals models are displayed in Table 6.1. Of the three models, the five-factor model provided a significantly better fit of the data with $\chi^2 = 1538.4$ ($df = 242$, $p < .001$), RMSEA = 0.0905, RMR = 0.213, AGFI = 0.944, CFI = 0.929, and NNFI = 0.919. While the four-factor model improved the fit of the data significantly above that of the three-factor model, $\Delta\chi^2 = 109.2$ ($\Delta df = 3$, $p < .001$), the five-factor model was a significant improvement upon the four-factor model, $\Delta\chi^2 = 46.5$ ($\Delta df = 4$, $p < .001$). The five-factor model also revealed that items 5, 21 and 22 had very large measurement errors associated with them (0.96, 0.93, 0.91, respectively), as expected. In addition, item 6 ("I eagerly participate in all types of activities in this class"), an indicator item for performance-approach goal was shown to have a large amount of covariance with the mastery-approach goal thus indicating this item had a large amount of cross-loading associated with it.

A second set of CFAs was conducted after removing items 5, 6, 21 and 22 (item 7 was retained since it had a relatively low measurement error and substantively was a reverse-coded indicator item of mastery-approach). For this set of analyses, three-factor (mastery-approach, performance-approach, avoidance) and four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) models were compared. The results of this set of CFAs are displayed in Table 6.2. Of the two models, the four-factor model provided a significantly better fit of the data with $\chi^2 = 738.5$ ($df = 164$, $p < .001$), RMSEA = 0.0732, RMR = 0.191, AGFI = 0.962, CFI = 0.951, and NNFI = 0.943. The four-factor model improved the fit of the data significantly above that of the three-factor model, $\Delta\chi^2 = 65.4$ ($\Delta df = 3$, $p < .001$). Thus, these analyses verified the existence of the four achievement goals.

Table 6.1

Achievement Goals Questionnaire: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	1694.1	249	.000	-	-	.0942	.250	.941	.921	.913
Four-factor model	1584.9	246	.000	109.2***	3	.0912	.233	.944	.927	.918
Five-factor model	1538.4	242	.000	46.5***	4	.0905	.213	.944	.929	.919

Note. $n = 655$; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. Five-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, misinterpretation. *** $p < .001$.

Table 6.2

Achievement Goals Questionnaire[a]: Results from Confirmatory Factor Analyses[b]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	803.9	167	.000	-	-	.0764	.204	.960	.946	.938
Four-factor model	738.5	164	.000	65.4***	3	.0732	.191	.962	.951	.943

Note. $n = 655$; [a]After removal of items 5, 21 and 22 due to extremely high measurement errors, and removal of item 6 for cross-loading; [b]Weighted Least Squares used as the estimation method; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. *** $p < .001$.

Motivational beliefs. An initial EFA of the Motivated Strategies for Learning Questionnaire (MSLQ; Appendix C) motivational belief items yielded three factors with eigenvalues greater than 1 as well as satisfying scree test requirements for three factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis contained four factors, accounting for 62.3% of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) The four factors represented the three hypothesised motivational beliefs of intrinsic value, self-efficacy and test anxiety, and the fourth factor was aligned with some intrinsic value items that were mastery-approach in nature: item 1 ("I prefer class work that is challenging so I can learn new things"), item 4 ("It is important for me to learn what is being taught in this class"), item 10 ("I often do more than required of me for homework assignments"), item 14 ("Even when I do poorly on a test or exam I try to learn from my mistakes") and item 21 ("Understanding the subject is important to me"). The majority of perceived ability and perceived self-efficacy items loaded onto the same factor thus showing students did not distinguish between these competence perceptions.

Confirmatory factor analysis using PRELIS 8.72 and LISREL 8.72 was used to investigate the degree of discrimination between the intrinsic value and achievement goal items, particularly between the intrinsic value and mastery-approach items. The first set of CFAs compared four first-order models. The four-factor model comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with all the intrinsic value items declared as indicator items of the mastery-approach factor. Five-factor Model A comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with all intrinsic value items forming the fifth factor, intrinsic value. Five-factor Model B comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with only item 5 ("I like what I am learning in this class"), item 7 ("I think I will be able to use what I learn in this class in other classes"), item 15 ("I think what I am learning in this class is useful for me to know") and item 17 ("I think that what we are learning in this class is interesting") forming the fifth factor, intrinsic value, the remaining intrinsic value items (items 1, 4, 10, 14, 21) were declared as indicator items of the mastery-approach goal. The six-factor model comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value (items 5, 7, 15, 17), and the sixth factor comprised of the remaining intrinsic value items (items 1, 4, 10, 14, 21). The results of the first set of CFAs are displayed in Table 6.3. Of the six models, the six-factor model provided a significantly better fit of the data with $\chi^2 = 2017.7$ ($df = 362$, $p < .001$), RMSEA = 0.0836, RMR = 0.315, AGFI = 0.960, CFI = 0.960, and NNFI = 0.955.

A second set of CFAs was conducted after removing intrinsic value items 1, 4, 10, 14, and 21; these seemed superfluous when items 5, 7, 15 and 17 were substantively more indicative of intrinsic value. For this set of analyses, four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) and five-factor [mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value (items 5, 7, 15, 17)] models were compared. The results of this set of CFAs are displayed in Table 6.4. Of the two models, the five-factor model provided a significantly better fit of the data with $\chi^2 = 1101.6$ ($df = 242$, $p < .001$), RMSEA = 0.0737, RMR = 0.234, AGFI = 0.964, CFI = 0.961, and NNFI = 0.955. The five-factor model improved the fit of the data significantly above that of the four-factor model, $\Delta\chi^2 = 72.9$ ($\Delta df = 4$, $p < .001$). Consequently, these analyses verified that items 5, 7, 15 and 17 were valid indicators of intrinsic value, to be distinguished from those that were indicators of mastery-approach and the other achievement goals.

Table 6.3

Mastery-Approach and Intrinsic Value Items: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Four-factor model	2080.0	371	.000	-	-	.0839	.319	.960	.959	.955
Five-factor Model A	2049.8	367	.000	30.2***	4	.0837	.320	.960	.960	.955
Five-factor Model B	2039.0	367	.000	10.8	-	.0835	.313	.960	.960	.956
Six-factor model	2017.7	362	.000	21.3***	5	.0836	.315	.960	.960	.955

Note. $n = 655$; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. Five-factor Model A: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, all intrinsic value. Five-factor Model B: mastery-approach + other intrinsic value, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value. Six-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value, other intrinsic value. *** $p < .001$.

Table 6.4

Mastery-Approach and Intrinsic Value Items: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Four-factor model	1174.5	246	.000	-	-	.0760	.251	.962	.958	.952
Five-factor model	1101.6	242	.000	72.9***	4	.0737	.234	.964	.961	.955

Note. n = 655; [a]Weighted Least Squares used as the estimation method; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. Five-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value. *** $p < .001$.

Self-regulated learning. An initial EFA of The Motivated Strategies for Learning Questionnaire (MSLQ; Appendix C) self-regulated learning items yielded three factors with eigenvalues greater than 1 as well as satisfying scree test requirements for three factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis contained three factors, accounting for 48.2 % of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) Two factors represented the hypothesised self-regulated learning constructs of cognitive strategy use (items 31, 32, 33, 34, 35, 41, 42) and regulatory strategy use (items 23, 24, 25, 28, 29, 30, 36, 39, 40, 43, 44), while the third factor was compatible with maladaptive self-regulated learning strategies: item 26 ("It is hard for me to decide what the main ideas are when I study"), item 27 ("When work is hard I either give up or study the easy parts"), item 37 ("I often find the material I use for studying difficult to understand"), and item 38 ("I find that when the teacher is talking I think of other things and don't really listen to what is being said"). All items loaded above 0.35 on their primary factor and one item (item 35) crossloaded (> 0.32 on two or more factors) in the final EFA solution.

Confirmatory factor analysis using PRELIS 8.72 and LISREL 8.72 was used to investigate the degree of discrimination between the self-regulated learning items with respect to the hypothesised self-regulated learning constructs of cognitive strategy use, regulatory strategy use and maladaptive strategy use. The CFAs compared four first-order models. The one-factor model comprised of all the self-regulated learning items, forming a single self-regulated learning factor. Two-factor Model A comprised of cognitive strategy use and regulatory strategy use with the indicator items being in accordance with that classified by the MSLQ. Two-factor Model B comprised of the self-regulated learning factor and the maladaptive strategy use factor, which was formed from items 26, 27, 37 and 38. The three-factor model comprised of the three factors and their items as identified in the EFA: cognitive strategy use (items 31, 32, 33, 34, 35, 41, 42), regulatory strategy use (items 23, 24, 25, 28, 29, 30, 36, 39, 40, 43, 44), and maladaptive strategy use (items 26, 27, 37, 38). The results of this set of CFAs are displayed in Table 6.6. Of the four models, the three-factor model provided a significantly better fit of the data with $\chi^2 = 864.7$ ($df = 206$, $p < .001$), RMSEA = 0.0699, RMR = 0.237, AGFI = 0.949, CFI = 0.895, and NNFI = 0.882. The three-factor model improved the fit of the data significantly above that of two-factor Model B, $\Delta\chi^2 = 65.9$ ($\Delta df = 2$, $p < .001$). These analyses verified students could indeed distinguish between the self-regulated learning constructs of cognitive strategy use and regulatory strategy use.

Table 6.5

Self-Regulated Learning Items (MSLQ): Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
One-factor model	1053.3	209	.000	-	-	.0786	.259	.939	.865	.851
Two-factor Model A	1053.0	208	.000	.3	1	.0788	.259	.939	.865	.850
Two-factor Model B	930.6	208	.000	122.4	-	.0729	.253	.946	.885	.872
Three-factor model	864.7	206	.000	65.9***	2	.0699	.237	.949	.895	.882

Note. n = 655; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; p = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. One-factor model: MSLQ SRL items. Two-factor Model A: MSLQ cognitive strategy use, MSLQ regulatory strategy use. Two-factor Model B: MSLQ SRL items, EFA maladaptive strategy use. Three-factor model: EFA cognitive strategy use, EFA regulatory strategy use, EFA maladaptive strategy use. *** $p < .001$.

6.3.2 Preliminary Analyses: One-Factor Congeneric Measurement Model Analyses

The analyses reported above were concerned with determining the construct validity of indicator items. Next, fitted one-factor congeneric measurement models were used to form the composite variables that represent the various social/cognitive constructs investigated in the present research. One-factor congeneric modelling involves the use of confirmatory factor analysis in order to determine the relative weighting of single indicator (or response) items in forming a composite latent variable or factor (Jöreskog, 1971). This approach is based upon structural equation modelling and consequently involves an approach that analyses the covariances amongst items used to represent a latent variable. One-factor congeneric modelling has several important advantages over traditional measurement analyses such as exploratory factor analysis (EFA) and principal components (Holmes-Smith & Rowe, 1994; Rowe, 2002, 2006; Rowe & Hill, 1998). Firstly, one-factor congeneric models are based on a priori estimates of indicator or response items that tap into a particular construct. As such, it is a confirmatory factor analysis technique that specifically assesses the hypothesised psychometric relations between indicator items and their composite latent variable (or construct). Secondly, this approach accounts for the measurement variance associated with the observed indicator items and their composite latent variable in addition to the variance associated with measurement error. The aim is to "maximise" the fit of the indicator items and the construct they represent and in so doing minimising the impact of measurement error in computing composite scale scores (Fleishman & Benson, 1987; Rowe, 2006). Factor analysis does not enable the researcher to account for the variance associated with measurement error. Furthermore, the CFA approach provides estimates of unique measurement error of each indicator item and the inter-item measurement error ("joint measurement error"). This provides a more accurate estimate of the composite scale reliability than Cronbach's alpha, which takes into account both the measurement error and measurement variance associated with items and their composite variable (Raykov, 1998; Rowe, 2006). Thirdly, the construction of composite variable scale scores from this method is based on the weighted contribution of relevant items whereas traditional research composite scale score computation assumes that each indicator item has equal weighting or is "unit-weighted" (Rowe, 2006). This process also allows the researcher to provide important information regarding the validity of scale items and thus highlight any important measurement properties of questionnaire scales and their indicators. For example, items found to have minimal weighting contribution to a composite scale may in questionnaire development be altered or removed. Fourthly, this approach enables the researcher to deal with items that are ordinal in nature, typical of many psychometric scales that utilise Likert scales, and cater for items that have non-normal distributional properties of their data. As described above, PRELIS 8.72 caters for the statistical analysis of ordinal data by computing inter-item polychoric correlations and asymptotic covariance matrices, which can then be analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation model (Jöreskog, 2002). Implementing these processes increases both the reliability and validity of composite scales computed from indicator items as compared to the traditional means of generating composite scale scores using factor analysis and unit-weightings of indicator items from ordinal data (see McKenzie, Gow, & Schwietzer, 2004; Rowe, 2003; Rowe & Rowe, 1999; Webster & Fisher, 2001; Young, 1998).

The results of the measurement properties attained from fitting one-factor congeneric models are presented in Tables 6.6 to 6.10. Items found to have small partial regression weights and large measurement error variance (> 0.90) were eliminated since these were either inappropriate indicator items for the latent variable or were inappropriately worded and thus introduced a large amount of inconsistency when interpreted by students. These items may be of interest to researchers associated with the relevant questionnaire design and modifications. The one-factor congeneric model for a latent variable was repeated if items were eliminated from its embryonic model; the results obtained are therefore devoid of poor fitting indicator items. All but one of the composite scales exhibited satisfactory composite scale parameter results. The composite score reliability coefficients (r_c) ranged from 0.704 to 0.937; the variance estimate of items attributed to the composite variable ($\hat{\lambda}_c$) ranged from 0.839 to 0.950; and, the variance estimate of items attributed to measurement error ($\hat{\theta}_c$) ranged from 0.094 to 0.296. The maladaptive strategy use scale had such poor composite scale reliability (< 0.70) to warrant dropping it from further analyses. The relevant goodness of fit indices of each composite scale are presented in Tables 6.11 and 6.12; these were also satisfactory.

Table 6.6

Constructivist Pedagogy Dimensions: Composite Scale Parameters (Study 1)

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		pr1[a] (1)[b]	pr2 (2)	pr3 (3)	pr4 (4)	pr5 (5)	pr6 (6)					
Personal relevance	654	.210[c]	.003	.106	.464	.328	.033	2[e], 1 3, 2 5, 1 6, 3	.767	.876	.233	.741
		.184[d]	.003	.093	.406	.287	.029					
		u1 (7)	u2 (8)	u3 (9)	u4 (10)	u5 (11)	u6 (12)					
Uncertainty	655	.126	.355	.163	.083	.411	.115	4, 2 4, 3 5, 1 5, 4	.704	.839	.296	.641
		.101	.283	.130	.066	.328	.092					
		cv1 (13)	cv2 (14)	cv3 (15)	cv4 (16)	cv5 (17)	cv6 (18)					
Critical voice	655	.120	-	.027	.131	.450	.363	3, 1 4, 3 5, 1	.870	.913	.125	.836
		.110	-	.025	.120	.412	.333					
		sc1 (19)	sc2 (20)	sc3 (21)	sc4 (22)	sc5 (23)	sc6 (24)					
Shared control	652	.137	.213	.195	.198	.243	.130	5, 2 6, 1	.937	.922	.057	.898
		.123	.191	.175	.177	.218	.116					

Table 6.6 *Continued*

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		sn1 (25)	sn2 (26)	sn3 (27)	sn4 (28)	sn5 (29)	sn6 (30)					
Student negotiation	653	-	.286	.182	.129	.376	.144	3, 2 5, 2 5, 3	.907	.931	.089	.886
		-	.256	.163	.115	.337	.129					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 6.7

Classroom Goal Structures and Metacognitive Structure: Composite Scale Parameters (Study 1)

Composite Variable	*n*	Item Weights					TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Mastery goal structure	653	clmast1[a] (31)[b]	clmast2 (32)	clmast3 (33)	clmast4 (34)	clmast5 (35)	2[e], 1 4, 1 5, 4	.882	.919	.113	.858
		.047[c]	.193	.538	.151	.147					
		.044[d]	.179	.500	.140	.137					
Performance-approach goal structure	653	clpap1 (36)	clpap2 (37)	clpap3 (38)	-	-	-	.782	.862	.207	.735
		.245	.562	.244	-	-					
		.233	.535	.232	-	-					
Performance-avoidance goal structure	650	clpav1 (39)	clpav2 (40)	clpav3 (41)	clpav4 (42)	-	2, 1	.821	.852	.158	.779
		.038	.110	.412	.491	-					
		.036	.105	.392	.467	-					
Classroom metacognitive structure	653	clmeta1 (43)	clmeta2 (44)	clmeta3 (45)	clmeta4 (46)	clmeta5 (47)	4, 2 4, 1 5, 1	.896	.934	.101	.853
		.325	.153	.071	.496	.107					
		.282	.133	.062	.431	.093					

Note. *n* = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 6.8

Personal Achievement Goals: Composite Scale Parameters (Study 1)

Composite Variable	*n*	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		map1[a] (7)[b]	map2 (8)	map3 (9)	map4 (10)	map5 (11)	map6 (12)					
Mastery-approach	652	.051[c]	.187	.401	.311	.118	.051	5[e], 2 6, 5	.871	.928	.127	.837
		.046[d]	.167	.358	.278	.105	.046					
		mav1 (19)	mav2 (20)	mav3 (21)	mav4 (22)	mav5 (23)	mav6 (24)					
Mastery-avoidance	641	.538	.048	-	-	.182	.444	6, 1 6, 2	.718	.845	.280	.662
		.444	.040	-	-	.150	.366					
		pap1 (1)	pap2 (2)	pap3 (3)	pap4 (4)	pap5 (5)	pap6 (6)					
Performance-approach	653	.089	.311	.404	.250	-	-	2, 1	.898	.930	.098	.891
		.084	.295	.383	.237	-	-					
		pav1 (13)	pav2 (14)	pav3 (15)	pav4 (16)	pav5 (17)	pav6 (18)					
Performance-avoidance	653	.211	.084	.356	.238	.325	.050	2, 1 5, 3 5, 2 6, 5	.753	.867	.247	.715
		.167	.066	.282	.188	.257	.040					

Note. *n* = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 6.9

Motivational Beliefs: Composite Scale Parameters (Study 1)

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Intrinsic value	653	ig1[a] (1)[b]	ig2 (4)	ig3 (5)	ig4 (7)	ig5 (10)	ig6 (14)	7[e], 4	.878	.926	.119	.864
		-	-	.426[c]	.072	-	-					
		-	-	.403[d]	.068	-	-					
		ig7 (15)	ig8 (17)	ig9 (21)	-	-	-					
		.148	.411	-	-	-	-					
		.140	.389	-	-	-	-					
Test anxiety	652	ta1 (3)	ta2 (12)	ta3 (20)	ta4 (22)	-	-	4, 1	.834	.900	.161	.811
		.187	.516	.280	.099	-	-					
		.173	.477	.259	.091	-	-					

Table 6.9 *Continued*

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Self-efficacy	652	se1 (2)	se2 (8)	se3 (9)	se4 (13)	se5 (11)	se6 (18)	3, 1 4, 1 7, 1 7, 6 8, 4	.902	.950	.098	.876
		.028	-	.241	.272	.108	.191					
		.024	-	.203	.229	.091	.161					
		se7 (6)	se8 (11)	se9 (19)	-	-	-					
		.056	.173	.117	-	-	-					
		.047	.146	.099	-	-	-					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 6.10

Self-Regulated Learning: Composite Scale Parameters (Study 1)

Composite Variable	*n*	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Regulatory strategy use	647	suc1[a] (23)[b]	suc2 (24)	suc3 (26)	suc4 (28)	suc5 (29)	suc6 (30)	2[e], 1 13, 6 5, 4 9[#], 6 6, 5 10, 1 1[#], 2	.906	.950	.094	.878
		.158[c]	.067	-	.073	.047	.128					
		.123[d]	.052	-	.057	.037	.100					
		suc9 (36)	suc10 (39)	suc13 (44)	susr1[#] (25)	susr8 (40)	susr9[#] (43)					
		.110	.211	.221	.079	.121	.065					
		.086	.165	.173	.062	.095	.051					
Cognitive strategy use	647	suc7 (31)	suc8 (34)	suc11 (41)	suc12 (42)	susr3 (32)	susr4 (33)	4, 12 4, 3	.829	.906	.169	.794
		.178	.247	-	.245	.127	.196					
		.144	.200	-	.199	.103	.159					
		susr5 (35)	-	-	-	-	-					
		.241	-	-	-	-	-					
		.195	-	-	-	-	-					

Table 6.10 *Continued*

Composite Variable	*n*	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		suc3 (26)	susr2 (27)	susr6 (37)	susr7 (38)	-	-					
Maladaptive strategy use	647	.157	.396	.219	.335	-	-	6, 3	.633	.794	.365	.627
		.142	.358	.198	.303	-	-					

Note. *n* = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 6.11

Classroom Learning Environment Constructs: One-Factor Congeneric Model Fit Indices (Study 1)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Personal relevance	6	5.402	5	.369	.999	.995	.0185	.0111
Uncertainty	6	5.307	5	.380	.990	.995	.0203	.0097
Critical voice	5	2.744	2	.254	.999	.996	.0128	.0238
Shared control	6	14.515	7	.043	.997	.992	.0285	.0405
Student negotiation	5	3.687	2	.158	.999	.995	.0103	.0359
Mastery goal structure	5	1.335	2	.513	1.000	.998	.0064	.0000
Performance-approach goal structure	3	-	-	-	-	-	-	-
Performance-avoidance goal structure	4	.264	1	.608	1.000	.999	.0030	.0000
Classroom metacognitive structure	5	5.701	2	.058	.999	.990	.0182	.0532

Note. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

Table 6.12

Personal Constructs: One-Factor Congeneric Model Fit Indices (Study 1)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Mastery-approach	6	5.707	7	.574	.999	.997	.0149	.0000
Mastery-avoidance	4	.000	0	1.000	-	-	-	-
Performance-approach	4	.057	1	.812	1.000	1.000	.0013	.0000
Performance-avoidance	6	4.502	5	.480	.999	.996	.0151	.0000
Intrinsic value	4	.675	1	.411	1.000	.998	.0040	.0000
Test anxiety	4	.427	1	.513	1.000	.999	.0047	.0000
Self-efficacy	8	23.81	15	.068	.997	.992	.0344	.0300
Regulatory strategy use	11	52.04	37	.052	.994	.989	.0489	.0249
Cognitive strategy use	6	11.00	7	.140	.998	.993	.0233	.0295

Note. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

6.3.3 Descriptive Statistics

The distributional properties of the composite scales were then examined for use in multilevel multiple regression and structural equation modelling analyses. The distributional properties of missing data were also ascertained using PRELIS. This showed no systematic patterns for the missing data and thus a listwise method was employed in dealing with missing data. Descriptive statistics and univariate normality tests of the raw composite scale data are presented in Tables 6.13 and 6.14. These results show that the composite scale data, even after completion of the one-factor congeneric modelling analyses described above, was not normally distributed with most composites exhibiting significant skewness and kurtosis. Normalised values of the raw composite scale scores were achieved using *MLwiN* 2.02 (Rasbash, Browne, Healy, Cameron, & Charlton, 2005a; Rasbash, Steele, Browne, & Prosser, 2005b), which rescores the raw composite scale scores on the basis of normal equivalent deviates in accordance with the original score rankings (Rowe, 2003, 2006). The resultant descriptive statistics and univariate normality tests of the normalised composite scale data are shown in Tables 6.15 and 6.16. This process resulted in most composite scales having distributional properties close to being normal distributed with insignificant skewness and kurtosis. Despite normalisation, two classroom level composites, shared control and classroom performance-avoidance goal structure, still exhibited significant skewness and kurtosis. Both constructs were significantly positively skewed with many students reporting they perceive their science classroom as being low in shared control and low in performance-avoidance goal structure. Hence these classroom learning environment variables were transformed into dichotomous nominal types (1 = low, 2 = high) using a median-split procedure. Students were classified as having a high shared control perception of their classroom if their normalised shared control composite scale score was ≥ 0.000 (the median value); students with normalised shared control composite scores < 0.000 were classified as perceiving their science classroom being a low in shared control. A similar procedure was used to classify students for their performance-avoidance goal structure composite scale scores. The normalised composite scale scores were used in multilevel multiple regression and structural equation modelling analyses. Despite satisfactorily achieving normality for independent composites, multivariate normality tests were still significant even with the exclusion of the two dichotomous variables, shared control and performance-avoidance goal structure (Table 6.17). Four multiple goal constructs (Mastery-approach X Mastery-avoidance, Mastery-approach X Performance-approach, Performance-approach X Performance-avoidance, Mastery-avoidance X Performance-avoidance) were formed from the relevant composite scales in order to investigate the impact of multiple achievement goals. The composite scale scores for each of these were also normalised (Table 6.18).

Table 6.13

Classroom Learning Environment Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 1)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Personal relevance	3.587	.771	1-5	1-5	-.566	-5.444	.000	.332	1.583	.113	32.14	.000
Uncertainty	3.730	.660	1.1-5	1-5	-.680	-6.383	.000	.681	2.782	.005	48.49	.000
Critical voice	3.778	.982	1-5	1-5	-.807	-7.362	.000	.110	.634	.526	54.60	.000
Shared control	1.991	.829	1-5	1-5	.701	6.552	.000	-.029	-.058	.953	42.93	.000
Student negotiation	3.386	.922	1-5	1-5	-.358	-3.581	.000	-.116	-.544	.587	13.12	.001
Mastery goal structure	3.808	.960	1-5	1-5	-.901	-8.037	.000	.355	1.670	.095	67.39	.000
Performance-approach goal structure	3.059	1.074	1-5	1-5	-.248	-2.512	.012	-.751	-6.314	.000	46.18	.000
Performance-avoidance goal structure	2.185	1.031	1-5	1-5	.499	4.870	.000	-.772	-6.620	.000	67.54	.000
Metacognitive structure	2.785	.930	1-5	1-5	-.020	-.210	.834	-.465	-3.050	.002	9.35	.009

Note. *n* = 623.

Table 6.14

Personal Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 1)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	5.197	1.293	1-7	1-7	-.742	-6.874	.000	.031	.253	.800	45.31	.000
Mastery-avoidance	3.441	1.153	1-7	1-7	.222	2.257	.024	-.139	-.677	.498	5.55	.062
Performance-approach	3.894	1.547	1-7	1-7	-.014	-.144	.886	-.747	-6.247	.000	39.05	.000
Performance-avoidance	3.998	1.236	1-7	1-7	-.043	-.438	.662	-.457	-2.983	.003	9.088	.011
Intrinsic value	4.420	1.537	1-7	1-7	-.379	-3.776	.000	-.567	-4.041	.000	30.59	.000
Test anxiety	3.822	1.545	1-7	1-7	.056	.576	.565	-.735	-6.074	.000	37.23	.000
Self-efficacy	4.292	1.206	1-7	1-7	-.288	-2.901	.004	-.230	-1.248	.212	9.98	.011
Regulatory strategy use	4.741	1.117	1-7	1-7	-.691	-6.477	.000	.816	3.175	.001	52.03	.000
Cognitive strategy use	4.195	1.272	1-7	1-7	-.169	-1.728	.084	-.230	-1.248	.212	4.543	.103

Note. n = 623.

Table 6.15

Classroom Learning Environment Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 1)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Personal relevance	.000	1.00	-3.155 – 3.155	-.001	-.011	.991	-.034	-.088	.930	.008	.996
Uncertainty	.000	1.00	-3.155 – 3.155	-.001	-.010	.992	-.033	-.081	.935	.007	.997
Critical voice	-.005	.979	-2.340 – 3.155	-.060	-.616	.538	-.330	-1.953	.051	4.192	.123
Shared control	.020	.952	-1.356 – 3.155	.284	2.865	.004	-.445	-2.872	.004	16.458	.000
Student negotiation	-.006	.978	-2.408 – 1.840	-.087	-.898	.369	-.388	-2.399	.016	6.560	.038
Mastery goal structure	-.007	.979	-2.725 – 1.818	-.114	-1.166	.244	-.336	-1.994	.046	5.334	.069
Performance-approach goal structure	.004	.975	-1.851 – 2.231	.064	.656	.512	-.436	-2.800	.005	8.267	.016
Performance-avoidance goal structure	.025	.940	-1.240 – 3.155	.342	3.424	.001	-.472	-3.113	.002	21.413	.000
Metacognitive structure	.002	.987	-2.124 – 2.408	.033	.343	.732	-.292	-1.678	.093	2.935	.231

Note. $n = 623$.

Table 6.16

Personal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 1)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	-.002	.994	-2.947 – 2.310	-.038	-.386	.700	-.160	-.809	.419	.803	.669
Mastery-avoidance	.001	.997	-2.589 – 2.947	.015	.151	.880	-.102	-.464	.643	.238	.888
Performance-approach	.002	.981	-1.990 – 2.256	.040	.408	.683	-.375	-2.298	.022	5.448	.066
Performance-avoidance	.000	.999	-2.819 – 3.155	.008	.082	.935	-.058	-.217	.828	.054	.973
Intrinsic value	.000	.988	-2.282 – 2.256	-.003	-.033	.974	-.285	-1.628	.104	2.651	.266
Test anxiety	.003	.986	-2.052 – 2.488	.051	.522	.602	-.297	-1.713	.087	3.206	.201
Self-efficacy	.000	.998	-3.155 – 3.155	.001	.008	.994	-.034	-.085	.933	.007	.996
Regulatory strategy use	.000	.998	-2.819 – 2.726	-.004	-.037	.971	-.094	-.419	.675	.177	.915
Cognitive strategy use	.000	.995	-2.535 – 2.589	.003	.034	.973	-.156	-.780	.435	.610	.737

Note. *n* = 623.

Table 6.17

Multivariate Normality Tests for Normalised Data (Study 1)

Variables measured	Effective sample size	Skewness			Kurtosis			Skewness and Kurtosis	
		value	z-score	*p*	value	z-score	*p*	χ^2	*p*
All	623	20.24	12.75	.000	444.06	13.79	.000	352.82	.000
All except for shared control and performance-avoidance goal structure	623	14.12	9.790	.000	361.37	13.15	.000	268.75	.000

Note. $n = 623$.

Table 6.18

Personal Multiple Goal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 1)

Variable[a]	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach X Mastery-avoidance	.000	.999	-3.155 – 2.947	-.003	-.040	.968	-.045	-.144	.885	.022	.989
Mastery-approach X Performance-approach	.000	1.00	-3.155 – 3.155	-.001	-.008	.994	-.034	-.085	.933	.007	.996
Performance-approach X Performance-avoidance	.000	1.00	-3.155 – 3.155	-.001	-.009	.993	-.034	-.085	.932	.007	.996
Mastery-avoidance X Performance-avoidance	.000	1.00	-3.155 – 3.155	.000	.000	1.00	-.031	-.072	.943	.005	.997

Note. $n = 623$. [a]Multiple goals were formed initially using personal goals' normalised data and then normalised.

Variance-covariance relations of the normalised composite scales are found in Table 6.19. Although Pearson product-moment correlations are invalid measures when data are not-normally distributed and ordinal (Jöreskog, 1990; Rowe, 2006), they may be of interest when the composite scale scores satisfy normal distribution properties, as in the case of this study. Correlations among the variables are presented in Table 6.20. Note the similarity between the correlation values with those obtained for the covariances amongst the variables. Of particular interest were the positive relations between the constructivist pedagogy dimensions with the mastery goal and classroom metacognitive structures, mastery-approach goals, intrinsic value, self-efficacy, cognitive strategy, and regulatory strategy constructs. All personal achievement goals had positive relations with each other; they also positively related to the motivational beliefs of intrinsic value, test anxiety, and self-efficacy, and with the cognitive and regulatory strategy constructs. Compared to males, females reported to have lower mastery-avoidance, lower performance-approach, higher performance-avoidance, greater test anxiety, lower self-efficacy and greater use of cognitive strategies. Females also reported they perceived greater student negotiation in their science classroom than males. Selective school students reported greater use of cognitive and regulatory strategies than their regular counterparts. They also perceived their science classroom to have a greater emphasis on student negotiation and classroom metacognitive structures than regular students. Junior students perceived less emphasis in their science classroom in terms of personal relevance, uncertainty, student negotiation, mastery goal and classroom metacognitive structures than seniors. Juniors also had lower mastery-approach goals, intrinsic value, test anxiety, and less use of cognitive and regulatory strategies than seniors.

Table 6.19

Variance-Covariance Estimates for Variables - Normalised Data (Study 1)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Personal relevance	.999																
2. Uncertainty	.327	.999															
3. Critical voice	.311	.232	.958														
4. Shared control[a]	.304	.071	.239	1.00													
5. Student negotiation	.295	.215	.236	.294	.956												
6. Mastery goal structure	.470	.351	.380	.343	.363	.959											
7. Performance-approach goal structure	.078	.112	-.017	.083	.163	.057	.950										
8. Performance-avoidance goal structure[a]	.010	-.030	-.128	.330	.073	-.012	.255	1.00									
9. Metacognitive structure	.316	.257	.219	.455	.360	.478	.184	.327	.973								
10. Mastery-approach	.466	.321	.217	.211	.382	.398	.081	.006	.263	.988							
11. Mastery-avoidance	.103	.082	-.028	.105	.033	.039	.077	.184	.096	.263	.994						
12. Performance-approach	.121	.147	.003	.071	.124	.015	.110	.151	.055	.340	.444	.962					
13. Performance-avoidance	.123	.164	.019	.099	.081	.036	.079	.134	.090	.295	.507	.541	.998				
14. Intrinsic value	.508	.329	.243	.303	.344	.476	.100	.072	.315	.670	.172	.269	.177	.975			
15. Test anxiety	.003	.070	-.002	.030	.037	-.012	.007	.080	.052	.151	.250	.263	.489	.088	.972		
16. Self-efficacy	.307	.214	.169	.188	.239	.228	.134	.096	.164	.499	.350	.518	.308	.542	.048	.999	
17. Regulatory strategies	.390	.302	.189	.222	.366	.275	.129	.042	.292	.594	.185	.337	.333	.548	.104	.555	.995

Table 6.19 *Continued*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18. Cognitive strategies	.269	.214	.120	.227	.227	.195	.119	.072	.280	.450	.206	.294	.375	.414	.217	.402	.718
19. Mastery-approach x Mastery-avoidance	-.148	-.091	-.037	-.058	-.104	-.085	-.010	.072	.014	-.115	.027	.017	.018	-.139	-.057	-.058	-.105
20. Mastery-approach x Performance-approach	-.160	-.087	-.035	-.058	-.064	-.132	.038	.070	-.047	-.065	.027	.112	.002	-.120	-.018	-.036	-.084
21. Performance-approach x Performance-avoidance	-.035	.088	.019	-.054	-.058	.032	-.045	-.050	.002	-.028	-.042	-.026	-.060	-.052	-.053	-.092	-.082
22. Mastery-avoidance x Performance-avoidance	-.047	.048	-.004	.047	-.032	-.042	-.018	.047	.049	.006	-.041	-.031	-.026	-.021	-.005	-.026	-.019
23. Gender[b]	.066	-.002	.066	.043	.250	.096	-.020	-.173	.078	.021	-.261	-.171	.104	-.018	.216	-.189	.076
24. Student type[c]	.015	.065	-.051	.090	.169	-.062	-.046	-.027	.103	-.012	-.050	.027	.072	.036	.010	-.096	.204
25. Age[d]	-.155	-.288	-.089	-.091	-.151	-.184	.111	-.090	-.121	-.228	.050	-.066	-.059	-.242	-.122	.002	-.153

Note. *n* = 623; [a]Ordinal variables coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior.

Table 6.19 *Continued*

Variable	18	19	20	21	22	23	24	25
18. Cognitive strategies	.990							
19. Mastery-approach x Mastery-avoidance	-.072	.999						
20. Mastery-approach x Performance-approach	-.075	.460	.999					
21. Performance-approach x Performance-avoidance	-.102	.129	.190	.999				
22. Mastery-avoidance x Performance-avoidance	.006	.236	.099	.376	1.00			
23. Gender[c]	.113	-.063	-.052	.041	.053	1.00		
24. Student type[d]	.185	.027	-.080	.027	-.025	.013	1.00	
25. Age[e]	-.112	.091	.005	-.069	.046	-.222	-.104	1.00

Note. *n* = 623; [a]Ordinal variables coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior.

Table 6.20

Intercorrelations among Variables - Normalised Data (Study 1)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Personal relevance	-																
2. Uncertainty	.327**	-															
3. Critical voice	.318**	.237**	-														
4. Shared control[a]	.243**	.057	.195**	-													
5. Student negotiation	.305**	.220**	.247*	.240**	-												
6. Mastery goal structure	.480**	.358**	.396**	.279**	.379**	-											
7. Performance-approach goal structure	.080*	.115**	-.017	.068	.171**	.060	-										
8. Performance-avoidance goal structure[a]	.008	-.024	-.105**	.214**	.059	-.010	.209**	-									
9. Metacognitive structure	.320**	.261**	.227**	.368**	.373**	.495**	.192**	.265**	-								
10. Mastery-approach	.470**	.323**	.223**	.169**	.393**	.408**	.084*	.005	.268**	-							
11. Mastery-avoidance	.103**	.082*	-.028	.084*	.033	.040	.080*	.148**	.098*	.265**	-						
12. Performance-approach	.124**	.150**	.003	.058	.129**	.016	.115**	.123**	.057	.349**	.454**	-					
13. Performance-avoidance	.123**	.164**	.019	.079*	.083*	.037	.082*	.107**	.092*	.297**	.509**	.552**	-				
14. Intrinsic value	.514**	.333**	.252**	.245**	.357**	.492**	.103**	.059	.323**	.683**	.175**	.277**	.180	-			
15. Test anxiety	.004	.071	-.002	.024	.038	-.013	.007	.065	.053	.154**	.254**	.272**	.497**	.091*	-		
16. Self-efficacy	.307**	.215**	.173**	.150**	.245**	.233**	.138**	.077	.166**	.502**	.351**	.528**	.309**	.549**	.048	-	
17. Regulatory strategies	.391**	.303**	.194**	.178**	.375**	.281**	.133**	.034	.297**	.599**	.186**	.344**	.334**	.556**	.106**	.557**	-

Table 6.20 *Continued*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18. Cognitive strategies	.271**	.215**	.124**	.182**	.233**	.200**	.123**	.058	.285**	.455**	.208**	.301**	.377**	.421**	.221**	.404**	.724**
19. Mastery-approach x Mastery-avoidance	-.148**	-.091*	-.038	-.045	-.107**	-.087*	-.010	.058	.015	-.115**	.028	.018	.018	-.141**	-.058	-.058	-.106**
20. Mastery-approach x Performance-approach	-.160**	-.087*	-.036	-.043	-.066	-.135**	.039	.056	-.047	-.065	.027	.114**	.002	-.122**	-.018	-.036	-.084*
21. Performance-approach x Performance-avoidance	-.035	.088*	.020	-.038	-.060	.032	-.046	-.040	.002	-.028	-.043	-.027	-.060	-.053	-.054	-.092*	-.083*
22. Mastery-avoidance x Performance-avoidance	-.047	.048	-.004	.027	-.033	-.043	-.019	.038	.049	.006	-.041	-.032	-.026	-.021	-.005	-.026	-.019
23. Gender[b]	.053	-.001	.054	-.057	.204**	.078	-.016	-.111**	.063	.017	-.209**	-.139**	.083*	-.015	.175**	-.151**	.061
24. Student type[c]	.012	.051	-.041	.090	.135**	-.050	-.037	-.017	.083*	-.009	-.040	.022	.057	.028	.008	-.075	.161**
25. Age[d]	-.120**	-.226**	-.071	-.091	-.121**	-.145**	.089*	-.057	-.096*	-.179**	.040	-.053	-.046	-.191**	-.097*	.001	-.119**

Note. n = 623; [a]Ordinal variables coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. .* $p < .05$. ** $p < .01$.

Table 6.20 *Continued*

Variable	18	19	20	21	22	23	24	25
18. Cognitive strategies	-							
19. Mastery-approach x Mastery-avoidance	-.072	-						
20. Mastery-approach x Performance-approach	-.076	.460**	-					
21. Performance-approach x Performance-avoidance	-.103*	.130**	.190**	-				
22. Mastery-avoidance x Performance-avoidance	.006	.236**	.099*	.377**	-			
23. Gender[c]	.090*	-.050	-.042	.033	.043	-		
24. Student type[d]	.146**	.022	-.063	.021	-.019	.008	-	
25. Age[e]	-.088*	.071	.004	-.054	.036	-.140**	-.065	-

Note. n = 623; [a]Ordinal variables coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. .* $p < .05$. ** $p < .01$.

6.3.4 Regression Analyses: Preliminary Multilevel Regression Modelling Analyses

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environment and personal factors with personal achievement goals, and self-regulated learning (cognitive and regulatory strategy use). All education systems have an inherent hierarchical structure comprised of students at the first level, students grouped into classes at a second level, and classes that are nested within schools forming a third level. Multilevel systems such as education systems thereby have several frames of reference with regards to the analysis of data gleaned from such settings.

In the context of the present research, the achievement goals and SRL of students may be attributed to the motivational beliefs and personal characteristics that feature at the individual level; on the other hand, they could well be influenced by class membership, which may impact in two ways. Firstly, the social, motivational and affective climates associated with class membership may be influential on its members and the teacher. These class membership factors may have some bearing on the pedagogy employed by the teacher when teaching that class. Secondly, all class members experience the same teacher, who determines the class activities, learning and social atmospheres. For example, a class of students that are predominantly performance-based and efficacious may have considerable influence on the performance-approach and performance-avoidance goals of its members and also influence the teaching style of the teacher. In a reciprocated fashion, if the teacher has a performance-focus, then the learning environment they foster may be influential on students' performance-associated achievement goals. In this case, it is the teaching practice of the teacher that should form the focus of the study. Furthermore, school-based effects such as accomplishment and recognition may also have potent effects on students' motivation (Anderman & Maehr, 1994). The unit of analysis in such contexts, therefore, is of considerable importance in determining the methodology utilised and the significance of research findings (Goldstein, 2003; Rasbash et al., 2005b; Rowe, 2006).

The data collected for this study came from a total of 38 classes clustered within ten schools. As such, one limitation of adopting a multilevel approach to the statistical analyses employed in this study was the small number of schools. Consequently, the multilevel analyses of this study were constrained to a two-level hierarchy, with students at the first level and their classroom membership forming the second level. Besides, from a substantive perspective, the constructs studied are expected to have not much relation to school-level units since they are specific to science classrooms and students were asked to report on their science classrooms and science experiences not whole-school experiences. Rarely are multilevel analyses conducted in the context of achievement goals (for exceptions, see Anderman & Young, 1994; Church et al., 2001; Ee et al., 2003; Wolters, 2004), constructivist learning environment dimensions, motivational beliefs, and self-regulated learning.

Multilevelling modelling enables variance attributed to the student-level and class-level to be controlled and thus improve the validity of analyses. In so doing, this increases the potential generalisibility of outcomes. Multilevel modelling is also useful in determining if data used in structural equation modelling should be multilevel. If multilevel modelling reveals significant effects at various levels, then it may be necessary to conduct structural equation modelling at each level rather than being confined to single-level analyses (Rowe, 2003, 2006).

Before commencing the formal regression analyses, a multilevel variance components model (also known as the null or base model) was determined for each variable (construct) (Rasbash et al., 2005b). The multilevel variance components model involved determining the residual variance attributed to only the level 1 (student-level) and level 2 (class-level) units for each variable with no explanatory variables involved. The multilevel variance components models for all variables are reported in Tables 6.21 and 6.22. For the classroom learning environment variables, the variance of residuals attributed to the class-level ranged from 4.9 to 40.9% while the variance attributed to the personal-level ranged from 59.1 to 95.1%. For the personal variables, the variance of residuals attributed to the class-level ranged from 0 to 10.3% and the variance accounted for at the personal-level ranged from 89.7 to 100%. These results indicate that there is slightly greater agreement amongst students in reporting on their perception of the learning environment they experience than on the reporting of their personal goals. Hence, much of the variance associated with the reporting of personal goals is accounted for at the personal level and not to classroom-level differences.

Table 6.21

Classroom Learning Environment Constructs: Base Variance Components Models (Study 1)

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0ij} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Personal relevance	-.046 (.073)	.144 (.046)	14.2	.870 (.051)	85.8	1.010
Uncertainty	.003 (.065)	.098 (.036)	9.7	.913 (.053)	90.3	1.011
Critical voice	-.034 (.074)	.155 (.048)	16.1	.807 (.047)	83.9	.962
Shared control[b]	-.001 (.063)	.095 (.034)	10.4	.816 (.048)	89.6	.911
Student negotiation	-.019 (.057)	.065 (.028)	6.8	.894 (.052)	93.2	.959
Mastery goal structure	-.087 (.110)	.419 (.106)	40.9	.606 (.035)	59.1	1.025
Performance-approach goal structure	-.004 (.071)	.138 (.044)	14.6	.805 (.047)	85.4	.943
Performance-avoidance goal structure[b]	.010 (.051)	.043 (.022)*	4.9	.839 (.049)	95.1	.882
Metacognitive structure	-.035 (.077)	.170 (.052)	17.2	.821 (.048)	82.8	.991

Note. n = 623. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test); [b]not normally distributed.

Table 6.22

Personal Constructs: Base Variance Components Models (Study 1)

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0ij} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach	-.016 (.055)	.054 (.026)	5.5	.934 (.055)	94.5	.988
Mastery-avoidance	.001 (.040)	.000 (.000)*	0	.993 (.056)	100	.993
Performance-approach	.008 (.049)	.031 (.020)*	3.2	.932 (.054)	96.8	.963
Performance-avoidance	.000 (.040)	.000 (.000)*	0	.996 (.056)	100	.996
Intrinsic value	-.027 (.065)	.101 (.036)	10.3	.877 (.051)	89.7	.978
Test anxiety	.007 (.043)	.010 (.016)*	1.0	.960 (.056)	99.0	.970
Self-efficacy	.000 (.040)	.000 (.000)*	0	.998 (.057)	100	.998
Regulatory strategy use	-.014 (.053)	.045 (.024)*	4.5	.950 (.055)	95.5	.995
Cognitive strategy use	-.002 (.043)	.009 (.015)*	.9	.979 (.057)	99.1	.988

Table 6.22 *Continued*

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0ij} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach X Mastery-avoidance	.000 (.040)	.000 (.000)*	0	.997 (.056)	100	.997
Mastery-approach X Performance-approach	.011 (.050)	.032 (.021)*	3.2	.967 (.056)	96.8	.999
Performance-approach X Performance-avoidance	.000 (.040)	.000 (.000)*	0	.998 (.057)	100	.998
Mastery-avoidance X Performance-avoidance	.000 (.040)	.000 (.000)*	0	.998 (.057)	100	.998

Note. n = 623. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

The second type of multilevel variance components models incorporated the subpopulation variables of age (junior or senior), gender and school type (regular or selective) as fixed effects explanatory variables with the residual variance of the construct under focus being partitioned into the level 1 (student-level) and level 2 (class-level) units with no other explanatory variables involved. Hence this type of multilevel variance components model enables the variance of each construct attributed to the student level and the class level to be calculated whilst controlling for the variance attributed to the fixed subpopulation variables ("classifier variables") of age, gender and school type. The results of these analyses are reported in Tables 6.23 and 6.24. Note the exclusion of the two dichotomous classroom learning environment variables of shared control and classroom performance-avoidance goal structure in these models. For each construct, the incorporation of the classifier variables significantly improved the fit of the model beyond the initial multilevel variance components model. This was determined by calculating the difference between the -2loglikelihood (iterative generalised least squares deviance) of the two models and using a chi-square distribution with the degrees of freedom equivalent to the number of classifier variables ("fitted parameters") used (three in this case). For the classroom learning environment variables, the variance of residuals attributed to the class-level ranged from 3.7 to 39.3% while the variance attributed to the personal-level ranged from 60.7 to 96.3%. For the personal variables, the variance of residuals attributed to the class-level ranged from 0 to 6.5% and the variance accounted for at the personal-level ranged from 93.5 to 100%. Once again, these results indicate that there is a degree of convergence when students report on their perception of the learning environment they experience and that most of the variance associated with the reporting of personal-based constructs is accounted for at the personal level and not to classroom-level differences. Results of interest include the large degree of variance at the classroom-level (39.3%) in the perception of the mastery goal structure experienced by students in their science classroom. This is much larger than the next largest amount of class-level variation reported, which was attributed to the metacognitive structure (16.0%). Interestingly, there were no significant class-level effects for the constructivist pedagogy dimensions of uncertainty and student negotiation; most of the variance for these constructs assigned to the student-level. Of the personal constructs, only intrinsic value achieved significant variance at the class-level, although this was still small (6.5%). These findings are similar to others that have used hierarchical analyses of achievement goals (Anderman & Young, 1994; Ee et al., 2003; Wolters, 2004).

Table 6.23

Classroom Learning Environment Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 1)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercepts	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0ij} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Personal relevance	.065 (.137)	-.297 (.144)	.100 (.077)*	.044 (.142)*	.127 (.042)	12.8	.865 (.051)	87.2
Uncertainty	.306 (.102)	-.497 (.102)	-.076 (.078)*	.085 (.101)*	.035 (.021)*	3.7	.911 (.053)	96.3
Critical voice	.056 (.142)	-.180 (.150)*	.096 (.074)*	-.072 (.148)*	.147 (.046)	15.5	.804 (.047)	84.5
Student negotiation	-.201 (.100)	-.186 (.100)*	.377 (.076)	.257 (.099)	.034 (.020)*	3.8	.858 (.050)	96.2
Mastery goal structure	.090 (.200)	-.386 (.218)*	.171 (.064)	-.074 (.216)*	.387 (.098)	39.3	.598 (.035)	60.7
Performance-approach goal structure	-.062 (.136)	.156 (.143)*	-.007 (.074)*	-.076 (.136)*	.130 (.042)	13.9	.805 (.047)	86.1
Metacognitive structure	-.014 (.145)	-.219 (.153)*	.129 (.075)*	.109 (.152)*	.156 (.048)	16.0	.816 (.048)	84.0

Note. n = 623; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

Table 6.24

Personal Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 1)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercepts	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0ij} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach	.250 (.098)	-.387 (.096)	-.016 (.079)*	-.041 (.095)*	.024 (.019)*	2.5	.930 (.054)	97.5
Mastery-avoidance	.229 (.086)	.017 (.081)*	-.413 (.079)	-.076 (.079)*	.000 (.000)*	0	.948 (.054)	100
Performance-approach	.235 (.101)	-.170 (.100)*	-.295 (.078)	.061 (.099)*	.031 (.020)*	3.3	.907 (.053)	96.7
Performance-avoidance	-.083 (.087)	-.065 (.083)*	.156 (.080)*	.110 (.081)*	.000 (.000)*	0	.985 (.056)	100
Intrinsic value	.264 (.113)	-.428 (.115)	-.076 (.077)*	.029 (.114)*	.061 (.027)	6.5	.874 (.051)	93.5
Test anxiety	-.070 (.085)	-.148 (.080)*	.324 (.078)	.003 (.079)*	.000 (.000)*	0	.936 (.053)	100
Self-efficacy	.249 (.087)	-.052 (.082)*	-.308 (.080)	-.153 (.080)*	.000 (.000)*	0	.969 (.055)	100
Regulatory strategy use	-.054 (.093)	-.217 (.090)	.096 (.079)*	.317 (.089)	.013 (.016)*	1.4	.941 (.055)	98.6
Cognitive strategy use	-.113 (.086)	-.137 (.081)*	.158 (.079)	.285 (.080)	.000 (.000)*	0	.955 (.054)	100

Table 6.24 *Continued*

Construct	Fixed Part				Random Part (Residual variance)			
	Intercepts	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0ij} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach X Mastery-avoidance	-.064 (.088)	.137 (.083)*	-.082 (.081)*	.053 (.088)*	.000 (.000)*	0	.990 (.056)	100
Mastery-approach X Performance-approach	.113 (.102)	-.005 (.100)*	-.085 (.080)*	-.137 (.102)*	.028 (.020)*	2.8	.964 (.056)	97.2
Performance-approach X Performance-avoidance	.022 (.088)	-.102 (.083)*	.051 (.081)*	.036 (.088)*	.000 (.000)*	0	.994 (.056)	100
Mastery-avoidance X Performance-avoidance	-.087 (.088)	.086 (.083)*	.097 (.081)*	-.034 (.088)*	.000 (.000)*	0	.994 (.056)	100

Note. n = 623; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

6.3.5 Regression Analyses: Environmental and Personal Predictors of Achievement Goals

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals. The classroom environmental factors that were the focus of this study included the constructivist pedagogy dimensions and the classroom goal and metacognitive structures. The motivational beliefs of intrinsic value, self-efficacy and test anxiety served as the personal factors. In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors (or explanatory variables) of achievement goals and self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). Each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1). As described above, shared control and classroom performance-avoidance goal structure were transformed into dichotomous categorical variables due to their non-normal distribution characteristics (0 = low, 1 = high).

Mastery-approach goals

The fifteen-explanatory variable model explained 54.5% of variance in the mastery-approach goal (Table 6.25). Significant predictors of mastery-approach goals were: personal relevance ($\beta = 0.127$, $p < .001$), student negotiation ($\beta = 0.149$, $p < .001$), intrinsic value ($\beta = 0.436$, $p < .001$), test anxiety ($\beta = 0.104$, $p < .001$), and self-efficacy ($\beta = 0.176$, $p < .001$). All of these explanatory variables were positive predictors of mastery-approach goals. There was no significant variance of mastery-approach goals attributable to class membership. No other variables acquired significance.

Table 6.25

Multilevel Regression Analysis Model Results for Mastery-Approach[a] (Study 1)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	.187 (.083)*	-
Gender[b]	-.039 (.058)	-.020
Student type[c]	-.069 (.067)	-.034
Age[d]	-.096 (.070)	-.047
Personal relevance	.126 (.034)**	.127
Uncertainty	.046 (.031)	.046
Critical voice	-.009 (.031)	-.009
Shared control[e]	-.066 (.060)	-.033
Student negotiation	.151 (.033)**	.149
Mastery goal structure	.037 (.039)	.036
Performance-approach goal structure	-.014 (.030)	-.014
Performance-avoidance goal structure[f]	-.095 (.060)	-.048
Metacognitive structure	-.005 (.035)	-.005
Intrinsic value	.439 (.039)**	.436
Test anxiety	.105 (.028)**	.104
Self-efficacy	.175 (.034)**	.176
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.012 (.009)	
Student level variance (σ^2_{e0})	.438 (.026)**	
% of variance explained	54.5	
-2loglikelihood (IGLS deviance)	1266.8	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Mastery-avoidance goals

The fifteen-explanatory variable model explained 24% of variance in the mastery-avoidance goal (Table 6.26). Critical voice was a negative predictor of mastery-avoidance goals (β = -0.080, $p < .05$) as was gender (β = -0.195, $p < .001$), with females reporting to have less mastery-avoidance than males. Test anxiety (β = 0.273, $p < .001$), and self-efficacy (β = 0.314, $p < .001$) were positive predictors of mastery-avoidance. There was no significant variance of mastery-avoidance goals attributable to class membership. No other variables acquired significance.

Performance-approach goals

The fifteen-explanatory variable model explained 37.6% of variance in the performance-approach goal (Table 6.27). Mastery goal structure was a negative predictor of performance-approach goals (β = -0.093, $p < .05$) as was gender (β = -0.102, $p < .001$), with females reporting to have less performance-approach than males. Test anxiety (β = 0.256, $p < .001$), and self-efficacy (β = 0.509, $p < .001$) were positive predictors of mastery-avoidance. A weak but significant amount of variance of performance-approach goals was attributable to class membership (6%, $p < .05$). No other variables acquired significance.

Performance-avoidance goals

The fifteen-explanatory variable model explained 35.3% of variance in the performance-avoidance goal (Table 6.28). Uncertainty was a positive predictor of performance-avoidance goals (β = 0.095, $p < .05$) as was student type (β = 0.076, $p < .05$), with selective school students reporting to have greater performance-avoidance than regular students. Test anxiety (β = 0.467, $p < .001$), and self-efficacy (β = 0.310, $p < .001$) were also positive predictors of performance-avoidance. There was no significant variance of performance-avoidance goals attributable to class membership. No other variables acquired significance.

Table 6.26

Multilevel Regression Analysis Model Results for Mastery-Avoidance[a] (Study 1)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	.069 (.099)	-
Gender[b]	-.389 (.075)**	-.195
Student type[c]	-.041 (.073)	-.020
Age[d]	.079 (.076)	.039
Personal relevance	.051 (.044)	.051
Uncertainty	.017 (.040)	.017
Critical voice	-.081 (.040)*	-.080
Shared control[e]	.058 (.078)	.029
Student negotiation	-.014 (.043)	-.014
Mastery goal structure	-.012 (.050)	-.012
Performance-approach goal structure	.004 (.038)	.004
Performance-avoidance goal structure[f]	.124 (.077)	.062
Metacognitive structure	.044 (.046)	.044
Intrinsic value	-.045 (.051)	-.045
Test anxiety	.276 (.037)**	.273
Self-efficacy	.314 (.044)**	.314
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.000 (.000)	
Student level variance (σ^2_{e0})	.755 (.043)**	
% of variance explained	24.0	
-2loglikelihood (IGLS deviance)	1592.6	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Table 6.27

Multilevel Regression Analysis Model Results for Performance-Approach[a] (Study 1)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	.083 (.104)	-
Gender[b]	-.201 (.066)**	-.102
Student type[c]	.125 (.091)	.063
Age[d]	-.122 (.094)	-.061
Personal relevance	.016 (.039)	.016
Uncertainty	.045 (.035)	.046
Critical voice	-.041 (.036)	-.041
Shared control[e]	-.018 (.069)	-.009
Student negotiation	.037 (.037)	.037
Mastery goal structure	-.093 (.045)*	-.093
Performance-approach goal structure	.046 (.035)	.046
Performance-avoidance goal structure[f]	.096 (.068)	.049
Metacognitive structure	-.039 (.040)	-.039
Intrinsic value	-.001 (.045)	.001
Test anxiety	.255 (.032)**	.256
Self-efficacy	.500 (.038)**	.509
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.036 (.017)*	
Student level variance (σ^2_{e0})	.565 (.033)**	
% of variance explained	37.6	
-2loglikelihood (IGLS deviance)	1438.5	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * p < .05. ** p < .001.

Table 6.28

Multilevel Regression Analysis Model Results for Performance-Avoidance[a] (Study 1)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	-.240 (.091)*	-
Gender[b]	.130 (.070)	.065
Student type[c]	.155 (.068)*	.076
Age[d]	.038 (.071)	-.019
Personal relevance	.057 (.040)	.057
Uncertainty	.095 (.037)*	.095
Critical voice	-.031 (.037)	-.030
Shared control[e]	.052 (.072)	.026
Student negotiation	-.040 (.039)	-.039
Mastery goal structure	-.038 (.046)	-.037
Performance-approach goal structure	.025 (.035)	.024
Performance-avoidance goal structure[f]	.115 (.071)	.058
Metacognitive structure	-.006 (.042)	-.006
Intrinsic value	-.063 (.047)	.062
Test anxiety	.473 (.034)**	.467
Self-efficacy	.310 (.040)**	.310
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.000 (.000)	
Student level variance (σ^2_{e0})	.644 (.037)**	
% of variance explained	35.3	
-2loglikelihood (IGLS deviance)	1494.3	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

6.3.6 Regression Analyses: Environmental and Personal Predictors of Self-Regulated Learning

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environmental and personal factors with each of the constructs that represented self-regulated learning in the study, namely cognitive strategy and regulatory strategy use. The classroom environmental factors included the constructivist pedagogy dimensions, the classroom goal and metacognitive structures; the personal factors included the personal achievement goals and the motivational beliefs of intrinsic value, self-efficacy and test anxiety. In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors of self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). As for the regressions employed above for the personal achievement goals, each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1). Four interactions were introduced for this set of regression analyses in order to ascertain the effects (that is, the interaction) of multiple goal models on self-regulated learning. Each approach goal was combined with its avoidance counterpart (mastery-approach X mastery-avoidance, performance-approach X performance-avoidance) and each approach goal combined (mastery-approach X performance-approach) and each the interaction of each avoidance goal (mastery-avoidance X performance-avoidance). As described above, shared control and classroom performance-avoidance goal structure were transformed into dichotomous categorical variables due to their non-normal distribution characteristics (0 = low, 1 = high).

Regulatory strategies

The twenty three-explanatory variable model explained 54.2% of variance in the use of regulatory strategies (Table 6.29). Mastery goal structure was a negative predictor of regulatory strategies ($\beta = -0.089$, $p < .05$) as was mastery-avoidance ($\beta = -0.085$, $p < .05$). Positive predictors of regulatory strategies were: student negotiation ($\beta =$

0.066, $p < .05$), metacognitive structure ($\beta = 0.104$, $p < .05$), intrinsic value ($\beta = 0.127$, $p < .05$), self-efficacy ($\beta = 0.316$, $p < .001$), mastery-approach ($\beta = 0.277$, $p < .001$), and performance-avoidance ($\beta = 0.169$, $p < .001$). Gender was a positive predictor of regulatory strategy use ($\beta = 0.064$, $p < .05$), with females reporting to use more regulatory strategies than males. Student type was also a positive predictor of regulatory strategy use ($\beta = 0.154$, $p < .001$), with selective school students reporting to have greater regulatory strategy use than regular students. There was no significant variance of regulatory strategy use attributable to class membership. No other variables acquired significance.

Cognitive strategies

The twenty three-explanatory variable model explained 36.9% of variance in the use of cognitive strategies (Table 6.30). Positive predictors of cognitive strategies were: metacognitive structure ($\beta = 0.160$, $p < .001$), intrinsic value ($\beta = 0.121$, $p < .05$), self-efficacy ($\beta = 0.197$, $p < .001$), mastery-approach ($\beta = 0.209$, $p < .001$), and performance-avoidance ($\beta = 0.205$, $p < .001$). Gender was a positive predictor of cognitive strategy use ($\beta = 0.081$, $p < .05$), with females reporting to use more cognitive strategies than males. Student type was also a positive predictor of cognitive strategy use ($\beta = 0.136$, $p < .001$), with selective school students reporting to have greater cognitive strategy use than regular school students. Of the multiple goal variables investigated, the performance-approach X performance-avoidance interaction was a significant negative predictor of cognitive strategy use ($\beta = -0.073$, $p < .05$). There was no significant variance of cognitive strategy use attributable to class membership. No other variables acquired significance.

Table 6.29

Multilevel Regression Analysis Model Results for Regulatory Strategy Use[a] (Study 1)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	-.167 (.087)	-
Gender[b]	.127 (.061)*	.064
Student type[c]	.312 (.072)**	.154
Age[d]	.000 (.074)	.000
Personal relevance	.043 (.035)	.043
Uncertainty	.054 (.031)	.054
Critical voice	.021 (.032)	.021
Shared control[e]	-.026 (.061)	-.013
Student negotiation	.067 (.034)*	.066
Mastery goal structure	-.091 (.040)*	-.089
Performance-approach goal structure	.021 (.030)	.021
Performance-avoidance goal structure[f]	-.042 (.060)	-.021
Metacognitive structure	.105 (.036)*	.104
Intrinsic value	.128 (.044)*	.127
Test anxiety	-.040 (.033)	.040
Self-efficacy	.316 (.039)**	.316
Mastery-approach	.278 (.041)**	.277
Mastery-avoidance	-.085 (.034)*	-.085
Performance-approach	-.021 (.039)	-.021
Performance-avoidance	.169 (.039)**	.169
Mastery-approach X Mastery-avoidance	-.029 (.032)	-.029
Mastery-approach X Performance-approach	.008 (.032)	.008
Performance-approach X Performance-avoidance	-.029 (.030)	-.029
Mastery-avoidance X Performance avoidance	.002 (.030)	.002

Table 6.29 *Continued*

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.016 (.010)	
Student level variance (σ^2_{e0})	.440 (.026)**	
% of variance explained	54.2	
-2loglikelihood (IGLS deviance)	1273.8	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Table 6.30

Multilevel Regression Analysis Model Results for Cognitive Strategy Use[a] *(Study 1)*

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0ij}x_0$)	-.204 (.092)*	-
Gender[b]	.161 (.072)*	.081
Student type[c]	.274 (.068)**	.136
Age[d]	.008 (.071)	.004
Personal relevance	.004 (.041)	.004
Uncertainty	.018 (.037)	.018
Critical voice	.001 (.037)	.001
Shared control[e]	.067 (.071)	.034
Student negotiation	-.044 (.040)	-.043
Mastery goal structure	-.072 (.046)	-.071
Performance-approach goal structure	.042 (.035)	.041
Performance-avoidance goal structure[f]	-.058 (.071)	-.029
Metacognitive structure	.161 (.042)**	.160
Intrinsic value	.112 (.051)*	.111
Test anxiety	.055 (.038)	.055
Self-efficacy	.196 (.046)**	.197
Mastery-approach	.209 (.048)**	.209
Mastery-avoidance	-.041 (.040)	-.041
Performance-approach	-.015 (.046)	-.015
Performance-avoidance	.204 (.046)**	.205
Mastery-approach X Mastery-avoidance	-.022 (.037)	-.022
Mastery-approach X Performance-approach	-.007 (.037)	-.007
Performance-approach X Performance-avoidance	-.073 (.035)*	-.073
Mastery-avoidance X Performance avoidance	.035 (.036)	.035

Table 6.30 *Continued*

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.001 (.009)	
Student level variance (σ^2_{e0})	.622 (.036)**	
% of variance explained	36.9	
-2loglikelihood (IGLS deviance)	1473.0	

Note. n = 623 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high; [f]Performance-avoidance goal structure is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Aiken and West's (1991) simple slope analysis was used to interpret the performance-approach X performance-avoidance interaction (β = -0.073, $p < .05$). In accordance with this protocol, the effect of performance-approach on cognitive strategy use was plotted at low (one standard deviation below mean), medium (mean) and high levels (one standard deviation above mean) of performance-avoidance goal values in order to examine how performance-avoidance goals moderate the relations between performance-approach and cognitive strategy use. Figure 6.1 displays the resultant plots. There was a significant difference between the high level and low level performance-avoidance slopes thus indicating the moderating effect of performance-avoidance goals on performance-approach. The figure shows that the impact of performance-approach goals on cognitive strategy use depends on the performance-avoidance goal orientation of the students. For students having high performance-avoidance goals, an increase in performance-approach corresponds with a decrease in cognitive strategy use. For students with low performance-avoidance goals, an increase in performance-approach results in an increase in cognitive strategy use. These results show the potential adaptive importance of the performance-approach orientation in cognitive strategy use.

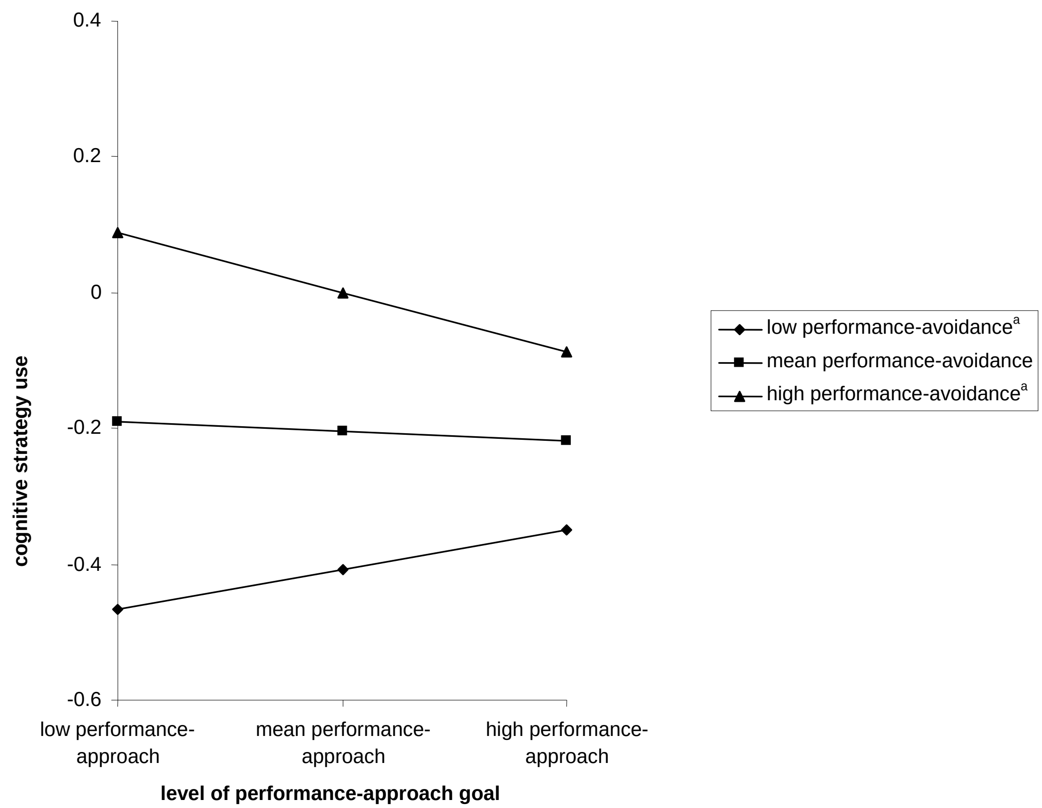

Figure 6.1. Plots of the performance-approach goal X performance-avoidance goal interaction. [a]Slopes significantly differ at $p < .05$.

The regression analyses presented above were used to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals and self-regulated learning for high school science students. Synopses of the significant predictors of personal achievement goals and self-regulated learning as yielded by the regression analyses are presented in Table 6.31.

Table 6.31

Synopsis of Significant Predictors of Personal Achievement Goals and Self-Regulated Learning for High School Science Students (Study 1)

Mastery-approach	Mastery-avoidance	Performance-approach	Performance-avoidance	Cognitive strategy use	Regulatory strategy use
personal relevance (+)	gender[a] (-)	gender[a] (-)	student type[b] (+)	gender[a] (+)	gender[a] (+)
student negotiation (+)	critical voice (-)	mastery goal structure (-)	uncertainty (+)	student type[b] (+)	student type[b] (+)
intrinsic value (+)	test anxiety (+)	test anxiety (+)	test anxiety (+)	classroom metacognitive structure (+)	student negotiation (+)
test anxiety (+)	self-efficacy (+)	self-efficacy (+)	self-efficacy (+)	intrinsic value (+)	mastery goal structure (-)
self-efficacy (+)				self-efficacy (+)	classroom metacognitive structure (+)
				mastery-approach (+)	intrinsic value (+)
				performance-avoidance (+)	self-efficacy (+)
				performance-approach X performance-avoidance (-)	mastery-approach (+)
					mastery-avoidance (-)
					performance-avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective. All relationships are significant at a minimum of $p < .05$.

6.3.7 Structural Equation Modelling analyses: Environmental and Personal Predictors of Self-Regulated Learning

Structural equation modelling was used to analyse the simultaneous relationships between the explanatory and response variables. The multilevel multiple regression analyses revealed most of the variance of the response variables, namely personal achievement goals and cognitive and regulatory strategy use, was attributed to the student-level. Only one achievement goal, performance-approach, attained a significant amount of variance attributed to the classroom-level, however this was a relatively modest 6% ($p < .05$). Furthermore, the base variance components models showed that the majority of variance of the classroom learning environment variables excluding mastery goal structure was also attributed to the student-level. Although the variances of many of these explanatory variables were statistically significant at the classroom-level, the amounts were relatively modest, ranging from 3.7 to 16%. Only the mastery goal structure had an appreciable amount of variance at the classroom-level (39.3%). Consequently, these results vindicate a single-level structural equation modelling approach for the data rather than a two-level structural equation modelling approach. In addressing the applicability of the structural equation modelling, the variances attributed to the classifier variables, namely gender, student age and student type, were removed. This was achieved by fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 (Rowe, 2006; Rowe & Hill, 1998; Rowe & Rowe, 1999), with the classifier variables of gender, student age and student type assigned as fixed explanatory variables; the residuals of the other variables are allowed to be random thus yielding a variance-covariance matrix of these variables which can be used for structural equation modelling. The two classroom learning environment dichotomous variables, shared control and performance-avoidance goal structure, were also declared as classifier variables. None of the multiple goal constructs were included in the structural equation modelling for substantive reasons - where does one position the goal interactions with respect to the classroom learning environment and personal variables in a structural equation model? Furthermore, how are such interactions interpreted in the context of simultaneous relationship analyses such as those performed in structural equation modelling? The results of fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 are displayed in Table 6.32.

The variance-covariance matrix displayed in Table 6.32 was used in the structural equation modelling. Note that the variance-covariance matrix of the variables has been 'purged' (Rowe, 2006) of the variance attributed to the classifier variables thus increasing the generalisability of the structural equation modelling analyses. Therefore, the aim of the structural equation modelling approach used in the present research is to produce a model applicable to the 'general' high school science student: What are the interactions between the classroom learning environment and personal-level variables in high school science classrooms when the effects of classifier variables such as gender, student age, and student type are controlled for?

The theoretically-based hypothesised self-regulated learning structural equation model is presented in Figure 6.2. Using the maximum likelihood method of estimation via LISREL 8.72 (Jöreskog & Sörbom, 2005) showed, however, this initial model provided an unsatisfactory fit of the data with $\chi^2 = 593.2$ ($df = 54$, $p < .001$), RMSEA = 0.1260, SRMR = 0.0801, GFI = 0.897, AGFI = 0.741, CFI = 0.906, and NFI = 0.899 (Table 6.33). Revision of the initial model and the subsequent modelling was based upon the results obtained from the multilevel multiple regressions reported above and by investigating the suggested modification indices within substantive grounds using the maximum likelihood method of estimation via LISREL 8.72. This approach resulted in the final self-regulated learning structural equation model providing a satisfactory fit of the data with $\chi^2 = 48.17$ ($df = 40$, $p = .176$), RMSEA = 0.0182, SRMR = 0.0156, GFI = 0.990, AGFI = 0.967, CFI = 0.999, and NFI = 0.992 (Table 6.33). Using generalised least squares used as the estimation method also revealed the model to satisfactorily fit the data with $\chi^2 = 45.82$ ($df = 40$, $p = .244$), RMSEA = 0.0225, SRMR = 0.0171, GFI = 0.991, AGFI = 0.969, CFI = 0.992, and NFI = 0.949 (Table 6.33).

Table 6.32

Results of Fitting a Student-Level Multivariate Model for the Classroom Learning Environment and Personal Constructs - Normalised Data (Study 1)

Fixed part of model		Random part of model																
Classifier Variable	Estimates (s.e.)	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gender[a]	.057 (.036)	1. Mastery-approach	**.954**	*.265*	*.349*	*.297*	*.683*	*.599*	*.455*	*.470*	*.323*	*.393*	*.408*	*.084*	*.268*	*.502*	*.154*	*.223*
Student type[b]	.005 (.036)	2. Mastery-avoidance	.248	**.996**	*.454*	*.509*	*.175*	*.186*	*.208*	*.103*	*.082*	*.033*	*.040*	*.080*	*.098*	*.351*	*.254*	*-.028*
Age[c]	-.079 (.037)*	3. Performance-approach	.324	.446	**.963**	*.552*	*.277*	*.344*	*.302*	*.124*	*.150*	*.129*	*.016*	*.115*	*.057*	*.528*	*.272*	*.003*
Shared control[d]	.261 (.037)**	4. Performance-avoidance	.271	.501	.533	**.982**	*.180*	*.334*	*.377*	*.123*	*.164*	*.083*	*.037*	*.082*	*.092*	*.309*	*.497*	*.019*
Performance-avoidance goal structure[e]	.113 (.037)**	5. Intrinsic value	.624	.145	.241	.141	**.917**	*.556*	*.421*	*.514*	*.333*	*.357*	*.492*	*.103*	*.323*	*.549*	*.091*	*.252*
		6. Regulatory strategy use	.558	.168	.319	.307	.500	**.957**	*.724*	*.391*	*.303*	*.194*	*.281*	*.133*	*.297*	*.557*	*.106*	*.194*
		7. Cognitive strategy use	.413	.188	.275	.347	.365	.679	**.949**	*.271*	*.215*	*.234*	*.200*	*.123*	*.285*	*.404*	*.221*	*.124*
		8. Personal relevance	.425	.079	.097	.090	.453	.346	.224	**.948**	*.327*	*.305*	*.481*	*.080*	*.320*	*.308*	*.004*	*.318*
		9. Uncertainty	.302	.082	.147	.155	.298	.282	.192	.300	**.995**	*.220*	*.358*	*.115*	*.261*	*.215*	*.071*	*.237*
		10. Student negotiation	.334	.003	.093	.042	.284	.316	.176	.242	.182	**.892**	*.379*	*.171*	*.373*	*.245*	*.038*	*.247*
		11. Mastery goal structure	.351	.011	-.013	-.001	.417	.226	.146	.415	.319	.302	**.899**	*.060*	*.495*	*.233*	*-.013*	*.396*
		12. Performance-approach goal structure	.062	.076	.108	.069	.068	.108	.096	.050	.107	.129	.025	**.943**	*.192*	*.138*	*.007*	*-.018*
		13. Metacognitive structure	.192	.043	.001	.028	.232	.219	.205	.236	.201	.274	.394	.127	**.863**	*.166*	*.053*	*.227*

Table 6.32 *Continued*

Fixed part of model		Random part of model																
Classifier Variable	Estimates (s.e.)	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		14. Self-efficacy	.476	.345	.512	.294	.507	.530	.376	.276	.207	.202	.193	.125	.103	**.986**	*.048*	*.173*
		15. Test anxiety	.133	.249	.262	.479	.058	.083	.195	-.023	.066	.004	-.043	.002	-.005	.039	**.966**	*-.002*
		16. Critical voice	.191	-.036	-.006	.002	.205	.161	.091	.276	.220	.195	.340	-.029	.155	.153	-.014	**.937**

Note. n = 623 (effective sample size); [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior; [d]Shared control (low) is coded 0; [e]Performance-avoidance goal structure (low) is coded 0. Residual variance estimates (in bold) are on the diagonal with covariance estimates given below the diagonal. Correlation estimates are given above the diagonal in italics. * $p < .05$. ** $p < .01$.

For clarity, the final model is presented over three figures (Figures 6.3 to 6.5). The standardised direct effects path model for the classroom learning environment variables is displayed in Figure 6.3. As hypothesised, the constructivist pedagogical dimensions had significant relations with personal achievement goals and self-regulated learning. Of these dimensions, personal relevance ($\gamma = 0.133$, $p < .01$) and student negotiation ($\gamma = 0.159$, $p < .001$) were significant positive predictors of mastery-approach while uncertainty was a positive predictor of performance-avoidance ($\gamma = 0.141$, $p < .01$). Personal relevance was also a positive predictor of intrinsic value ($\gamma = 0.305$, $p < .001$). There was also some support for the hypothesised relations for the classroom goal and metacognitive structures. Although the mastery goal structure was not a significant predictor of mastery-approach ($\gamma = 0.009$), it had positive relations with intrinsic value ($\gamma = 0.257$, $p < .001$) and negative relations with performance-approach ($\gamma = -0.121$, $p < .001$). Interestingly, the performance-approach goal structure had no significant relations with the performance-related achievement goals. Three of the classroom learning environment variables had significant impact on students' self-regulated learning. Student negotiation was a positive influence on regulatory strategy use ($\gamma = 0.083$, $p < .01$) as was the metacognitive goal structure ($\gamma = 0.139$, $p < .001$). The mastery goal structure was a significant negative predictor of regulatory strategy use ($\gamma = -0.119$, $p < .001$).

The standardised direct effects path model for the motivational belief variables is displayed in Figure 6.4. As hypothesised, intrinsic value was a positive predictor of master-approach ($\beta = 0.578$, $p < .001$); it also had direct negative relations with mastery-avoidance ($\beta = -0.035$) and performance-avoidance ($\beta = -0.103$), although these negative relations were not statistically significant. Self-efficacy was an influential explanatory variable for personal achievement goals and self-regulated learning. Self-efficacy was a significant positive predictor of mastery-avoidance ($\gamma = 0.230$, $p < .001$), performance-approach ($\gamma = 0.400$, $p < .001$), and performance-avoidance ($\gamma = 0.368$, $p < .001$); it had non-significant relations with mastery-approach ($\gamma = 0.051$). Self-efficacy also positively predicted intrinsic value ($\gamma = 0.440$, $p < .001$) and regulatory strategy use ($\gamma = 0.414$, $p < .001$), and was a non-

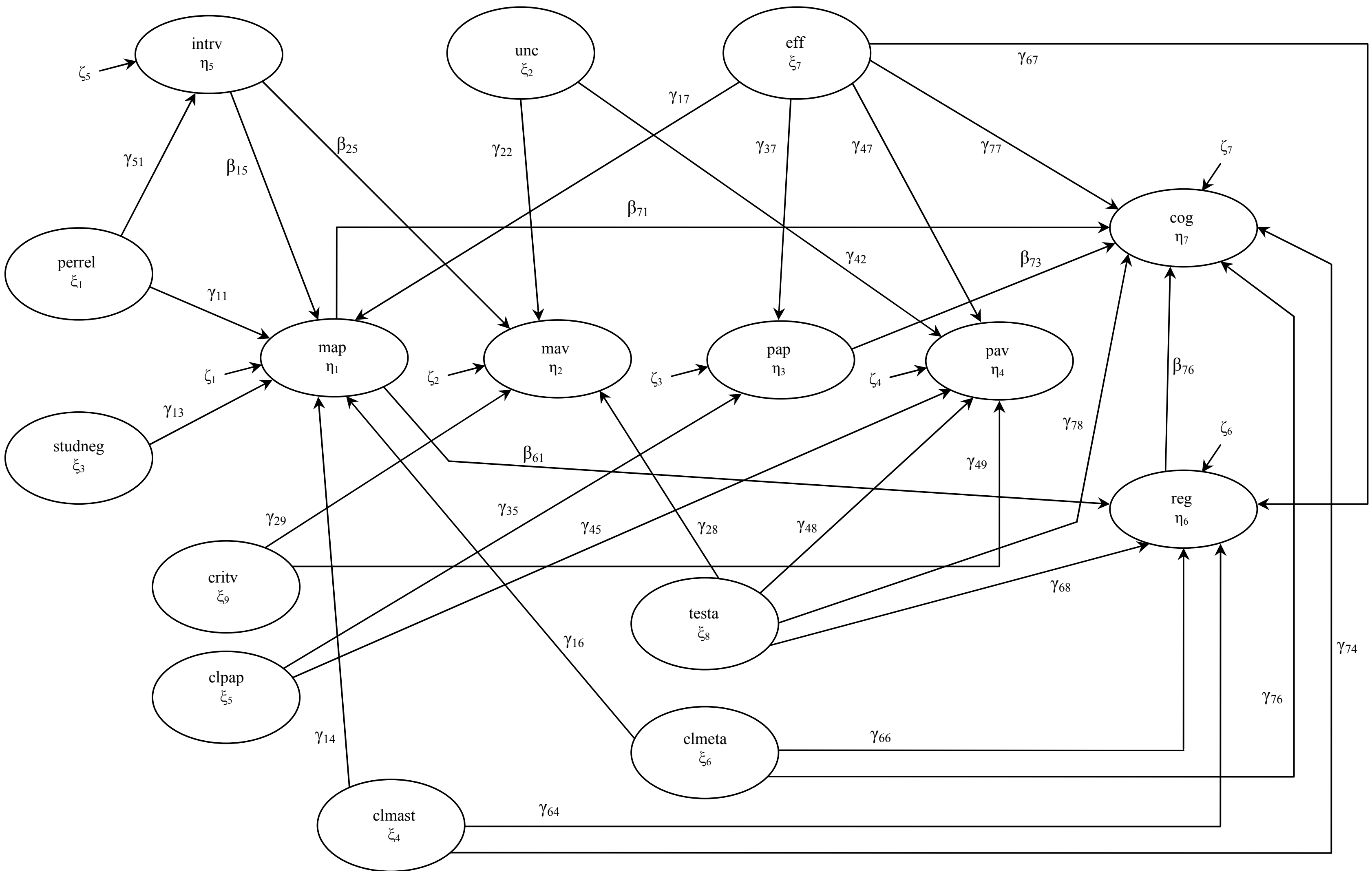

Figure 6.2. Hypothesised self-regulated learning structural equation model. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); student negotiation (studneg); mastery goal structure (clmast); performance-approach goal structure (clpap); metacognitive structure (clmeta); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg).

Table 6.33

Self-Regulated Learning Structural Equation Model Fit Indices (Study 1)

Variable	χ^2	*df*	*p*	GFI	AGFI	NFI	CFI	SRMR	RMSEA
Hypothesised model[a]	593.20	54	.000	.897	.741	.899	.906	.0801	.1260
Revised model[a]	48.17	40	.176	.990	.967	.992	.999	.0156	.0182
Revised model[b]	45.82	40	.244	.991	.969	.949	.992	.0171	.0225

Note. $n = 623$; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; SRMR = standardised root mean square residual; RMSEA = root mean square error of approximation; [a]Maximum likelihood used as the estimation method; [b]Generalised least squares used as the estimation method.

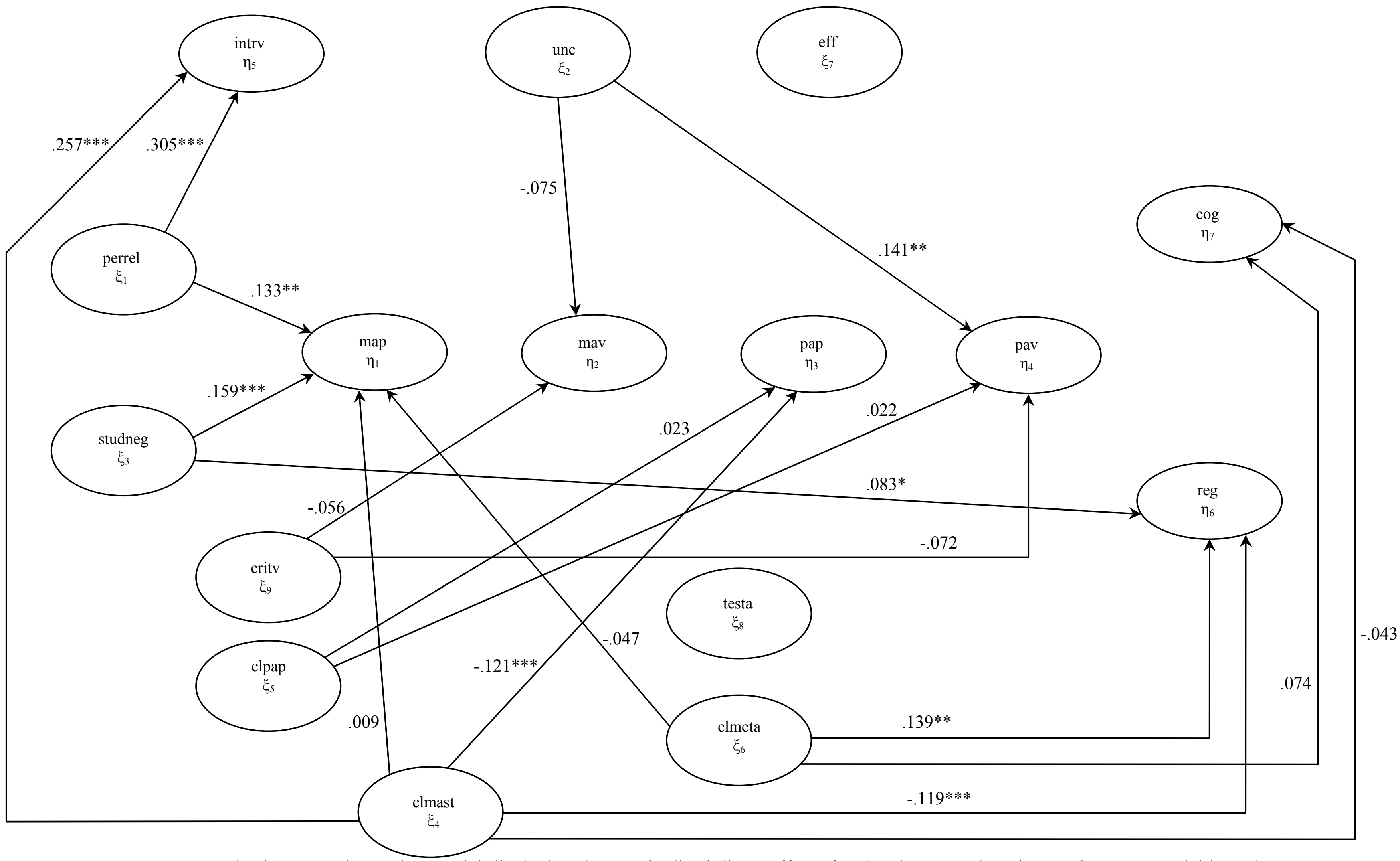

Figure 6.3. Revised structural equation model displaying the standardised direct effects for the classroom learning environment variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); student negotiation (studneg); mastery goal structure (clmast); performance-approach goal structure (clpap); metacognitive structure (clmeta); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

significant negative predictor of cognitive strategy use (γ = -0.061). As expected, test anxiety was a significant positive predictor of performance-avoidance (γ = 0.598, $p < .001$) and had negative relations with mastery-avoidance (γ = -0.122) and performance-approach (γ = -0.062), although these were statistically non-significant. Test anxiety also negatively predicted regulatory strategy use (γ = -0.162, $p < .01$) in contrast to its relation to cognitive strategy use (γ = 0.171, $p < .001$), for which it was a positive predictor.

The standardised direct effects path model for the personal achievement goals and self-regulated learning variables is displayed in Figure 6.5. Regulatory strategy use was positively predicted by mastery-approach (β = 0.422, $p < .001$) and performance-avoidance (β = 0.507, $p < .001$). Negative predictors of regulatory strategy use included mastery-avoidance (β = -0.311, $p < .001$) and performance-approach (β = -0.158, $p < .05$). The only significant predictor of cognitive strategy use was regulatory strategy use (β = 0.878, $p < .001$). The rather large amount of covariance between cognitive and regulatory strategy use indicated that these two variables were highly related. A significant amount of covariance was found to exist between performance-avoidance with the other achievement goals. Performance-avoidance was found to positively predict mastery-approach (β = 0.214, $p < .001$), mastery-avoidance (β = 0.714, $p < .001$) and performance-approach (β = 0.536, $p < .001$). These results indicate that most students endure some form of avoidance with respect to external competence-related issues and this is irrespective of students' other achievement goal orientations. The variances of the endogenous variables explained by the revised model (Figures 6.4 and 6.5) were as follows: mastery-approach (68%), mastery-avoidance (55%) performance-approach (60%), performance-avoidance (53%), intrinsic value (59%), cognitive strategy use (72%), and regulatory strategy use (63%). These totals were considerably more than those obtained using multilevel multiple regression analyses. The standardised direct, indirect and total effects for the revised self-regulated learning structural equation model using maximum likelihood as the estimation method are presented in Table 6.34. Almost identical results were obtained using generalised least squares as the estimation method and these are presented in Table 6.35.

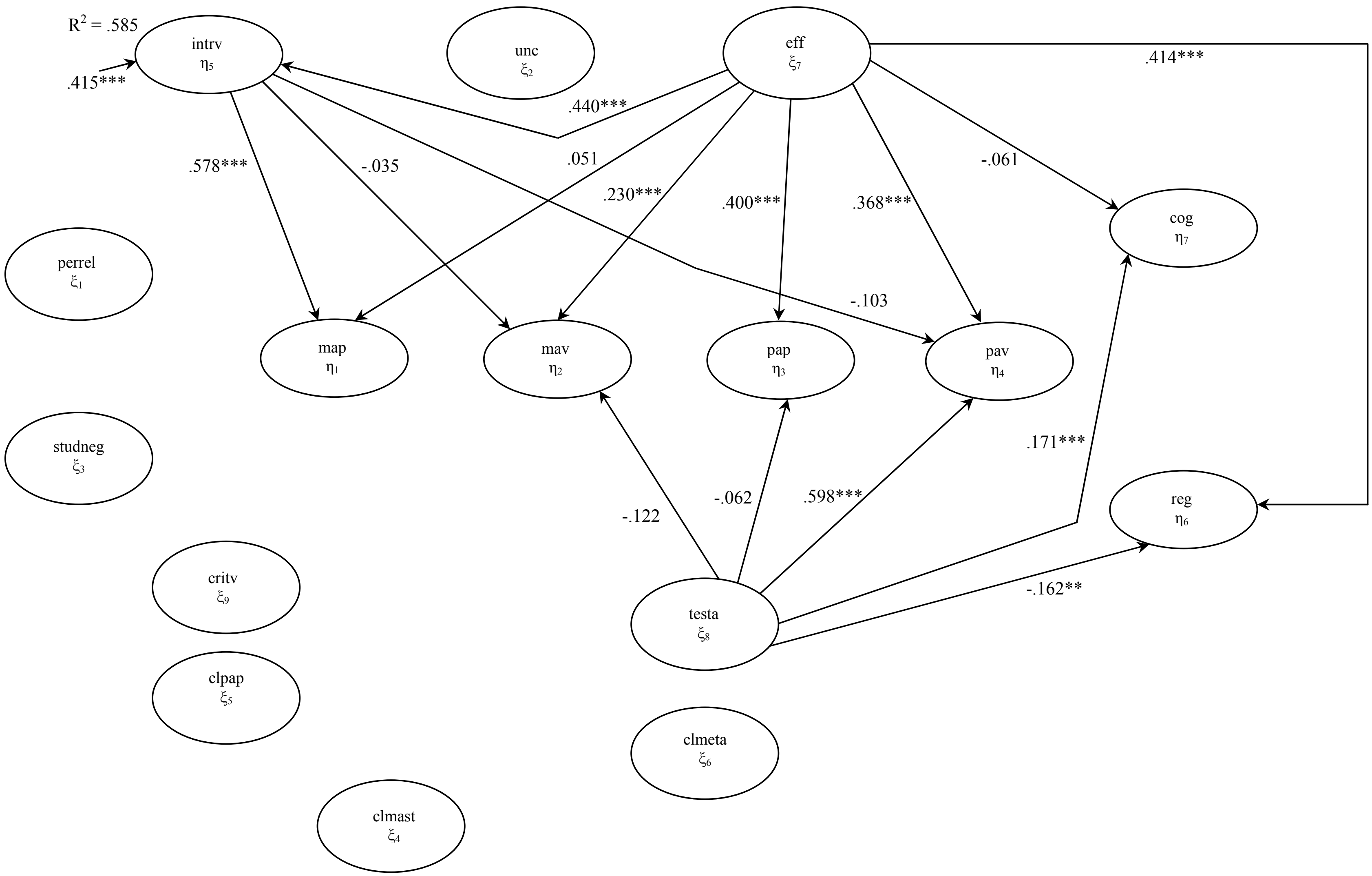

Figure 6.4. Revised structural equation model displaying the standardised direct effects for the motivational belief variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); student negotiation (studneg); mastery goal structure (clmast); performance-approach goal structure (clpap); metacognitive structure (clmeta); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

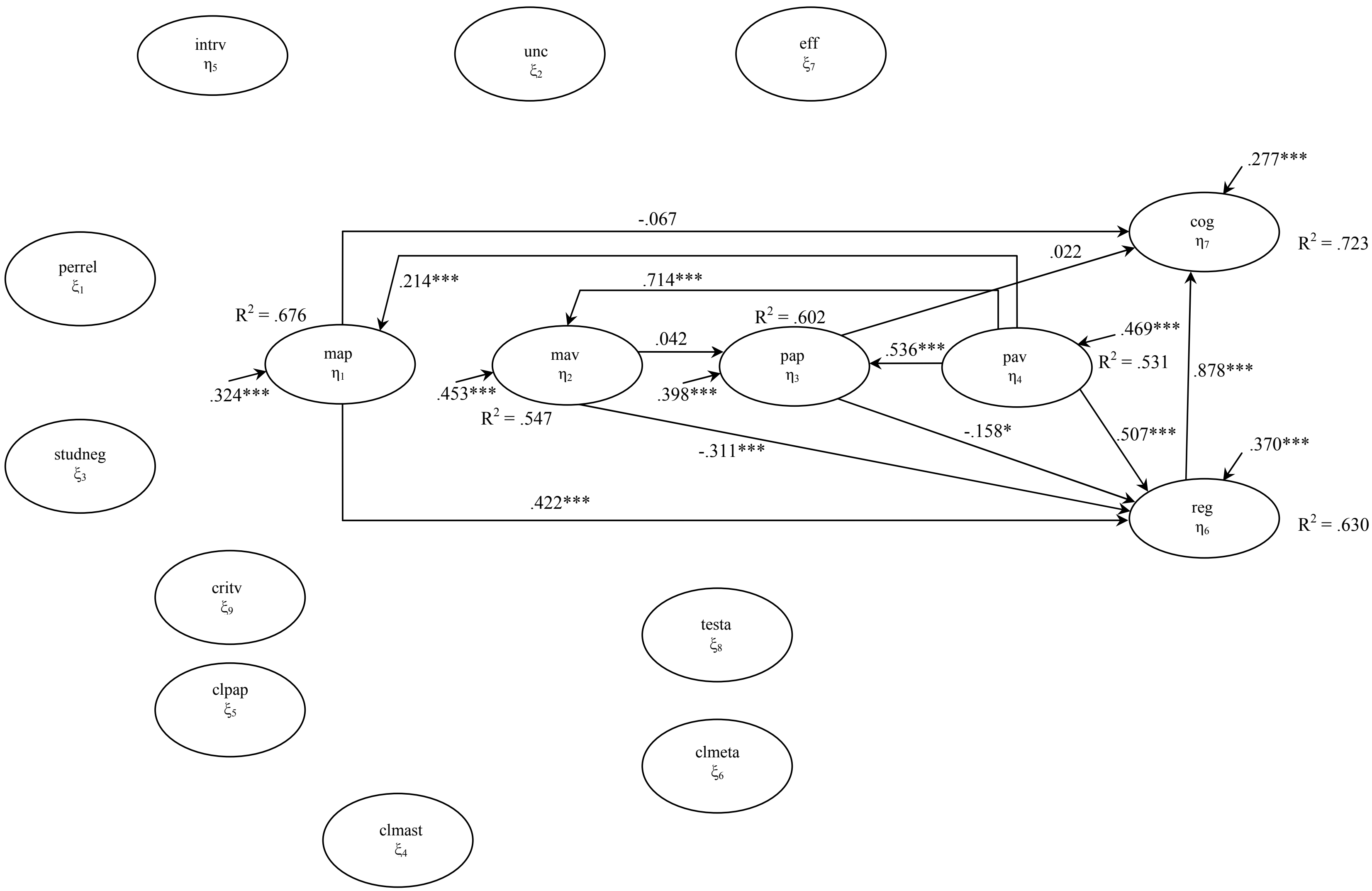

Figure 6.5. Revised structural equation model displaying the standardised direct effects for the personal achievement goals and self-regulated learning variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); student negotiation (studneg); mastery goal structure (clmast); performance-approach goal structure (clpap); metacognitive structure (clmeta); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6.34

Self-Regulated Learning Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Personal relevance on:	Mastery-approach	.133**	.170***	.303***
	Mastery-avoidance	-	-.033	-.033
	Performance-approach	-	-.018	-.018
	Performance-avoidance	-	-.031	-.031
	Intrinsic value	.305***	-	.305***
	Regulatory strategies	-	.125***	.125***
	Cognitive strategies	-	.089***	.089***
Uncertainty on:	Mastery-approach	-	.030*	.030*
	Mastery-avoidance	-.075	.101**	.026
	Performance-approach	-	.077*	.077*
	Performance-avoidance	.141**	-	.141**
	Regulatory strategies	-	.064*	.064*
	Cognitive strategies	-	.056*	.056*
Critical voice on:	Mastery-approach	-	-.016	-.016
	Mastery-avoidance	-.056	-.052	-.108*
	Performance-approach	-	-.043	-.043
	Performance-avoidance	-.072	-	-.072
	Regulatory strategies	-	-.003	-.003
	Cognitive strategies	-	-.002	-.002
Student negotiation on:	Mastery-approach	.159***	-	.159***
	Regulatory strategies	.083*	.067***	.150***
	Cognitive strategies	-	.121***	.121***
Mastery goal structure on:	Mastery-approach	.009	.143***	.152**
	Mastery-avoidance	-	-.028	-.028
	Performance-approach	-.121***	-.015	-.136***
	Performance-avoidance	-	-.026	-.026
	Intrinsic value	.257***	-	.257***
	Regulatory strategies	-.119***	.081**	-.038
	Cognitive strategies	-.043	-.047	-.090
Performance-approach goal structure on:	Mastery-approach	-	.005	.005
	Mastery-avoidance	-	.016	.016
	Performance-approach	.023	.012	.036
	Performance-avoidance	.022	-	.022
	Regulatory strategies	-	.003	.003
	Cognitive strategies	-	.003	.003

Table 6.34 *Continued*

Effect		Direct effect	Indirect effect	Total effects
Metacognitive structure on:	Mastery-approach	-.047	-	-.047
	Regulatory strategies	.139***	-.020	.119**
	Cognitive strategies	.074	.108**	.182***
Self-efficacy on:	Mastery-approach	.051	.324***	.375***
	Mastery-avoidance	.230***	.215***	.445***
	Performance-approach	.400***	.191***	.592***
	Performance-avoidance	.368***	-.045	.323***
	Intrinsic value	.440***	-	.440***
	Regulatory strategies	.414***	.090	.504***
	Cognitive strategies	-.061	.430***	.369***
Test anxiety on:	Mastery-approach	-	.128***	.128***
	Mastery-avoidance	-.122	.427***	.306***
	Performance-approach	-.062	.333***	.271***
	Performance-avoidance	.598***	-	.598***
	Regulatory strategies	-.162**	.219***	.057
	Cognitive strategies	.171***	.048	.218***
Mastery-approach on:	Regulatory strategies	.422***	-	.422***
	Cognitive strategies	-.067	.370***	.303***
Mastery-avoidance on:	Performance-approach	.042	-	.042
	Regulatory strategies	-.311***	-.007	-.317***
	Cognitive strategies	-	-.278***	-.278***
Performance-approach on:	Regulatory strategies	-.158*	-	-.158*
	Cognitive strategies	.022	-.138*	-.116
Performance-avoidance on:	Mastery-approach	.214***	-	.214***
	Mastery-avoidance	.714***	-	.714***
	Performance-approach	.536***	.030	.565***
	Regulatory strategies	.507***	-.221**	.286***
	Cognitive strategies	-	.249***	.249***
Intrinsic value on:	Mastery-approach	.578***	-.022	.556***
	Mastery-avoidance	-.035	-.073	-.108
	Performance-approach	-	-.060	-.060
	Performance-avoidance	-.103	-	-.103
	Regulatory strategies	-	.225***	.225***
	Cognitive strategies	-	.159***	.159***
Regulatory strategies on:	Cognitive strategies	.878***	-	.878***

Note. n = 623 (effective sample size); [a]Maximum likelihood used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6.35

Self-Regulated Learning Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Personal relevance on:	Mastery-approach	.145**	.174***	.318***
	Mastery-avoidance	-	-.031	-.031
	Performance-approach	-	-.020	-.020
	Performance-avoidance	-	-.033	-.033
	Intrinsic value	.311***	-	.311***
	Regulatory strategies	-	.131***	.131***
	Cognitive strategies	-	.096***	.096***
Uncertainty on:	Mastery-approach	-	.033**	.033**
	Mastery-avoidance	-.078	.109**	.032
	Performance-approach	-	.085**	.085**
	Performance-avoidance	.152**	-	.152**
	Regulatory strategies	-	.068*	.068*
	Cognitive strategies	-	.061*	.061*
Critical voice on:	Mastery-approach	-	-.016	-.016
	Mastery-avoidance	-.060	-.054	-.114*
	Performance-approach	-	-.047	-.047
	Performance-avoidance	-.075	-	-.075
	Regulatory strategies	-	-.003	-.003
	Cognitive strategies	-	-.003	-.003
Student negotiation on:	Mastery-approach	.164***	-	.164***
	Regulatory strategies	.074	.070***	.143***
	Cognitive strategies	-	.118***	.118***
Mastery goal structure on:	Mastery-approach	.003	.144***	.141**
	Mastery-avoidance	-	-.025	-.025
	Performance-approach	-.121***	-.016	-.138***
	Performance-avoidance	-	-.027	-.027
	Intrinsic value	.257***	-	.257***
	Regulatory strategies	-.118**	.075**	-.042
	Cognitive strategies	-.039	-.051	-.090
Performance-approach goal structure on:	Mastery-approach	-	.004	.004
	Mastery-avoidance	-	.013	.013
	Performance-approach	.025	.010	.036
	Performance-avoidance	.018	-	.018
	Regulatory strategies	-	.001	.001
	Cognitive strategies	-	.002	.002

Table 6.35 *Continued*

Effect		Direct effect	Indirect effect	Total effects
Metacognitive structure on:	Mastery-approach	-.051	-	-.051
	Regulatory strategies	.142***	-.022	.120**
	Cognitive strategies	.065	.112**	.177***
Self-efficacy on:	Mastery-approach	.042	.331***	.373***
	Mastery-avoidance	.226***	.222***	.448***
	Performance-approach	.393***	.199***	.592***
	Performance-avoidance	.371***	-.047	.324***
	Intrinsic value	.447***	-	.447***
	Regulatory strategies	.421***	.091	.511***
	Cognitive strategies	-.080	.452***	.373***
Test anxiety on:	Mastery-approach	-	.131***	.131***
	Mastery-avoidance	-.119	.433***	.314***
	Performance-approach	-.078	.346***	.268***
	Performance-avoidance	.604***	-	.604***
	Regulatory strategies	-.169**	.221***	.052
	Cognitive strategies	.169***	.045	.214***
Mastery-approach on:	Regulatory strategies	.424***	-	.424***
	Cognitive strategies	-.069	.382***	.314***
Mastery-avoidance on:	Performance-approach	.050	-	.050
	Regulatory strategies	-.305***	-.008	-.313***
	Cognitive strategies	-	-.281***	-.281***
Performance-approach on:	Regulatory strategies	-.158*	-	-.158*
	Cognitive strategies	.027	-.142*	-.115
Performance-avoidance on:	Mastery-approach	.218***	-	.218***
	Mastery-avoidance	.717***	-	.717***
	Performance-approach	.547***	.036	.583***
	Regulatory strategies	.503***	-.219*	.284***
	Cognitive strategies	-	.258***	.258***
Intrinsic value on:	Mastery-approach	.582***	-.023	.559***
	Mastery-avoidance	-.023	-.076	-.099
	Performance-approach	-	-.063	-.063
	Performance-avoidance	-.106	-	-.106
	Regulatory strategies	-	.224***	.224***
	Cognitive strategies	-	.162***	.162***
Regulatory strategies on:	Cognitive strategies	.903***	-	.903***

Note. n = 623 (effective sample size); [a]Generalised least squares used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

6.4 DISCUSSION

This study contributed to research addressed by the fields of constructivist pedagogy, achievement motivation and self-regulated learning in two ways. Firstly, the present research adopted a multidisciplinary approach in studying the interactions of the constructs associated with each field in the context of the high school science classroom. By incorporating students' perceptions of the constructivist pedagogical nature of their science classroom with achievement goal theory, motivational belief and self-regulated learning constructs, the present study attempted to extend the understanding of the nature of teaching and learning in the high school science classroom from an integrated social cognitive perspective. A second contribution to the fields was studying these relations in two distinct high school subpopulations based on global ability within a large state education system. That is, these multidisciplinary relations were examined for regular high school and selective high school students. It was proposed that students belonging to these two school subpopulations may differ in terms of the associations between their personal achievement goals and self-regulated learning along with the type of learning environment they experience.

Besides examining these associations, of prime importance was establishing if high school science students could identify with several constructs that prior research involving both secondary school and university students has shown to be particularly useful in studying constructivist pedagogy, achievement goals, motivational beliefs and self-regulated learning. All of the constructs affiliated with constructivist pedagogy, achievement goals, motivational beliefs and self-regulated learning were identified by the students involved in Study 1 thus showing the validity of addressing these constructs in terms of how they interact towards influencing students' learning of science. A most noteworthy result was the existence of the mastery-avoidance goal, a construct that has barely received attention and when it has been a focus of study the subjects have been university students (Elliot & McGregor, 2001; Karabenick, 2004). Although high school students have identified the performance-avoidance goal in prior research (Church et al., 2001; Elliot & Church, 1997; Middleton & Midgley, 1997; Wolters, 2004), these studies did not involve the mastery-avoidance goal. The results of this study lend credence to the theory of Elliot (Elliot, 1999; Elliot & McGregor, 2001) and Pintrich (Pintrich, 2000a, 2000b), who have both proposed the existence of approach-avoidance dimensions for mastery and performance achievement goals. Two other studies (Elliot & McGregor, 2001; Karabenick, 2004) have used a 2 X 2 goals framework thereby incorporating both mastery-avoidance and performance-avoidance goals; however, how these studies validated the mastery-avoidance construct is questionable. Karabenick (2004) did not report using factor analysis to identify the achievement goals in his study, while Elliot and McGregor (2001) used principal components to identify the goal constructs. Principal components, which has been the traditional "exploratory factor" analysis method used for the constructs investigated, uses both the shared and unique variance thus limiting the accuracy of the latent variables' structure (Costello & Osborne, 2005; Reise et al., 2000). The present study used principal axis factoring in an "exploratory sense" on the basis that it uses only the shared variance of the items for a factor, not the unique variance and error. The present study then used confirmatory factor analysis to verify a four-goal model. Moreover, the studies of Elliot and McGregor (2001) and Karabenick (2004) involved university students, for which perhaps performance-related issues are more salient as compared with high school science students. It is important to note that the sample of students used in the present research were in years 9 and 11, years that do not involve significant milestone high school achievements.

Another construct validity issue related to high school students' differentiation between the perceptions of ability and self-efficacy. Although it was hypothesised that students would be able to distinguish between these two, the present study found this was not the case with the items associated with both mastery-related (self-efficacy) and performance-related (ability perceptions) competence perceptions loading onto the one factor, which was labelled as "self-efficacy". One reason for this result could be that students find it difficult to distinguish competence perceptions when asked at the trait level, as in the case of the present research, and thus refer to general, historical experiences which have, in the main, external-based referents. Hence there is some convergence in terms of students interpreting their peer-referenced ability and their self-efficacy. There is some theory regarding competence perceptions as having an historical basis (Elliot, 1999). This aspect will be addressed in Study 3 (Chapters 8 to 12), which examines these perceptions at a context-level.

Two statistical procedures were employed to analyse the structural relations amongst the data, multilevel multiple regression and structural equation modelling. The multilevel multiple regression analyses revealed that only one classroom learning environment variable - mastery goal structure - had a substantial large amount of variance attributable to the classroom level (39.3%); the remaining classroom environment variables had relatively modest amounts of variance attributed to the classroom-level (3.7 to 16%). The personal-based constructs, as expected, had negligible variance attributed to the classroom-level. Similar results have been found by others in terms of the effects of constructivist pedagogical dimensions (Aldridge et al., 2000) and achievement goals (Anderman & Young, 1994; Ee et al., 2003; Wolters, 2004) at the class-level. Although there is a slightly greater degree of convergence regarding the type of environmental dimensions experienced as compared to those that are personally situated, the preponderance of variance for most of the constructs investigated in the present research occurred at the personal-level. This result implies that students' perception of their classroom learning environment varies on the basis of personal-based factors. Consequently, this supports the ethos of the present research, which contends that the motivational, affective and self-regulated aspects of students' learning are important influences upon students in classrooms. As such, studies that focus on the impact of the learning environment should be interdisciplinary in nature also considering the social cognitive aspects of students' existence in the classroom. It must be kept in mind, however, that a small number of classroom-level units (38 classrooms in total) were studied in the present research. Future larger scale classroom studies should examine if these results also occur in order to ascertain the importance of personal-based factors in students' perceptions of their classroom learning environment and hence the impact of the teacher and teaching methodology upon students' learning.

The following two questions concerning the interactions of constructivist pedagogy, achievement goals, motivational beliefs and self-regulated learning were addressed by Study 1:

> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?

> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

For Research Question Three, the first focus of discussion concerns the results attained for the associations between the environmental and personal predictors of achievement goals. As hypothesised, the constructivist pedagogy dimensions of personal relevance and student negotiation were positive predictors of mastery-approach goals for high school science students. These results are of more significance when considering they were attained after controlling for the impact of the more established teacher-influenced environmental variables of achievement goal structures and the metacognitive goal structure. Thus, students who perceive their science classroom as having an emphasis on making science relevant to them and fostering the negotiation of their understanding will tend to adopt mastery-approach goals. It should be kept in mind that this study was correlational in nature and any causal paths discussed are inferred only. To prove causality, experimental-based or longitudinal studies need to be conducted. For example, although the personal relevance and student negotiation features of the science classroom are presented as significant environmental predictors of the mastery-approach goal in the present research findings it could well be that students who report higher mastery-approach goal orientations perceive their classroom as higher in personal relevance and student negotiation than students who report lower mastery-approach goal orientations. Nevertheless, the results show the importance of these two constructivist pedagogical features for the adoption of mastery-approach goals. This has implications towards the generalisability of these findings: science teachers will take a step towards procuring mastery-approach goals in their students if they place an emphasis on personal relevance and the student negotiation of learning.

Contrary to that hypothesised the mastery goal structure and the classroom metacognitive structure did not significantly associate directly with the mastery-approach goal in both the multiple regression and structural equation model analyses. The inclusion of the constructivist pedagogy dimensions and the motivational beliefs of intrinsic value, self-efficacy and test anxiety may have nullified the direct impact of the mastery goal structure, which has been traditionally considered as the main learning environment influence on the mastery-approach goal of students, upon mastery-approach. Previous research has found that students who perceived their teachers as emphasising mastery-related approaches to learning report this approach to have a positive influence on their adoption of mastery-approach goals (Ee et al., 2003; Kaplan et al., 2002; Midgley & Urdan, 2001; Urdan, 2004; Wolters, 2004). Of course this body of research did not investigate the impact of constructivist pedagogical dimensions and motivational beliefs on mastery-approach goals. The results of the present research found that the motivational belief of intrinsic value may have mediated the impact of the mastery goal structure on students' mastery-approach, with both paths having positive relations. Hence students' intrinsic value will increase with an increase in the classroom's mastery goal structure; an increase in intrinsic value, in turn, increases the mastery-approach of science students. This result indicates that the high school science teacher who actively creates an environment with a focus upon students' learning may have an indirect positive influence upon student's mastery-approach goals.

Of the personal factors, intrinsic value was a highly significant direct positive predictor of the mastery-approach goal, although as described above it may have mediated the relations between mastery goal structure and mastery-approach. This result was expected at the personal level since according to the hierarchical model of achievement goals (Elliot, 1999; Elliot & Church, 1997; Elliot & Harackiewicz, 1996; Elliot & McGregor, 2001) mastery-approach is associated with the need to achieve in learning and this would stem from having some form of intrinsic value associated with the task or learning experience. Indeed, this finding has implications for constructivist approaches to science learning in that an emphasis on personal relevance by the teacher may be of use in fostering greater intrinsic value in students and hence a mastery-approach to learning; this view is supported by the positive relations between personal relevance and intrinsic value in the structural equation model (Figure 6.3). Prior research has shown self-efficacy to be a positive predictor of mastery-approach goals (Kaplan & Maehr, 1999; Kaplan & Midgley, 1999; Middleton et al., 2004; Middleton, & Midgley, 1997; Patrick et al., 1999; Roeser et al., 1996; Skaalvik, 1997), however, in the present research this was the case only in the regression analyses. According to the 2 X 2 achievement goals model of Elliot and colleagues (e.g., Elliot & McGregor, 2001), efficacious students tend to persist with tasks since they believe that they are capable of accomplishing the task. Furthermore, the relationship between self-efficacy and mastery is volitional in nature, with students developing greater efficacy as they achieve mastery of the task (Schunk, 1990, 1996; Schunk & Ertmer, 1999). This theory may not apply to students who are already highly efficacious, such as the selective students who made up 41% of the sample, with respect to their task mastery skills. Perhaps also the mastery-approach goal of high school science students is more dependent on the intrinsic value of the task rather than on the level of process-type skills and efficacy they perceive they have. The regression analyses also found text anxiety to have positive relations with mastery-approach; however, this relationship was not echoed in the SEM analyses, with test anxiety being a highly significant positive predictor of performance-avoidance. Indeed, test anxiety and self-efficacy had positive relations with all the personal achievement goals in the regression analyses. A positive relationship was also found between performance-avoidance and mastery-approach goals using SEM. The relationship between performance-avoidance and mastery-approach was, although significant, small ($\beta = 0.214$, $p < .001$) compared with the relations between performance-avoidance and the other achievement goals: mastery-avoidance ($\beta = 0.714$, $p < .001$) and performance-approach ($\beta = 0.536$, $p < .001$). This result could be explained by high school students being almost as concerned about their own learning accomplishment as they are about their fear of failing in front of others and these two concerns are somewhat related, albeit distally. Concerns about failing to learn and failing to perform in the science classroom would be expected to be more closely related than concerns about achieving learning and fear of failing and thereby explains why the beta estimate for performance-avoidance and mastery-avoidance is higher than that obtained for performance-avoidance with mastery-approach. Similarly, the relations between the need to perform normatively and fear of failing would be expected to be more proximal than achieving learning and fear of failing and thus the beta estimate for performance-avoidance and performance-approach is higher than for performance-avoidance with mastery-approach. For example, according to the hierarchical theory on achievement goals of Elliot and his colleagues (Church et al., 2001; Elliot, 1999; Elliot & Church, 1997; Elliot & McGregor, 2001), the performance-approach goal has the need for both achieving and not failing.

For mastery-avoidance, the critical voice dimension was the only environmental factor to have a significant impact; however, this result only occurred in the regression analyses. As hypothesised, critical voice was a negative predictor of mastery-avoidance. Students that experience science classrooms in which they are able to make critical comments about their learning would be expected to have greater control in their learning accomplishments and thus alleviate their learning failures; this in turn reduces their mastery-avoidance tendencies. However, the results of the SEM analyses indicated that only self-efficacy and performance-avoidance were significant positive predictors of mastery-avoidance. These results support the prevailing theory on mastery-avoidance goals which suggests that such goals are related to students that have high expectations towards their learning goals (Elliot, 1999; Elliot & McGregor, 2001; Pintrich, 2000a). It would be expected that such students would have high feelings of self-efficacy and therefore have high levels of personal learning expectations.

Of the classroom environmental factors associated with performance-approach goals, both forms of analyses found the mastery goal structure to be a negative predictor. Thus, an emphasis on learning by the teacher reduces the performance-approach tendencies of high school science students. Contrary to the hypotheses, none of the other classroom goal structures significantly predicted the performance-approach goals. Although there is research showing that a classroom emphasis on performance encourages performance-approach and avoidance goals (Midgley & Urdan, 2001; Wolters, 2004), there is also research that has found inconsistent relations between performance goal structures and personal performance goals. For example, Anderman and Midgley (1997) found only grade 6 females' performance achievement goals to increase with perceptions of increases in performance goal structure. Young's (1997) study showed only positive relations between performance goal structure and performance-approach goals for English classes and not for math classes. Nolen (2003) found no relations between an ability-meritocracy goal structure (similar to performance-approach goal structure) toward the personal performance-approach goal for ninth-grade high school science students. In the present research, the performance-goal structure had no bearing upon student's personal goals. Research has shown, in the main, that mastery-approach goals are more sensitive to the influence of classroom goal structures than performance-based goals (Anderman & Midgley, 1997; Ee et al., 2003; Nolen, 2003; Urdan & Midgley, 2003; Young, 1997). This finding was weakly supported in the present research, with only the mastery-approach goal affected by more than one of the students' perceptions of the classroom learning environment features, namely the constructivist pedagogy dimensions of personal relevance and student negotiation. Apart from the mastery goal structure being a negative predictor of performance-approach goals, the traditional classroom features of mastery goal and performance goal structures did not associate with personal goals after controlling for the effects of the constructivist pedagogy dimensions amongst other variables. Thus, it seems that constructivist pedagogy is a considerable influence upon the personal mastery-approach goals of high school science students. As hypothesised, self-efficacy was a positive predictor of performance-approach goals. This is to be expected, for students who are more efficacious would more likely pursue performance-associated goals.

Of the environmental predictors, only uncertainty was found in the regression analyses to positively predict performance-avoidance; this relationship was also significant in the SEM analyses. This result is puzzling since the uncertainty construct measures students' perceptions of their classroom in respect to the nature of science and was hypothesised to have null relations with the performance-based goals. As for mastery-avoidance and performance-approach, the personal factors of self-efficacy and test anxiety were both positive predictors of performance-avoidance in the SEM analyses. Having test anxiety as a positive predictor of performance-avoidance is expected as this achievement goal is grounded in concerns with failing (Elliot, 1999). The self-efficacy finding is at odds with other research which has found negative relations between self-efficacy and performance-avoidance goals (Middleton & Midgley, 1997; Skaalvik, 1997) and between perceived ability and performance-avoidance goals (Church et al., 2001; Elliot & Church, 1997; Pajares et al., 2000). It is expected that students who are highly efficacious or have high ability perceptions would tend not to avoid performance-based endeavours in the classroom. This aspect will be discussed later under the proposal of a "concern" hypothesis, which the present research has postulated to describe some of the results involving the performance-avoidance goal.

The second focus of discussion regarding Research Question Three concerns the results attained for the associations between the environmental and personal predictors of self-regulated learning for high school science students, namely the use of cognitive and regulatory strategies. One limitation of the self-regulated learning items used in the present research concerns the amount of out-of-class references the items contain. After factor analysis and confirmatory factor analysis, the items representing both cognitive and regulatory strategies from the Motivated Strategies for Learning Questionnaire tended to focus on students' studying habits out of class ("When studying for a test I try to remember as many facts as I can") rather than their in-class self-regulated learning. This limitation is addressed in Study 4, in which students are asked to report on their self-regulated learning within specified learning contexts. Thus, students' use of cognitive and regulatory strategies may have limited valid relations with classroom environmental parameters such as student negotiation and mastery goal structure and thus may cause invalid relations to occur between classroom-associated variables and self-regulated learning. For example, in both the regression and SEM analyses, the mastery goal structure was a negative predictor of regulatory strategy use, which is contrary to that hypothesised. Despite these limitations, there was substantial support for the hypothesised positive influence of the metacognitive goal structure upon students' reporting of their self-regulated learning. The metacognitive goal structure was a significant positive predictor of regulatory strategy use in both the regression and SEM analyses; and, it was a positive predictor of cognitive strategy use, but only in the regression analyses. Although the regression analyses showed the constructivist pedagogical dimension of student negotiation to have a positive relationship with regulatory strategy use, as hypothesised, this result was not supported in the SEM.

The study found several personal factors to influence self-regulated learning. As hypothesised, there were positive associations between mastery-approach and regulatory strategy use in both forms of analyses. These results support the normative goal model, which contends that a mastery goal orientation fosters the use of self-regulatory strategies such as monitoring with respect to one's internal standards and regulating progress in attempting to find effective strategies that bring about learning and understanding (Pintrich, 2000a). These results also support prior research regarding the positive associations of mastery-approach with self-regulated learning using regression analyses (Ablard & Lipschultz, 1998; Ee et al., 2003; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Pajares et al., 2000; Patrick et al., 1999; Turner et al., 1998; Wolters, 2004; Wolters et al., 1996) and using SEM analyses (Bandalos et al., 2003; Greene et al., 2004; Meece et al., 1988; Niemivirta, 1997; Valle et al., 2003).

This study was one of the first to investigate the consequences of the mastery-avoidance goal in terms of self-regulated learning. The results obtained show that mastery-avoidance has some negative effects towards the use of self-regulated learning, with negative associations between mastery-avoidance and regulatory strategy use obtained for the regression and SEM analyses. According to Elliot's & McGregor's (2001) seminal work on mastery-avoidance, mastery-avoidance is associated with disorganisation, test anxiety, worry, and emotionality issues. This study supplements that work in finding that students who tend towards mastery-avoidance also report themselves as using less self-regulated learning in terms of regulatory strategy use. Hence there is some support here for the negative connotations of internal-referenced avoidance tendency.

On the basis of previous research, it was hypothesised that performance-approach goals would have null relations with self-regulated learning (Bandalos et al., 2003; Ee et al., 2003; Elliot & McGregor, 2001; Elliot et al., 1999; Ford et al., 1998; Greene & Miller, 1996; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Neber & Schommer-Aikins, 2002; Niemivirta, 1997; Pajares et al, 2000; Turner et al., 1998; Wolters, 2004). However, the SEM analyses used in the present research found performance-approach to be a negative predictor of regulatory strategy use. Hence students who report they pursue ability or external standards in the classroom tended to report they use less regulatory strategies. This result may be partly explained by examining the intent of the items used for the regulatory strategy use and performance-approach constructs. The performance-approach goal items reflected the within-class-time aspirations of students ("I am trying to show that I have better ability than others in this class") and are more ecologically attuned to performance-related issues within the classroom. In contrast, those items used to represent regulatory strategy use tended to reflect out-of-class experiences. Consequently, the regulatory strategy use items are indicative of metacognitive learning approaches students associate with outside the classroom rather than demonstrations of normative competence within the classroom. Nevertheless, this result supports the traditional achievement goals theory which contends that performance-based motivation is associated with negative patterns of learning processes such as surface processing. According to traditional goals theory, performance-focused students make judgements about their progress that are mediated by perceptions of effort and ability and utilising surface processing approaches to learning require minimal amounts of effort (Ames & Archer, 1988; Dweck & Elliott, 1983; Dweck & Leggett, 1988; Elliott & Dweck, 1988). As a consequence of this theory, adoption of a performance goal construes negative learning processes such as adopting superficial learning strategies since these require minimisation of effort and therefore ability-based perceptions of competence are not threatened. On the other hand, according to this theory, mastery goal-focused students attribute failure not to ability but to effort; they simply increase their effort in the face of failure. In other words, there was no support for the adaptive nature of the performance-approach goal in the present research.

Although performance-avoidance was hypothesised as having null relations with self-regulated learning, the present study found it to be a positive predictor of regulatory strategy use in the regression and SEM analyses. Performance-avoidance was also found to have positive associations with cognitive strategy use but only in the regression analyses. Similar to that described above for performance-approach goals, the intent of the performance-avoidance items was classroom-situated rather than at a generic, trait-level outside-classroom-reference, which is what the bulk of the regulatory strategy use items were based upon. Future studies would need to consider this important distinction when examining the relations between achievement goals and self-regulated learning. In consideration of the results found in the present research, it seems that the performance–avoidance goal represented the fear of failing, as expected from Elliot's (1999) hierarchical theory of achievement goals and as already described above. The fear of failing, however, in terms of failing to meet external or normative standards of acceptance, as divorced from the fear of failing one's own set of internally set standards of competence (mastery-avoidance), had some adaptive qualities associated with it. In the current case, it was found that performance-avoidance had positive associations with regulatory strategy use, mastery-approach and cognitive strategy use; the latter only the regression analyses. These results indicate that the fear of failing with respect to external standards may be a motivational stimulus for students to self-regulate adaptively outside the classroom - students will avoid failing if they prepare for class. The results also reflect that the fear of failing is orthogonal with respect to the other personal achievement goals. That is, the fear of failing is an orientation affiliated with the concern of failing to meet external competence expectations and this orientation may be coupled with other classroom learning environment concerns such as the concerns of accomplishing learning and achieving performance-based outcomes as alluded to above. Thus, students may have high orientations in all these types of concerns. Indeed the results of the present research have spawned a form of "concern" hypothesis in that the concern of students may be an important antecedent of achievement goals. Students that are concerned about their learning, concerned about their performance and concerned about failing to perform in exams may report to have high achievement goal orientations in mastery-approach, performance-approach and performance-avoidance respectively; those who are not concerned about these matters will tend to report low achievement goal orientations. This model explains the various associations found in the present research amongst the achievement goals and their consequences.

The regression analyses examined the impact of multiple goals on self-regulated learning by way of a variable-centred approach, in which the interactions amongst the achievement goals were assessed for their impact upon cognitive and regulatory strategy use. Just one of these interactions reached significance in the regression analyses: the performance-approach X performance-avoidance goal interaction had negative relations with cognitive strategy use. Simple slope analysis of this interaction showed two main interpretations of this interaction. Firstly, students classified as having high performance-avoidance reported a greater use of cognitive strategies than those classified as low performance-avoidance; this result supporting the "concern" hypothesis model described above. Secondly, there was evidence of the adaptiveness of performance-approach goals with students having low performance-avoidance reporting an increase in the use of cognitive strategies when their performance-approach goals increased. This increase was significantly different to that experienced by students classified as high in performance-avoidance when their performance-approach goals increased. Hence for students that are not concerned about the fear of failing in a performance sense an increase in performance-approach goals spurs them to use cognitive strategies to accomplish their competitive goals. This is not the same for students that have a high fear of failing (high performance-avoidance). For these students, an increase in performance-approach may result in more risk taking and thus greater risk of losing face should failure occur.

There was support for the hypothesised relations between the motivational beliefs and the use of self-regulated learning strategies. Only in the regression analyses was intrinsic value found to be a positive predictor of cognitive strategy use thus implying that students who value the subject will tend to employ the adaptive self-regulated learning strategies associated with rehearsal, organising and elaboration. Similar relations where found for intrinsic value and regulatory strategy use, strategies that are metacognitive in nature, requiring the monitoring and control of learning, the second parameter of self-regulated learning addressed in the present research. As hypothesised, high school science students reported that the use of these strategies was positively influenced by feelings of efficacy. This is in accord with theories of SRL which contend that efficacious students tend to utilise self-regulatory learning mechanisms such as metacognitive and cognitive strategies (Skunk & Ertmer, 1999; Zimmerman, 1989a) and with other research that has found self-efficacy to positively predict the use of regulatory strategies (Ames & Archer, 1988; Kaplan & Midgley, 1997; Neber & Schommer-Aikins, 2002; Wolters & Pintrich, 1998). Students that are efficacious have confidence in their ability and tend to persist in the face of difficulty, believing in effort attributions to success. The positive association between self-efficacy and regulatory strategy use was significant in the regression and SEM analyses thus indicating the consistency in such relations. Test anxiety was found to be a negative predictor of regulatory strategy use, as hypothesised, and a positive predictor of cognitive strategy use in the SEM, a result contrary to that hypothesised. These results, however, support those obtained by Wolters and Pintrich (1998), who found students who reported higher levels of test anxiety to maintain their use of cognitive strategies but use less metacognitive strategies (regulatory) than students who were less anxious. According to theory, more anxious students have a pronounced evaluative mindset and a focus on the negative consequences such that the student's application is hampered and thereby employ the use of lower order cognitive strategies over the more involved regulatory strategies (Elliot & Church, 1997; Middleton & Midgley, 1997; Turner et al., 1998).

Study 1 also addressed Research Question Five:

> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

The first focus of discussion for Research Question Five concerns the relations between the subpopulation variables of gender, student age and student type for the personal achievement goals. These relations were examined only using the multilevel multiple regression analyses. These analyses showed, in contrast to that hypothesised, there were no differences between juniors and seniors in terms of personal achievement goals and self-reported self-regulated learning. Indeed, there were no differences obtained amongst the subpopulation variables for the reporting of mastery-approach goals. However, there were two significant gender effects discovered. Males reported to have greater mastery-avoidance and performance-approach than females. The latter result consolidates prior research that shows males to be more performance-orientated than females (Anderman & Young, 1994; Anderman & Midgley, 1997; Bråten & Strømsø, 2004; Cavallo et al., 2004; Church et al., 2001; Middleton & Midgley, 1997; Midgley & Urdan, 1995; Pajares et al., 2000; Roeser et al., 1996; Thorkildsen, & Nicholls, 1998; Urdan, 1997; Young, 1997). These results support the contention of Patrick et al. (1999) who describe males as being more concerned about their social status and academic image than females and subsequently may have higher performance-approach aspirations. No gender effects occurred for performance-avoidance goals thus supporting what most studies have found. Although it was hypothesised that selective high school students would have greater mastery-avoidance than regular students, this was not the case in the present research. Instead, selective students were found to have greater performance-avoidance than regular students. This finding also supports the "concern" hypothesis model described above in that selective students would be expected to have a greater concern about their classroom performance than their regular counterparts and this concern about the fear of failing may be a motivational stimulus for self-regulated learning efforts outside the class room or indeed may cause these students to be more cautious than regular students in their learning during class work.

This theory is supported by considering the second focus of discussion for Research Question Five which concerns the relations between the subpopulation variables of gender, student age and student type for cognitive and regulatory strategy use. As hypothesised, selective students reported to use more self-regulated learning than regular students. These results support the limited prior research examining differences between regular and gifted (selective) students in terms of self-regulated learning (Ablard & Lipschultz, 1998; Zimmerman & Martinez-Pons, 1990). Given that the focus of the self-regulated learning items used in the present research emphasised outside-classroom contexts, with a "concern" hypothesis, it would be expected that students who have a high performance-avoidance in the classroom may be expected to deal with this fear of failing in class by preparing outside the class. Such is the case reported by the selective students in this sample. Although no gender differences were expected for self-regulated learning, significant gender effects were found for cognitive and regulatory strategy use with females reporting to use a greater amount of self-regulated learning strategies than males; this result supporting prior research findings (Ablard & Lipschultz, 1998; Joo et al., 2000; Pokay & Blumenfeld, 1990; Zimmerman & Martinez-Pons, 1990). Generally, mixed results are found for gender effects on self-regulated learning.

6.5 LIMITATIONS

There were several limitations that pertained to the research conducted in Study 1. First, the methodology employed was a single-administration questionnaire protocol that assessed students' trait-based interpretations of the environmental and personal constructs. This correlational-based protocol was limited in that it could not control for students' prior perceptions of the classroom learning environment and personal parameters addressed nor could it establish the exact direction of the relationship paths presented. Although the intention of the present research was to examine the relations of environmental constructs with personal constructs and achievement, controlling for prior achievement goals would enable a more valid determination of the impact of environmental parameters such as the constructivist pedagogical dimensions on students' achievement goals. Such a protocol would be one step towards establishing causality for these relations. For example, although the personal relevance and student negotiation had positive relations with mastery-approach goals, these relations could be a result of students' developmental processes rather than the impact of the constructivist pedagogy employed by their current science teacher. On the other hand, these relations may be underpinned by students' motivational profiles – students with mastery-approach goals may perceive the personal relevance and student negotiation characteristics of their classroom rather than these dimensions predicting students' adoption of mastery-approach goals.

Another caution affiliated with data gained from trait-based measures is the accuracy of students' reporting their perceptions of the environment and personal constructs. There was no way of establishing students' historical assessments with regards to items such as "My goal is to get a better grade than most of the students" or "Students are asked by the teacher to try new ways of learning science". Perceptions about the learning environment, achievement goals and motivational beliefs may vary throughout the school year pending the type of emotional successes and failures, and negative or positive affect experienced by students and teachers. Students may only report on events or experiences that are atypical highlights rather than the norm.

Third, the bulk of items used to measure students' self-regulated learning had external classroom referents, such as reporting their cognitive strategy and regulatory strategy use when studying. These may not have been valid when considering that many of the environmental and personal items used had internal classroom referents. The majority of these limitations are addressed in Study 4 which involves examining most of the personal-based constructs at context-levels. There have been some suggestions for contextual analyses to further our understanding of the important relations between personal motivational factors and other constructs such as self-regulated learning (Barron & Harackiewicz, 2001; Harackiewicz & Sansone, 1991; Linnenbrink, 2002; Senko, 2002; Wolters, et al., 1996).

The fourth limitation of the study is concerned with the type of students and classrooms that formed the samples. Although a number of regular and selective high schools were involved in the study, these being randomly selected from state education system high schools located in the Sydney region, many other schools declined to participate. The schools that had given consent for the involvement of their students in the study may have had a particular interest in being involved or were comfortable that their students would be conscientious subjects in a study involving motivation and the classroom learning environment. The results reported, therefore, may have reflected those of well-adjusted and motivated students rather than accommodate a range of student abilities, interests and attitude to science. Hence, there may have been an inherent form of sampling bias attached with the study which may impact upon the generalisability of the findings.

Finally, the multilevel analyses of this study were constrained to a two-level hierarchy, with students at the first level and their classroom membership forming the second level. Only 38 classrooms formed the number of classroom-level units thus any significant variance attributed to the classroom-level was harder to attain amongst the constructs investigated. This may have led to an increase in the potential of Type II errors occurring for the relations involving the classroom learning environment variables.

6.6 SUMMARY

In summary, Study 1 addressed the following three research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?
>
> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

A single-administration questionnaire protocol was adopted with students completing three questionnaires during one of their science lessons in the middle of the school year. These questionnaires were well established instruments in the respective fields of science education (Constructivist Learning Environment Survey) and educational psychology (Science Classroom Motivation Questionnaire, Motivated Strategies for Learning Questionnaire). There was support for the 2 X 2 achievement goals framework although the performance-avoidance goal construct reflected concern tendencies rather than avoidance behaviour. Two statistical forms of analyses were used to ascertain the relations amongst the constructs that were validated from these questionnaires: multilevel multiple regression and structural equation modelling (SEM). The multilevel multiple regression analyses determined the impact of variance attributed to personal-level and classroom-level units upon the classroom learning environment variables, and those associated with motivational beliefs, achievement goals and self-regulated learning (SRL). The regression analyses also measured the impact of various subpopulation variables (gender, student type, age) upon achievement goals and SRL. Of particular interest was the influence of student type (regular or selective high school students) upon the environmental and personal variables. This technique found that the bulk of variance for all constructs was attributed to the personal-level with large amounts of intra-class variation for students' perception of their classroom learning environment variables and, as expected, their personal-based variables. These results therefore justified a single-level SEM model approach in examining the simultaneous interdependent relations amongst the variables. This study focused on presenting a structural equation model that was applicable to the general high school student and thus controlled for the variance associated with gender, age and student type (regular or selective high school student).

The following statistically significant relationships were found to exist for Research Questions Three and Five.

6.6.1 Research Question Three: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' learning environment characteristics and students' personal achievement goals were as follows. Mastery-approach was positively predicted by personal relevance and student negotiation. Mastery-avoidance was negatively predicted by critical voice. Performance-approach was negatively predicted by the mastery goal structure. Performance-avoidance was positively predicted by uncertainty.

The relations found between students' learning environment characteristics and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by classroom metacognitive structure. Regulatory strategy use was positively predicted by student negotiation and classroom metacognitive structure, and negatively predicted by the mastery goal structure.

The relations found between students' motivational beliefs and students' personal achievement goals were as follows. Mastery-approach was positively predicted by intrinsic value, self-efficacy and test anxiety. Mastery-avoidance was positively predicted by self-efficacy and test anxiety. Performance-approach was positively predicted by self-efficacy and test anxiety. Performance-avoidance was positively predicted by self-efficacy and test anxiety.

The relations found between students' motivational beliefs and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by intrinsic value and self-efficacy. Regulatory strategy use was positively predicted by intrinsic value and self-efficacy.

The relations found between students' personal achievement goals and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by mastery-approach and performance-avoidance; it was negatively predicted by the performance-approach X performance-avoidance interaction. Regulatory strategy use was positively predicted by mastery-approach and performance-avoidance, and was negatively predicted by mastery-avoidance.

6.6.2 Research Question Three: Statistically Significant Associations found using Structural Equation Modelling Analyses

The relations found between students' learning environment characteristics and students' personal achievement goals were as follows. Mastery-approach was positively predicted by personal relevance and student negotiation. Performance-approach was negatively predicted by the mastery goal structure. Performance-avoidance was positively predicted by uncertainty.

The relations found between students' learning environment characteristics and students' motivational beliefs were as follows. Intrinsic value was positively predicted by personal relevance and the mastery goal structure.

The relations found between students' learning environment characteristics and students' self-regulated learning were as follows. Regulatory strategy use was positively predicted by student negotiation and classroom metacognitive structure, and negatively predicted by the mastery goal structure.

The relations found between students' motivational beliefs and students' personal achievement goals were as follows. Mastery-approach was positively predicted by intrinsic value. Mastery-avoidance was positively predicted by self-efficacy. Performance-approach was positively predicted by self-efficacy. Performance-avoidance was positively predicted by self-efficacy and test anxiety. Intrinsic value was positively predicted by self-efficacy.

The relations found between students' motivational beliefs and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by test anxiety. Regulatory strategy use was positively predicted by self-efficacy and negatively predicted by test anxiety.

The relations found between students' personal achievement goals and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by regulatory strategy use. Regulatory strategy use was positively predicted by mastery-approach and performance-avoidance, and was negatively predicted by mastery-avoidance and performance-approach. Performance-avoidance positively predicted mastery-approach, mastery-avoidance and performance-approach.

6.6.3 Research Question Five: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' subpopulation variables and students' personal achievement goals were as follows. Females reported less mastery-avoidance and less performance-approach goal orientations than males. Selective high school students reported higher performance-avoidance orientations than regular high school students.

The relations found between students' subpopulation variables and students' self-regulated learning were as follows. Females reported greater use of cognitive and regulatory strategies than males. Selective high school students reported greater use of cognitive and regulatory strategies than regular high school students.

Study 1 had several limitations that should be addressed by other studies. Firstly, in Study 1 the predictive properties of personal achievement goals were only examined with respect to the self-regulated learning constructs of cognitive strategy and regulatory strategy use. However, achievement goals have been considered as having important consequences for a variety of other personal-based variables, particularly academic achievement (e.g., Church et al., 2001; Ee et al., 2003; Elliot & Church, 1997; Greene et al., 2004; Rao et al., 2000; Roeser et al., 1996; Urdan et al., 1997; Wolters et al., 1996; Wolters, 2004). Similarly, self-regulated learning has also been considered as an important predictor of academic achievement (Elliot et al., 1999; Greene et al., 2004; Niemivirta, 1997; Pintrich & De Groot, 1990; Pokay & Blumenfeld, 1990). Study 1, however, was confined to examining only the relations between achievement goals and self-regulated learning, with achievement goals situated as predictors of cognitive strategy and regulatory strategy use; these self-regulated learning constructs were the response variables (dependent variables) in this investigation. Future studies may address this limitation by examining the relations between achievement goals, self-regulated learning and science achievement. Although such a study was conducted by the author as part of his doctoral research, space restrictions preclude the reporting of this study in the present thesis.

Another limitation of Study 1 concerned the type of indicator items used in the MSLQ for measuring students' self-regulated learning. Many of these items had external classroom referents and these may have been invalid indicators of students' SRL when considering that all the other variables involved in the regression and

SEM analyses had internal classroom referents. In addition, the SRL constructs examined in Study 1 only measured the adaptive SRL qualities of students. Equally as valid would be to measure students' reporting of their maladaptive SRL behaviour. This would complement the relations found for the adaptive SRL construct and perhaps enrich our understanding of the relations between achievement goals, motivational beliefs and SRL. Study 3 (Chapters 8 to 12) addressed these issues by examining the relations between task efficacy, achievement goals, adaptive SRL, and maladaptive SRL in specific classroom learning environment contexts. In so doing Study 3 also addressed the trait versus state (learning context) reporting issues of these personal-based variables.

Finally, Study 1 was correlational in nature and as such the findings are based on single-event reporting by the students. Studies that investigate the causal relations between the classroom learning environment and personal variables by examining the impact of constructivist-based pedagogical interventions upon students' perceptions of these variables would be useful. Although one such study was conducted by the author as part of his doctoral research, space restrictions preclude the reporting of this small scale study in this thesis.

Chapter 7

STUDY 2

7.1 STUDY 2: AIMS

Study 2 was designed to investigate the relations between variables at the trait-level and in so doing attended to the following three research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?
>
> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

Although these three research questions were addressed by Study 1 (Chapter 6), Study 2 was an auxiliary form of research since the students forming the Study 2 sample also formed the sample used for the context-level analyses; the context-level analyses comprise Study 3. As an auxiliary study, Study 2 had three roles. Firstly, it was used to ascertain the interdependent relations of the variables at the trait-level for the sample of students studied in the context-level analyses (Study 3, Chapters 8 to 12). Towards this aim, Study 2 used the same trait-level questionnaires as those used in Study 1 to measure the constructivist pedagogical dimensions, students' personal achievement goals, motivational beliefs, and self-regulated learning. Secondly, Study 2 was used to examine the consistency of the interdependent relations of the variables at the trait level in comparison with those obtained in Study 1, which used a different sample of high school science students from the NSW State Education System. Consequently, the structural properties of the constructs obtained in Study 1 could be compared with those obtained in Study 2. However, there is one important caveat regarding this role. Unlike Study 1, none of the classroom goal or classroom metacognitive structures were examined in Study 2. Study 2 occurred throughout the middle of the 2003 school year and none of these classroom-level variables had been integrated into the research design at that particular stage. Study 1, which was conducted in Term 3, 2005 was designed to accommodate the classroom goal and classroom metacognitive structures. Thirdly, Study 2 enabled a comparison of the measurement properties of the constructs with respect to those obtained in Study 1. Both studies used exploratory factor analysis, confirmatory factor analysis and one-factor congeneric models to determine the psychometric properties of the questionnaires. The use of these types of analyses and procedures raises questions regarding the consistency of the construct validity properties across samples and across studies. These questions include: Is there consistency with respect to the loading of items on factors in the factor analyses? Is there consistency with respect to the items that have very high measurement errors associated with them? Is there consistency with respect to the items that form the composite latent variables? Is there consistency with respect to the loadings of indicator items in forming a composite variable?

Study 2 also differed to Study 1 in terms of the methodology employed to gather data. While Study 1 utilised a single-administration questionnaire procedure conducted with each class by the researcher, Study 2 relied on the class teacher administering the questionnaires. This protocol enabled the allocation of the context-level questionnaires when deemed appropriate by the class teacher. Teachers were given thorough instructions and training for the allocation procedure and the researcher was in constant contact throughout the period of questionnaire administration. Student responses were requested as anonymous in order to reduce any apprehension in students regarding this procedure.

The hypothesised relations between students' perceptions of their high school science learning environments, students' motivational components, their self-regulated learning, and subpopulation variables were presented in Chapter 5. It is expected that Study 2 would have similar structural properties to those obtained in Study 1 with the exception of the relations involving classroom goal and classroom metacognitive structures, which were not examined in Study 2. In terms of comparing the psychometric properties of the questionnaires across Studies 1 and 2, it is hypothesised that similar measurement properties would be obtained.

7.2 METHOD

7.2.1 Research Design

Similar to Study 1 (Chapter 6), the aim of the research was to measure high school students' perceptions of a collection of learning environment and personal constructs while experiencing a state education system science curriculum. This entailed the administration of a one-off trait-level questionnaire to the students during the second half of their school year (2003). This design accommodated an exploration of the associations amongst the constructs in situ - with respect to the implementation of the state science curriculum. Besides yielding embryonic baseline data on the associations amongst the constructs under focus, this design enabled a greater degree of participation in the study from schools, teachers and students, and an increase in the generalisibility of the findings compared with use of smaller-scale study designs such as case studies or interventions. Consequently, this approach did not necessitate the need for formal curriculum-based interventions or experimental-based protocols. Rather, it was expected that the nascent nature of the research would generate findings that could form the basis for future research that may utilise such methods.

7.2.2 Participants and Procedure

A sample of 617 high school science students (326 males and 291 females) was assembled from nine different New South Wales State education system high schools serving the Sydney metropolitan area. Each school was co-educational, catered for students from years 7 to 12, randomly chosen from state high schools in the Sydney area and invited to participate. Six schools were classified as regular (288 students) and served as the sample from the regular high school population. The regular students' sample comprised of 15 classes ranging in size from 9 to 27 students (mean class size = 19.2). Of this sample, 24 (13 males and 11 females) were in year 7, 107 (56 males and 51 females) were in year 8, 77 (38 males and 39 females) were in year 9, and 9 (3 males and 6 females) were in year 10. All of these junior classes were completing a general science curriculum. 71 (40 males and 31 females) were in year 11 completing a senior science curriculum. Three schools were classified as selective (329 students) and served as the sample from the selective high school population. The selective students' sample comprised of 16 classes ranging in size from 10 to 29 students (mean class size = 20.6). Of this sample, 55 (25 males and 30 females) were in year 8 and 119 (63 males and 56 females) were in year 9, completing a general science curriculum. 155 (88 males and 67 females) were in year 11 completing a senior science curriculum. Written parental permission was required for students to participate in the study. Students were informed that participation was voluntary and their responses would be kept confidential. Despite providing written parental permission, a small number of students declined to participate in the study.

Students were asked to complete three questionnaires (see 7.2.2 Measures below) during the middle of the third term of the school year in one of their science lessons. By this time of the school year students' relationships with class peers and class teacher were well established. The questionnaires were administered by the class teacher since the teacher had to decide when it was appropriate to issue the micro-learning event level questionnaires (Study 3). Since the students' science teacher was administering the questionnaires, students' names were not requested thereby making the responses anonymous. Teachers were provided with a suggested protocol by the researcher, who visited each teacher and trained him or her on how to administer the questionnaires. The researcher kept in contact with the teachers throughout the study administration procedure and collected the questionnaires after completion.

7.2.3 Measures

Trait-level analyses were conducted using the same questionnaires that were described in Study 1 excepting the items assessing classroom goal and classroom metacognitive structures. The Study 2 questionnaires are briefly outlined below. Like Study 1, these trait-level questionnaires were administered in one of the students' science lessons.

Constructivist pedagogy dimensions. The Constructivist Learning Environment

Survey (CLES; Taylor et al., 1997) was used to measure students' perceptions of the constructivist-based pedagogical features they experience in their science classroom learning environment.

Personal achievement goals. The Achievement Goals Questionnaire developed by Elliot and Church (1997) with the addition of the mastery-avoidance goal items (see Study 1) was used to measure students' personal achievement goals at the trait-level. The revised Achievement Goals, Questionnaire was labelled in the present research as the "Science Classroom Motivation Questionnaire-Macro-Level".

Perceived ability. One scale comprising of two items was used to measure students' perceptions of their relative ability in their science class.

Motivational beliefs. Three scales from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) were used to measure students' perceptions of their motivational beliefs (intrinsic value, test anxiety and self-efficacy).

Self-regulated learning. Two scales from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) were used to measure students' self-reporting of their use of self-regulated learning strategies in learning science.

7.3 RESULTS

7.3.1 Preliminary Analyses: Exploratory Factor Analyses and Confirmatory Factor Analyses

As in Study 1, exploratory factor analyses (EFA) were conducted on the items relevant to a priori construct predictions. Principal axis factoring with an oblique rotation method was conducted using the sample of high school science students (n = 617). Principal axis was chosen as the factor extraction method on the assumption that the data would have some deviation from being normally distributed. Oblique rotation was used on the assumption that there would be a degree of correlation between the factors.

Constructivist pedagogy dimensions. An initial EFA of *The Constructivist Learning Environment Survey* (CLES; Appendix A) items yielded seven factors with eigenvalues greater than 1 as well as satisfying scree test requirements for five factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. A five-factor solution analysis accounted for 51.1 % of the total variance after the initial extraction for the unrotated solution (after oblique rotation, proportions of total variance cannot be made due to correlation of factors). (See the author for complete results of the final EFA solution.) The five factors represented the five hypothesised constructivist pedagogy dimensions of perceived relevance, student negotiation, shared control, critical voice and uncertainty. All items loaded above 0.35 on their primary factor and none of the items crossloaded (> 0.32 on two or more factors).

Personal achievement goals. An initial EFA of the Achievement Goals questionnaire (Appendix B) items yielded five factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. After rotation, a four-factor solution accounted for 49.5 % of the total variance after the initial extraction for the unrotated solution. The four factors represented the hypothesised personal achievement goals of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. A five-factor solution was investigated to see if the data would yield similar results to the EFA solution obtained in Study 1. It was expected that items 5, 7, 21 and 22 would load onto a factor that was labelled 'misinterpretation' in the Study 1 results. However, the five-factor solution for Study 3 did not obtain this result and thus the four-factor solution was retained for the analyses.

Confirmatory factor analysis using PRELIS 8.72 (Jöreskog & Sörbom, 2005) and LISREL 8.72 (Jöreskog & Sörbom, 2005) was employed to determine which of two first-order models, three-factor (mastery-approach, performance-approach, avoidance) or four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) accounted for more variance and thus provided the better fit of the data. Polychoric correlations and asymptotic covariance matrices where generated using PRELIS 8.72 and these were then analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation model (Jöreskog, 2002).

The results of the first set of CFAs comparing the two first-order achievement goals models are displayed in Table 7.1. Of the two models, the four-factor model provided a significantly better fit of the data with $\chi^2 = 1565.2$ ($df = 246$, $p < .001$), RMSEA = 0.0933, RMR = 0.203, AGFI = 0.944, CFI = 0.932, and NNFI = 0.923. The four-factor model improved the fit of the data significantly above that of the three-factor model, $\Delta\chi^2 = 192.0$ ($\Delta df = 3$, $p < .001$). The four-factor model also revealed that items 5 (pap5) and 21 (mav3) had extremely high measurement errors associated with them (0.98 and 0.94 respectively) and they had very low squared multiple correlations (0.025 and 0.058 respectively). Thus, these two items: item 5 ("It is not important to me to do well compared to others in this class") and item 21 ("It doesn't worry me if I make mistakes when learning") were removed from the analysis. These results were expected since these items also had very high measurement error in Study 1. In addition, item 6 ("I eagerly participate in all types of activities in this class"), an indicator item for performance-approach goal was shown to have a large amount of covariance with the mastery-approach goal thus indicating this item had a large amount of cross-loading associated with it.

A second set of CFAs was conducted after removing items 5, 6, and 21 thus replicating the procedure employed in Study 1. Unlike Study 1, however, item 22 was retained since it had a high regression weight for its latent variable and its measurement error was lower than 0.90. For this set of analyses, three-factor (mastery-approach, performance-approach, avoidance) and four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) models were compared. The results of this set of CFAs are displayed in Table 7.2. Of the two models, the four-factor model provided a significantly better fit of the data with χ^2 = 1024.5 (*df* = 183, $p < .001$), RMSEA = 0.0864, RMR = 0.202, AGFI = 0.950, CFI = 0.933, and NNFI = 0.923. The four-factor model improved the fit of the data significantly above that of the three-factor model, $\Delta\chi^2$ = 181.4 (Δdf = 3, $p < .001$). These analyses therefore verified the existence of the four achievement goals.

Table 7.1

Achievement Goals Questionnaire: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	1757.2	249	.000	-	-	.0992	.209	.938	.922	.914
Four-factor model	1565.2	246	.000	192.0***	3	.0933	.203	.944	.932	.923

Note. $n = 617$; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. *** $p < .001$.

Table 7.2

Achievement Goals Questionnaire: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	1205.9	186	.000	-	-	.0943	.211	.942	.919	.909
Four-factor model	1024.5	183	.000	181.4***	3	.0864	.202	.950	.933	.923

Note. n = 617; [a]After removal of items 5 and 21 due to extremely high measurement errors, and removal of item 6 for cross-loading; [b]Weighted Least Squares used as the estimation method; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. *** $p < .001$.

Motivational beliefs. An initial EFA of the Motivated Strategies for Learning Questionnaire (MSLQ; Appendix C) motivational belief items yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for three factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis contained four factors, accounting for 60.2% of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) The four factors represented the three hypothesised motivational beliefs of intrinsic value, self-efficacy and test anxiety, and the fourth factor was aligned with some intrinsic value items that were mastery-approach in nature: item 4 ("It is important for me to learn what is being taught in this class"), item 14 ("Even when I do poorly on a test or exam I try to learn from my mistakes") and item 21 ("Understanding the subject is important to me"). These three items were also identified in Study 1 as mastery-approach in nature (in addition to items 1 and 10). Hence there was similarity in the Study 1 and Study 3 results for this factor. The perceived ability and perceived self-efficacy items loaded onto to the same factor thus showing students did not distinguish between the perceived ability and perceived self-efficacy competence perceptions.

As for the Study 1 data analysis, confirmatory factor analysis using PRELIS 8.72 and LISREL 8.72 was used to investigate the degree of discrimination between the intrinsic value and achievement goal items, particularly between the intrinsic value and mastery-approach items. The first set of CFAs compared four first-order models. The four-factor model comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with all the intrinsic value items declared as indicator items of the mastery-approach factor. Five-factor Model A comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with all intrinsic value items forming the fifth factor, intrinsic value. Five-factor Model B comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance with only item 5 ("I like what I am learning in this class"), item 7 ("I think I will be able to use what I learn in this class in other classes"), item 15 ("I think what I am learning in this class is useful for me to know") and item 17 ("I think that what we are learning in this class is interesting") forming the fifth factor, intrinsic value, the remaining intrinsic value items (items 1, 4, 10, 14, 21) were declared as indicator items of the mastery-approach goal. The six-factor model comprised of mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value (items 5, 7, 15, 17), and the sixth factor comprised of the remaining intrinsic value items (items 1, 4, 10, 14, 21). The results of the first set of CFAs are displayed in Table 7.3. Of the six models, the six-factor model provided a significantly better fit of the data with $\chi^2 = 3784.0$ ($df = 390$, $p < .001$), RMSEA = 0.1150, RMR = 0.281, AGFI = 0.956, CFI = 0.959, and NNFI = 0.955.

Repeating the procedures used in Study 1, a second set of CFAs was conducted after removing the superfluous intrinsic value items 1, 4, 10, 14, and 21; items 5, 7, 15 and 17 were substantively more indicative of intrinsic value. For this set of analyses, four-factor (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) and five-factor [mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value (items 5, 7, 15, 17)] models were compared. The results of this set of CFAs are displayed in Table 7.4. Of the two models, the five-factor model provided a significantly better fit of the data with $\chi^2 = 1781.9$ ($df = 265$, $p < .001$), RMSEA = 0.0936, RMR = 0.207, AGFI = 0.949, CFI = 0.943, and NNFI = 0.935. The five-factor model improved the fit of the data significantly above that of the four-factor model, $\Delta\chi^2 = 203.8$ ($\Delta df = 4$, $p < .001$). Consequently, these analyses verified that items 5, 7, 15 and 17 were valid indicators of intrinsic value, to be distinguished from those that were indicators of mastery-approach and the other achievement goals. These findings support those of Study 1.

Table 7.3

Mastery-Approach and Intrinsic Value Items[a]: Results from Confirmatory Factor Analyses[b]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Four-factor model	4584.6	399	.000	-	-	.127	.311	.948	.950	.945
Five-factor Model A	3982.4	395	.000	602.2***	4	.118	.299	.955	.957	.953
Five-factor Model B	4402.9	395	.000	420.5	-	.125	.292	.950	.952	.947
Six-factor model	3784.0	390	.000	618.9***	5	.115	.281	.956	.959	.955

Note. n = 617; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. Five-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value. Six-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value, other intrinsic value. *** $p < .001$.

Table 7.4

Mastery-Approach and Intrinsic Value Items[a]: Results from Confirmatory Factor Analyses[b]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Four-factor model	1985.7	269	.000	-	-	.0988	.227	.945	.935	.928
Five-factor model	1781.9	265	.000	203.8***	4	.0936	.207	.949	.943	.935

Note. $n = 617$; [a]Weighted Least Squares used as the estimation method; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance. Four-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance. Five-factor model: mastery-approach, mastery-avoidance, performance-approach, performance-avoidance, intrinsic value. *** $p < .001$.

Self-regulated learning. An initial EFA of The Motivated Strategies for Learning Questionnaire (MSLQ; Appendix C) self-regulated learning items yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for three factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Barlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis contained three factors, accounting for 44.2 % of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) Two factors represented the hypothesised self-regulated learning constructs of cognitive strategy use (items 31, 34, 40, 41, 42, 43) and regulatory strategy use (items 23, 24, 25, 28, 29, 30, 33, 35, 36, 39, 44), while the third factor was compatible with maladaptive self-regulated learning strategies: item 26 ("It is hard for me to decide what the main ideas are when I study"), item 27 ("When work is hard I either give up or study the easy parts"), item 37 ("I often find the material I use for studying difficult to understand"), and item 38 ("I find that when the teacher is talking I think of other things and don't really listen to what is being said"). Most items loaded above 0.35 on their primary factor and one item (item 38) crossloaded (> 0.32 on two or more factors) in the final EFA solution.

The difference between this solution with that obtained in Study 1 concerned four items, (items 33, 35, 40, 43). In Study 1, items 33 and 35 loaded onto the cognitive strategy use factor and items 40 and 43 loaded onto the regulatory strategy use factor. However, in Study 2 these items interchanged with items 33 and 35 loading onto regulatory strategy use and items 40 and 43 loading onto cognitive strategy use. These results demonstrate the arbitrary nature of either students' identification of self-reported self-regulated learning at a trait-level or the identification of the self-regulated learning items used in the MSLQ. This discrepancy potentially presented a problem regarding the identification of the self-regulated learning factors as the items identified for each self-regulated learning construct had similar substantive intent. Indeed, regulatory strategy use was found to have very large positive relations with cognitive strategy use in the final Study 1 SEM analyses with $\beta = 0.878$ ($p < .001$) and a very high factor covariance (correlation) of 0.939 ($p < .001$) in the Study 1 CFA; similar results were expected in Study 2.

Confirmatory factor analysis using PRELIS 8.72 and LISREL 8.72 was used to investigate the degree of discrimination between the self-regulated learning items with respect to the hypothesised self-regulated learning constructs of cognitive strategy use, regulatory strategy use and maladaptive strategy use. Preliminary CFAs conducted using the same protocol for Study 1 showed item 26 to have a very high measurement error (> 0.900) and to crossload onto the latent variables throughout the analyses; this item was removed and the final CFAs conducted. The final CFAs compared six first-order models. The one-factor model comprised of all the self-regulated learning items (with the exception of item 26) forming a single self-regulated learning factor. Two-factor Model A comprised of cognitive strategy use and regulatory strategy use with the indicator items being in accordance with that classified by the MSLQ. Two-factor Model B comprised of the self-regulated learning factor and the maladaptive strategy use factor, which was formed from items 27, 37 and 38. Three factor Model A comprised of comprised of cognitive strategy use and regulatory strategy use with the indicator items being in accordance with that classified by the MSLQ, and the maladaptive strategy use factor, which was formed from items 27, 37 and 38. Three-factor Model B comprised of the three factors and their items as identified in the EFA from Study 3: cognitive strategy use (items 31, 34, 40, 41, 42, 43), regulatory strategy use (items 23, 24, 25, 28, 29, 30, 33, 35, 36, 39, 44), and maladaptive strategy use (items 27, 37, 38). Three factor Model C comprised of the three factors as identified in the EFA from Study 1: cognitive strategy use (items 31, 32, 33, 34, 35, 41, 42), regulatory strategy use (items 23, 24, 25, 28, 29, 30, 36, 39, 40, 43, 44), and maladaptive strategy use (items 27, 37, 38). The results of this set of CFAs are displayed in Table 7.5. Of the six models, the three factor models provided a significantly better fit of the data; however, there were virtually no statistical differences between the three three-factor models. Of the three factor models, Model B was chosen since it was not statistically different to the other two three factor models and was specific to the Study 2 sample EFA results. The various fit statistics for three-factor Model B were χ^2 = 760.4 (df = 186, p < .001), RMSEA = 0.0708, RMR = 0.247, AGFI = 0.946, CFI = 0.866, and NNFI = 0.849. These results indicate a relatively high degree of consistency for the interpretation of the self-regulated learning items across the two studies. Like Study 1, there was a very high factor covariance (correlation) of 0.965 (p < .001) attained in the Study 2 CFA for cognitive and regulatory strategy use.

Table 7.5

Self-Regulated Learning Items (MSLQ): Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
One-factor model	910.6	189	.000	-	-	.0787	.278	.936	.831	.813
Two-factor Model A	885.2	188	.000	25.4***	1	.0776	.271	.938	.837	.818
Two-factor Model B	792.4	188	.000	92.8	-	.0722	.258	.944	.859	.842
Three-factor Model A	767.0	186	.000	25.4***	2	.0712	.252	.945	.864	.847
Three-factor Model B	760.4	186	.000	6.6	-	.0708	.247	.946	.866	.849
Three-factor Model C	760.8	186	.000	.4	-	.0708	.244	.946	.866	.848

Note. n = 617; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. One-factor model: MSLQ SRL items. Two-factor Model A: MSLQ cognitive strategy use, MSLQ regulatory strategy use. Two-factor Model B: MSLQ SRL items, EFA maladaptive strategy use. Three-factor Model A: MSLQ cognitive strategy use, MSLQ regulatory strategy use, EFA maladaptive strategy use. Three-factor Model B: EFA cognitive strategy use, EFA regulatory strategy use, EFA maladaptive strategy use (Study 2 EFAs). Three-factor Model C: EFA cognitive strategy use, EFA regulatory strategy use, EFA maladaptive strategy use. (Study 1 EFAs). *** $p < .001$.

7.3.2 Preliminary Analyses: One-Factor Congeneric Measurement Model Analyses

Fitted one-factor congeneric measurement models were used to form the composite variables that represent the various social/cognitive constructs investigated in Study 2. These analyses were performed in the same way as those in Study 1, using PRELIS 8.72 to compute the inter-item polychoric correlations and asymptotic covariance matrices for the ordinal data scales, which were then analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation models (Jöreskog, 2002).

The results of the measurement properties attained from fitting one-factor congeneric models are presented in Tables 7.6 to 7.9. Items found to have small partial regression weights and large measurement error variance (> 0.90) were eliminated since these were either inappropriate indicator items for the latent variable or were inappropriately worded and thus introduced a large amount of inconsistency when interpreted by students. These items may be of interest to researchers associated with the relevant questionnaire design and modifications. The one-factor congeneric model for a latent variable was repeated if items were eliminated from its embryonic model; the results obtained are therefore devoid of poor fitting indicator items. All but one of the composite scales exhibited satisfactory composite scale parameter results. The composite score reliability coefficients (r_c) ranged from 0.643 to 0.923; the variance estimate of items attributed to the composite variable ($\hat{\lambda}_c$) ranged from 0.800 to 0.959; and, the variance estimate of items attributed to measurement error ($\hat{\theta}_c$) ranged from 0.077 to 0.355. As in Study 1, the maladaptive strategy use scale had such poor composite scale reliability (0.579) to warrant dropping it from further analyses. The relevant goodness of fit indices of each composite scale are presented in Tables 7.10 to 7.11; these were also satisfactory. Overall, there was a high degree of congruence with the Study 1 composite scale parameters.

Table 7.6

Constructivist Pedagogy Dimensions: Composite Scale Parameters (Study 2)

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		pr1[a] (1)[b]	pr2 (2)	pr3 (3)	pr4 (4)	pr5 (5)	pr6 (6)					
Personal relevance	611	.158[c]	.039	.124	.424	.325	.102	2[e], 1 3, 2 5, 1 6, 3	.768	.875	.231	.753
		.135[d]	.033	.106	.362	.277	.087					
		u1 (7)	u2 (8)	u3 (9)	u4 (10)	u5 (11)	u6 (12)					
Uncertainty	611	.176	.270	.303	-	.188	.258	5, 2	.643	.800	.355	.614
		.147	.226	.254	-	.157	.216					
		cv1 (13)	cv2 (14)	cv3 (15)	cv4 (16)	cv5 (17)	cv6 (18)					
Critical voice	611	.077	-	.250	.521	.174	.070	3, 1 6, 1 6, 5	.807	.885	.187	.797
		.071	-	.229	.477	.159	.064					

Table 7.6 *Continued*

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		sc1 (19)	sc2 (20)	sc3 (21)	sc4 (22)	sc5 (23)	sc6 (24)					
Shared control	611	.084	.172	.260	.208	.358	.052	2, 1 5, 2 6, 2	.899	.906	.092	.852
		.074	.152	.229	.183	.316	.046					
		sn1 (25)	sn2 (26)	sn3 (27)	sn4 (28)	sn5 (29)	sn6 (30)					
Student negotiation	611	.032	.132	.129	.465	.083	.264	2, 1 3, 2 5, 3	.866	.918	.131	.840
		.029	.119	.117	.421	.075	.239					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 7.7

Personal Achievement Goals: Composite Scale Parameters (Study 2)

Composite Variable	*n*	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		map1[a]	map2	map3	map4	map5	map6					
		(7)[b]	(8)	(9)	(10)	(11)	(12)					
Mastery-approach	610	.119[c]	.181	.388	.334	.063	.082	4[e], 1 5, 4 6, 5	.834	.904	.163	.792
		.102[d]	.155	.332	.286	.054	.070					
		mav1	mav2	mav3	mav4	mav5	mav6					
		(19)	(20)	(21)	(22)	(23)	(24)					
Mastery-avoidance	607	.658	-.069	-	-	.050	.575	6, 1 6, 2	.730	.854	.270	.666
		.542	-.057	-	-	.041	.474					
		pap1	pap2	pap3	pap4	pap5	pap6					
		(1)	(2)	(3)	(4)	(5)	(6)					
Performance-approach	610	.097	.830	.065	.027	-	-	4, 3	.901	.933	.096	.893
		.095	.815	.064	.026	-	-					
		pav1	pav2	pav3	pav4	pav5	pav6					
		(13)	(14)	(15)	(16)	(17)	(18)					
Performance-avoidance	610	.265	.092	.396	.289	.055	.091	2, 1 5, 1 6, 5	.701	.837	.299	.688
		.223	.077	.333	.243	.046	.077					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 7.8

Motivational Beliefs: Composite Scale Parameters (Study 2)

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Intrinsic value	599	ig1[a] (1)[b]	ig2 (4)	ig3 (5)	ig4 (7)	ig5 (10)	ig6 (14)	7[e], 4	.839	.910	.159	.825
		-	-	.381[c]	.082	-	-					
		-	-	.355[d]	.076	-	-					
		ig7 (15)	ig8 (17)	ig9 (21)	-	-	-					
		.151	.458	-	-	-	-					
		.141	.427	-	-	-	-					
Test anxiety	599	ta1 (3)	ta2 (12)	ta3 (20)	ta4 (22)	-	-	4, 1	.834	.906	.163	.811
		.187	.516	.280	.099	-	-					
		.173	.477	.259	.091	-	-					

Table 7.8 *Continued*

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Self-efficacy	599	se1 (2)	se2 (8)	se3 (9)	se4 (13)	se5 (11)	se6 (18)	3, 1 8, 2 8, 4 9, 2 9, 4	.923	.959	.077	.902
		.067	.017	.131	.334	.094	.165					
		.057	.014	.111	.283	.080	.140					
		se7 (6)	se8 (11)	se9 (19)	-	-	-					
		.091	.164	.119	-	-	-					
		.077	.139	.101	-	-	-					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 7.9

Self-Regulated Learning: Composite Scale Parameters (Study 2)

Composite Variable	*n*	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
Regulatory strategy use	589	suc1[a] (23)[b]	suc2 (24)	suc3 (26)	suc4 (28)	suc5 (29)	suc6 (30)	10, 4 10, 5 10, 6 4[#], 6	.889	.941	.111	.852
		.142[c]	.158	-	.055	.049	.176					
		.106[d]	.118	-	.041	.037	.131					
		suc9 (36)	suc10 (39)	suc13 (44)	susr1[#] (25)	susr4[#] (33)	susr5[#] (35)					
		.081	.147	.141	.140	.138	.114					
		.060	.110	.105	.104	.103	.085					
Cognitive strategy use	590	suc7 (31)	suc8 (34)	suc11 (41)	suc12 (42)	susr3 (32)	susr8[#] (40)	12, 8 3, 8 8[#], 11 9, 8[#]	.818	.901	.181	.780
		.101	.421	.124	.344	.195	.063					
		.077	.320	.094	.262	.148	.048					
		susr9 (43)	-	-	-	-	-					
		.067	-	-	-	-	-					
		.051	-	-	-	-	-					

Table 7.9 *Continued*

Composite Variable	n	Item Weights						TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
		suc3 (25)	susr2 (32)	susr6 (33)	susr7 (35)	-	-					
Maladaptive strategy use	590	-	.460	.257	.313	-	-	-	.579	.757	.416	.558
		-	.447	.250	.304	-	-					

Note. n = effective sample size for variable; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of items attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of items attributed to measurement error; α = Cronbach's alpha estimate.

Table 7.10

Classroom Learning Environment Constructs: One-Factor Congeneric Model Fit Indices (Study 2)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Personal relevance	6	1.641	5	.896	1.00	.998	.0095	.0000
Uncertainty	5	5.098	4	.277	.998	.994	.0222	.0212
Critical voice	5	2.744	2	.856	1.00	.999	.0042	.0000
Shared control	6	10.755	6	.096	.998	.993	.0241	.0360
Student negotiation	6	5.643	6	.464	.999	.996	.0148	.0000

Note: χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

Table 7.11

Personal Constructs: One-Factor Congeneric Model Fit Indices (Study 2)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Mastery-approach	6	10.34	6	.111	.998	.993	.0237	.0344
Mastery-avoidance	4	0	0	1.00	-	-	-	-
Performance-approach	4	1.458	1	.227	1.00	.998	.0062	.0274
Performance-avoidance	6	3.078	6	.799	.999	.997	.0133	.0000
Intrinsic value	4	.0106	1	.918	1.00	1.00	.0006	.0000
Test anxiety	4	0	0	1.00	-	-	-	-
Self-efficacy	9	34.4	22	.045	.996	.991	.0381	.0307
Regulatory strategy use	11	55.14	40	.056	.993	.988	.0521	.0248
Cognitive strategy use	7	11.65	10	.309	.998	.993	.0258	.0164

Note. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

7.3.3 Descriptive Statistics

The distributional properties of the composite scales were then examined for use in multilevel multiple regression and structural equation modelling analyses. Analyses using PRELIS showed no systematic patterns for the missing data and thus a listwise method was employed in dealing with missing data. Descriptive statistics and univariate normality tests of the raw composite scale data are presented in Tables 7.12 and 7.13. These results show, like Study 1, that the composite scale data, even after completion of the one-factor congeneric modelling analyses described above, was not normally distributed with most composites exhibiting significant skewness and kurtosis. Normalised values of the raw composite scale scores were achieved using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b), which rescores the raw composite scale scores on the basis of normal equivalent deviates in accordance with the original score rankings (Rowe, 2003, 2006). The resultant descriptive statistics and univariate normality tests of the normalised composite scale data are shown in Tables 7.14 and 7.15. This process resulted in most composite scales having distributional properties close to being normal distributed with insignificant skewness and kurtosis. Despite normalisation, one classroom level composite, share control, still exhibited significant skewness and kurtosis. This was also the case in Study 1. Shared control was significantly positively skewed with many students reporting they perceive their science classroom as being low in shared control. Hence this classroom learning environment variable was transformed into dichotomous nominal types (1 = low, 2 = high) using a median-split procedure. Students were classified as having a high shared control perception of their classroom if their normalised shared control composite scale score was ≥ 0.000 (the median value); students with normalised share control composite scores < 0.000 were classified as perceiving their science classroom being a low in shared control. The normalised composite scale scores were used in multilevel multiple regression and structural equation modelling analyses. Despite satisfactorily achieving normality for independent composites, multivariate normality tests were still significant even with the exclusion of the dichotomous variable, shared control (Table 7.16). Four multiple goal constructs (Mastery-approach X Mastery-avoidance, Mastery-approach X Performance-approach, Performance-approach X Performance-avoidance, Mastery-avoidance X Performance-avoidance) were formed from the relevant composite scales in order to investigate the impact of multiple achievement goals. The composite scale scores for each of these were also normalised (Table 7.17).

Table 7.12

Classroom Learning Environment Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 2)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Personal relevance	3.552	.712	1.35-5	1-5	-.575	-5.349	.000	.339	1.566	.117	31.07	.000
Uncertainty	3.615	.616	1-5	1-5	-.468	-4.441	.000	.553	2.306	.021	25.04	.000
Critical voice	3.292	.973	1-5	1-5	-.297	-2.894	.004	-.509	-3.338	.001	19.52	.000
Shared control	1.886	.720	1-4.21	1-5	.605	5.593	.000	-.223	-1.158	.247	32.63	.000
Student negotiation	3.475	.896	1-5	1-5	-.455	-4.332	.000	.109	.618	.537	19.15	.000

Note. n = 583.

Table 7.13

Personal Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 2)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	5.423	1.104	1.33-7	1-7	-.834	-7.315	.000	.395	1.768	.077	56.64	.000
Mastery-avoidance	3.478	1.262	.66-7	1-7	.341	3.309	.001	.007	.132	.895	10.97	.004
Performance-approach	4.422	1.645	1-7	1-7	-.193	-1.906	.057	-.798	-6.786	.000	49.68	.000
Performance-avoidance	4.289	1.230	1-7	1-7	-.101	-1.007	.314	-.440	-2.731	.006	8.47	.014
Intrinsic value	4.409	1.358	1-7	1-7	-.293	-2.858	.004	-.315	-1.775	.076	11.32	.003
Test anxiety	3.678	1.440	1-7	1-7	.161	1.595	.111	-.699	-5.390	.000	31.60	.000
Self-efficacy	4.189	1.165	1-7	1-7	-.015	-.152	.879	-.267	-1.448	.148	2.12	.346
Regulatory strategy use	4.673	1.024	1-7	1-7	-.524	-4.919	.000	.840	3.148	.002	34.11	.000
Cognitive strategy use	3.967	1.255	1-7	1-7	-.071	-.704	.482	-.304	-1.698	.089	3.38	.185

Note. n = 583.

Table 7.14

Classroom Learning Environment Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 2)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Personal relevance	.000	.999	-3.136 – 2.798	-.009	-.087	.931	-.061	-.221	.825	.056	.972
Uncertainty	-.001	.998	-3.136 – 2.628	-.016	-.163	.871	-.083	-.339	.735	.14	.932
Critical voice	-.003	.985	-2.422 – 2.042	-.067	-.471	.638	-.315	-1.773	.076	3.36	.186
Shared control	.018	.956	-1.407 – 3.136	.261	2.556	.011	-.432	-2.665	.008	13.64	.001
Student negotiation	-.004	.987	-2.798 – 2.025	-.072	-.719	.472	-.255	-1.367	.172	2.39	.303

Note. $n = 583$.

Table 7.15

Personal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 2)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	-.003	.990	-3.136 – 2.097	-.069	-.683	.494	-.204	-1.039	.299	1.55	.461
Mastery-avoidance	.000	.999	-3.136 – 3.136	.002	.028	.982	-.040	-.108	.914	.012	.994
Performance-approach	-.002	.983	-2.316 – 2.042	-.037	-.370	.712	-.341	-1.962	.050	3.99	.136
Performance-avoidance	.000	1.00	-3.136 – 3.136	.000	.000	1.00	-.033	-.072	.943	.01	.997
Intrinsic value	.000	.994	-2.566 – 2.464	-.008	-.083	.934	-.175	-.862	.388	.75	.687
Test anxiety	.002	.992	-2.230 – 2.798	.040	.396	.692	-.199	-1.013	.311	1.18	.554
Self-efficacy	.000	.998	-3.136 – 2.704	-.012	-.120	.904	-.072	-.278	.781	.09	.955
Regulatory strategy use	.000	.998	-2.926 – 2.704	-.008	-.079	.937	-.086	-.354	.723	.13	.936
Cognitive strategy use	.000	.996	-2.566 – 2.798	.011	.114	.909	-.120	-.546	.585	.31	.856

Note. $n = 583$.

Table 7.16

Multivariate Normality Tests for Normalised Data (Study 2)

Variables measured	Effective sample size	Skewness			Kurtosis			Skewness and Kurtosis	
		value	z-score	*p*	value	z-score	*p*	χ^2	*p*
All	583	43.88	39.57	.000	427.1	17.63	.000	1876	.000
All except for shared control	583	41.36	40.08	.000	387.6	17.68	.000	1919	.000

Note. $n = 583$.

Table 7.17

Personal Multiple Goal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 2)

Variable[a]	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach X Mastery-avoidance	.000	1.000	-3.136 – 3.136	.000	.000	1.00	-.033	-.072	.943	.005	.997
Mastery-approach X Performance-approach	.000	.999	-3.136 – 3.136	-.002	-.019	.985	-.038	-.097	.923	.010	.995
Performance-approach X Performance-avoidance	.000	1.00	-3.136 – 3.136	.000	.000	1.00	-.033	-.072	.943	.005	.997
Mastery-avoidance X Performance-avoidance	.000	1.00	-3.136 – 3.136	.000	.000	1.00	-.033	-.072	.943	.005	.997

Note. $n = 583$. [a]Multiple goals were formed initially using personal goals normalised data and then normalised.

Variance-covariance relations of the normalised composite scales are found in Table 7.18. Although Pearson product-moment correlations are invalid measures when data are not-normally distributed and ordinal (Jöreskog, 1990; Rowe, 2006), they may be of interest when the composite scale scores satisfy normal distribution properties, as in the case of this study. Correlations among the variables are presented in Table 7.19. Note the similarity between the correlation values with those obtained for the covariances amongst the variables. Of particular interest were the positive relations between the constructivist pedagogy dimensions with mastery-approach goals, intrinsic value, self-efficacy, cognitive strategy, and regulatory strategy constructs. All personal achievement goals had positive relations with each other; they also positively related to the motivational beliefs of intrinsic value, test anxiety, and self-efficacy, and with the cognitive and regulatory strategy constructs. Compared to males, females reported to have lower mastery-avoidance, lower performance-approach, greater test anxiety, lower self-efficacy and greater use of cognitive strategies. Females also reported they perceived greater student negotiation in their science classroom than males. These results are almost identical to those obtained in Study 1. There was no difference between regular and selective school students regarding the use of cognitive and regulatory strategies, a result different to Study 1. Selective students perceived their science classroom to have a greater emphasis on student negotiation, as in Study 1, but less emphasis on critical voice than regular students. Selective students also reported greater mastery-avoidance but less performance-avoidance and lower self-efficacy than regular students. Junior students perceived less emphasis in their science classroom in terms of uncertainty, shared control, and student negotiation than seniors; these results almost identical to those obtained in Study 1. Juniors also had lower mastery-approach goals, intrinsic value, performance-approach, but more mastery-avoidance than seniors.

Table 7.18

Variance-Covariance Estimates for Variables - Normalised Data (Study 2)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Personal relevance	.997																				
2. Uncertainty	.239	.995																			
3. Critical voice	.198	.211	.970																		
4. Shared control[a]	.207	.050	.179	1.00																	
5. Student negotiation	.218	.191	.194	.224	.975																
6. Mastery-approach	.372	.145	.212	.104	.257	.980															
7. Mastery-avoidance	.082	.027	.054	.162	.068	.228	.999														
8. Performance-approach	.256	.087	.065	.172	.114	.391	.351	.967													
9. Performance-avoidance	.120	.027	.003	.066	.080	.230	.426	.405	.999												
10. Intrinsic value	.448	.124	.227	.221	.245	.570	.174	.297	.136	.988											
11. Test anxiety	.003	.013	-.042	.028	.055	-.015	.292	.107	.382	-.033	.984										
12. Self-efficacy	.263	.126	.119	.187	.100	.435	.259	.445	.217	.445	-.170	.997									
13. Regulatory strategies	.348	.215	.200	.222	.348	.571	.219	.328	.254	.582	.030	.469	.996								
14. Cognitive strategies	.247	.141	.115	.283	.264	.382	.167	.257	.287	.373	.139	.327	.665	.993							
15. Mastery-approach x Mastery-avoidance	-.073	-.056	-.120	-.050	-.032	-.036	.011	.016	.082	-.072	.032	-.022	-.027	.006	.999						
16. Mastery-approach x Performance-approach	-.102	-.019	-.009	.000	-.022	-.098	.001	.040	-.045	-.059	-.067	.031	-.016	.023	.280	.999					

Table 7.18 *Continued*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
17. Performance-approach x Performance-avoidance	-.039	-.012	.001	-.025	-.067	-.077	-.045	-.035	-.035	-.073	-.009	-.038	-.052	-.027	.131	.206	.999				
18. Mastery-avoidance x Performance-avoidance	-.035	.015	-.060	.041	.066	.061	.013	-.035	-.023	.010	-.040	-.008	.001	.025	.230	.063	.330	.999			
19. Gender[b]	-.038	.010	.058	-.100	.231	-.078	-.205	-.237	.003	-.089	.124	-.232	.029	.178	.049	-.030	-.052	.016	1.00		
20. Student type[c]	.091	.123	-.123	.101	.201	.049	-.240	.032	-.175	.007	-.092	-.135	.068	.022	-.089	-.153	.002	.065	-.056	1.00	
21. Age[d]	-.065	-.118	-.030	-.176	-.132	-.171	.159	-.244	.063	-.192	-.002	-.006	-.032	-.029	.089	.049	-.020	-.014	.128	-.353	1.00

Note. n = 583; [a]Shared control is coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior.

Table 7.19

Intercorrelations among Variables - Normalised Data (Study 2) Pearson Product Moment Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Personal relevance	-																				
2. Uncertainty	.240**	-																			
3. Critical voice	.201**	.214**	-																		
4. Shared control[a]	.166**	.040	.145**	-																	
5. Student negotiation	.221**	.194**	.200**	.181**	-																
6. Mastery-approach	.376**	.147**	.217**	.084*	.263**	-															
7. Mastery-avoidance	.083*	.027	.055	.130**	.069	.230**	-														
8. Performance-approach	.261**	.089*	.067	.139**	.117**	.402**	.358**	-													
9. Performance-avoidance	.120**	.027	.003	.053	.081	.232**	.427**	.412**	-												
10. Intrinsic value	.452**	.125**	.232**	.177**	.250**	.579**	.175**	.304**	.137**	-											
11. Test anxiety	.003	.013	-.043	.022	.057	-.015	.295**	.110**	.386**	-.034	-										
12. Self-efficacy	.264**	.126**	.121**	.150**	.102*	.440**	.260**	.453**	.218**	.449**	-.172**	-									
13. Regulatory strategies	.349**	.215**	.203**	.178**	.353**	.578**	.219**	.335**	.255**	.587**	.030	.471**	-								
14. Cognitive strategies	.248**	.142**	.117**	.227**	.268**	.387**	.168**	.262**	.288**	.377**	.141**	.329**	.669**	-							
15. Mastery-approach x Mastery-avoidance	-.073	-.056	-.122**	-.040	-.032	-.036	.011	.016	.082*	-.073	.032	-.022	-.027	.006	-						
16. Mastery-approach x Performance-approach	-.103*	-.019	.009	.000	-.022	-.099*	.001	.040	-.045	-.059	-.067	.031	-.016	.023	.281**	-					

Table 7.19 *Continued*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
17. Performance-approach x Performance-avoidance	-.039	-.012	.001	-.020	-.068	-.078	-.045	-.036	-.035	-.073	-.009	-.038	-.052	-.027	.131**	.207**	-	-			
18. Mastery-avoidance x Performance-avoidance	-.035	.015	-.061	.033	.066	.062	.013	-.035	-.023	.010	-.041	-.008	.001	.025	.230**	.063	.331**	-	-		
19. Gender[c]	-.030	.008	.047	-.064	.187**	-.063	-.163**	-.192**	.002	-.072	.100*	-.185**	.023	.142**	.039	-.024	-.041	.013	-		
20. Student type[d]	.072	.098*	-.100*	.064	.163**	.040	-.192**	.026	-.140**	.006	-.074	-.108**	.055	.017	-.071	-.122**	.002	.052	-.035	-	
21. Age[e]	-.050	-.091*	-.023	-.111**	-.103*	-.132**	.123**	-.192**	.049	-.149**	-.001	-.005	-.024	-.022	.070	.038	-.016	-.011	.080	-.223**	-

Note. n = 583; [a]Shared control is coded 0 = low and 1 = high; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. * *p* < .05. ** *p* < .01.

7.3.4 Regression Analyses: Preliminary Multilevel Regression Modelling Analyses

Multilevel multiple regression analyses using *MLwiN* 2.0 were used in the same way as reported in Study 1 to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals and self-regulated learning (cognitive and regulatory strategy use). The data collected for this study came from a total of 31 classes clustered within nine schools. Consequently, the multilevel analyses of this study were constrained to a two-level hierarchy, with students at the first level and their classroom membership forming the second level.

The multilevel variance components models for all variables are reported in Tables 7.20 and 7.21. For the classroom learning environment variables, the variance of residuals attributed to the class-level ranged from 3.4 to 8.9% while the variance attributed to the personal-level ranged from 91.1 to 96.6%. For the personal variables, the variance of residuals attributed to the class-level ranged from 0 to 15.5% and the variance accounted for at the personal-level ranged from 84.5 to 100%. These results indicate that, much of the variance associated with the reporting of personal goals is accounted for at the personal level and not to classroom-level differences.

Table 7.20

Classroom Learning Environment Constructs: Base Variance Components Models (Study 2)

Construct	Fixed part	Random Part (Residual variance)				
	Intercept	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_{T}
Personal relevance	.010 (.064)	.076 (.032)	7.7	.912 (.055)	92.3	.988
Uncertainty	.005 (.054)	.036 (.022)*	3.6	.957 (.058)	96.4	.993
Critical voice	.009 (.061)	.065 (.029)	6.7	.903 (.054)	93.3	.968
Shared control[b]	.031 (.051)	.031 (.020)*	3.4	.882 (.053)	96.6	.913
Student negotiation	-.002 (.066)	.086 (.034)	8.9	.884 (.053)	91.1	.970

Note. n = 583. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test); [b]not normally distributed.

Table 7.21

Personal Constructs: Base Variance Components Models (Study 2)

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach	.001 (.061)	.063 (.029)	6.4	.920 (.055)	93.6	.983
Mastery-avoidance	-.002 (.061)	.062 (.029)	6.2	.941 (.057)	93.8	1.003
Performance-approach	.010 (.057)	.050 (.025)	5.2	.915 (.055)	94.8	.965
Performance-avoidance	-.004 (.056)	.045 (.025)*	4.5	.953 (.057)	95.5	.998
Intrinsic value	.030 (.080)	.151 (.050)	15.5	.823 (.050)	84.5	.974
Test anxiety	.004 (.045)	.010 (.016)*	1.0	.972 (.058)	99.0	.982
Self-efficacy	.004 (.059)	.055 (.027)	5.5	.941 (.057)	94.5	.996
Regulatory strategy use	-.003 (.068)	.091 (.036)	9.2	.903 (.054)	90.8	.994
Cognitive strategy use	-.004 (.062)	.069 (.030)	7.0	.921 (.055)	93.0	.990

Table 7.21 *Continued*

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach X Mastery-avoidance	-.003 (.045)	.008 (.015)	.8	.990 (.059)	99.2	.998
Mastery-approach X Performance-approach	-.001 (.048)	.019 (.018)	1.9	.978 (.059)	98.1	.997
Performance-approach X Performance-avoidance	.000 (.041)	.000 (.000)	0	.998 (.058)	100	.998
Mastery-avoidance X Performance-avoidance	.000 (.041)	.000 (.000)	0	.998 (.058)	100	.998

Note. n = 583. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

As reported in Study 1, the second type of multilevel variance components models incorporated the subpopulation variables of age (junior or senior), gender and school type (regular or selective) as fixed effects explanatory variables ("classifier variables") with the residual variance of the construct under focus being partitioned into the level 1 (student-level) and level 2 (class-level) units with no other explanatory variables involved.. The results of these analyses are reported in Tables 7.22 to 7.23. Note the exclusion of the dichotomous classroom learning environment variable of share control in these models. For each construct, the incorporation of the classifier variables significantly improved the fit of the model beyond the initial multilevel variance components model. For the classroom learning environment variables, the variance of residuals attributed to the class-level ranged from 2.2 to 7.2% while the variance attributed to the personal-level ranged from 93.5 to 97.8%. For the personal variables, the variance of residuals attributed to the class-level ranged from 0 to 13.6% and the variance accounted for at the personal-level ranged from 86.4 to 100%. These results indicate that most of the variance associated with the reporting of both the classroom-level and personal-based constructs is accounted for at the personal level and not to classroom-level differences. Results of interest include the relatively large degree of variance at the class-level (13.6%) for intrinsic value reported by students in their science classroom. This is much larger than the next largest amount of personal-level variation reported, which was attributed to regulatory strategy use (9.3%). Intrinsic value also achieved significant variance at the class-level, although small (6.5%) in Study 1.

Table 7.22

Classroom Learning Environment Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 2)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Personal relevance	.019 (.134)	-.069 (.131)*	-.043 (.081)*	.097 (.129)*	.071 (.031)	7.2	.912 (.055)	92.8
Uncertainty	-.017 (.109)	-.141 (.103)*	.036 (.082)*	.165 (.101)*	.022 (.019)*	2.2	.957 (.058)	97.8
Critical voice	.158 (.125)	-.099 (.121)*	.091 (.080)*	-.254 (.119)	.053 (.026)	5.6	.899 (.054)	94.4
Student negotiation	-.208 (.126)	-.192 (.122)*	.396 (.078)	.251 (.121)	.059 (.027)	6.5	.847 (.051)	93.5

Note. n = 583; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

Table 7.23

Personal Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 2)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach	.196 (.119)	-.267 (.114)	-.085 (.081)*	.008 (.112)*	.041 (.023)*	4.3	.920 (.055)	95.7
Mastery-avoidance	.243 (.105)	.211 (.099)	-.358 (.080)	-.380 (.097)	.019 (.017)*	2.1	.903 (.054)	97.9
Performance-approach	.419 (.100)	-.369 (.093)	-.347 (.079)	-.049 (.091)*	.012 (.015)*	1.3	.887 (.053)	98.7
Performance-avoidance	.121 (.112)	.053 (.106)*	-.011 (.082)*	-.284 (.104)	.027 (.020)*	2.8	.951 (.057)	97.2
Intrinsic value	.256 (.157)	-.283 (.157)*	-.063 (.077)*	-.069 (.155)*	.129 (.044)	13.6	.823 (.050)	86.4
Test anxiety	.027 (.098)	-.053 (.090)*	.196 (.082)	-.154 (.088)*	.005 (.014)*	.5	.962 (.058)	99.5
Self-efficacy	.310 (.115)	-.016 (.109)*	-.362 (.081)	-.237 (.107)	.033 (.021)*	3.5	.914 (.055)	96.5
Regulatory strategy use	-.074 (.144)	-.039 (.142)*	.093 (.081)*	.096 (.140)*	.092 (.036)	9.3	.899 (.054)	90.7
Cognitive strategy use	-.128 (.134)	-.062 (.131)*	.303 (.080)	.033 (.129)*	.072 (.031)	7.4	.897 (.054)	92.6

Table 7.23 *Continued*

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach X Mastery-avoidance	-.038 (.096)	.112 (.088)*	.065 (.083)*	-.117 (.085)*	.000 (.000)*	0	.989 (.058)	100
Mastery-approach X Performance-approach	.141 (.098)	.026 (.090)*	-.057 (.082)*	-.241 (.087)	.003 (.014)*	.3	.978 (.059)	99.7
Performance-approach X Performance-avoidance	.058 (.096)	-.027 (.088)*	-.080 (.083)*	-.006 (.085)*	.000 (.000)*	0	.996 (.058)	100
Mastery-avoidance X Performance-avoidance	-.069 (.096)	-.001 (.088)*	.029 (.083)*	.104 (.085)*	.000 (.000)*	0	.995 (.058)	100

Note. n = 583; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

7.3.5 Regression Analyses: Environmental and Personal Predictors of Achievement Goals

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals. The classroom environmental factors that were the focus of this study included only the constructivist pedagogy dimensions, unlike Study 1 which also included the classroom goal and metacognitive structures. The motivational beliefs of intrinsic value, self-efficacy and test anxiety served as the personal factors. In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors (or explanatory variables) of achievement goals and self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). Each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1). As described above, shared control was transformed into a dichotomous categorical variable due to its non-normal distribution characteristics (0 = low, 1 = high).

Mastery-approach goals

The eleven-explanatory variable model explained 41.5% of variance in the mastery-approach goal (Table 7.24). Significant predictors of mastery-approach goals were: personal relevance ($\beta = 0.111$, $p < .05$), critical voice ($\beta = 0.085$, $p < .05$), shared control ($\beta = -0.071$, $p < .05$), student negotiation ($\beta = 0.103$, $p < .05$), intrinsic value ($\beta = 0.403$, $p < .001$), and self-efficacy ($\beta = 0.227$, $p < .001$). All of these explanatory variables except for shared control were positive predictors of mastery-approach goals. There was no significant variance of mastery-approach goals attributable to class membership. No other variables acquired significance. The Study 1 results for mastery-approach also showed personal relevance, student negotiation, intrinsic value and self-efficacy to be positive predictors.

Table 7.24

Multilevel Regression Analysis Model Results for Mastery-Approach[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.104 (.100)	-
Gender[b]	-.028 (.066)	-.014
Student type[c]	.081 (.088)	.041
Age[d]	-.121 (.089)	-.061
Personal relevance	.110 (.036)*	.111
Uncertainty	.008 (.033)	.008
Critical voice	.085 (.034)*	.085
Shared control[e]	-.142 (.066)*	-.071
Student negotiation	.103 (.035)*	.103
Intrinsic value	.401 (.040)**	.403
Test anxiety	.047 (.032)	.047
Self-efficacy	.225 (.037)**	.227
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.024 (.014)	
Student level variance (σ^2_{e0})	.551 (.033)**	
% of variance explained	41.5	
-2loglikelihood (IGLS deviance)	1324.5	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Mastery-avoidance goals

The eleven-explanatory variable model explained 25.9% of variance in the mastery-avoidance goal (Table 7.25). Shared control was a positive predictor of mastery-avoidance goals (β = -0.078, p < .05) as were test anxiety (β = 0.343, p < .001), and self-efficacy (β = 0.221, p < .001). Females reported to have less mastery-avoidance than males (β = -0.179, p < .001) and juniors reported greater mastery-avoidance than seniors (β = 0.138, p < .05). There was no significant variance of mastery-avoidance goals attributable to class membership. No other variables acquired significance. The Study 1 results for mastery-avoidance also showed test anxiety and self-efficacy to be positive predictors. Gender was also a negative predictor of mastery-avoidance in Study 1.

Performance-approach goals

The eleven-explanatory variable model explained 31.0% of variance in the performance-approach goal (Table 7.26). Personal relevance (β = 0.118, p < .05), test anxiety (β = 0.195, p < .001), and self-efficacy (β = 0.421, p < .001) were positive predictors of mastery-avoidance. Age was a negative predictor of performance-approach goals (β = -0.160, p < .001), with juniors reporting less performance-approach than seniors. Gender was also a negative predictor of performance-approach, with females reporting to have less performance-approach than males (β = -0.118, p < .05). No other variables acquired significance. The Study 1 results for performance-approach also showed test anxiety and self-efficacy to be positive predictors. Gender was also a negative predictor of performance-approach in Study 1.

Table 7.25

Multilevel Regression Analysis Model Results for Mastery-Avoidance[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.068 (.107)	-
Gender[b]	-.357 (.075)**	-.179
Student type[c]	-.290 (.093)*	-.145
Age[d]	.285 (.093)*	.138
Personal relevance	-.038 (.042)	-.038
Uncertainty	.001 (.038)	.001
Critical voice	.003 (.039)	.003
Shared control[e]	.156 (.075)*	.078
Student negotiation	.065 (.040)	.064
Intrinsic value	.087 (.046)	.087
Test anxiety	.345 (.037)**	.343
Self-efficacy	.221 (.042)**	.221
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.019 (.015)	
Student level variance (σ^2_{e0})	.724 (.044)**	
% of variance explained	25.9	
-2loglikelihood (IGLS deviance)	1478.4	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Table 7.26

Multilevel Regression Analysis Model Results for Performance-Approach[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.263 (.090)*	-
Gender[b]	-.232 (.071)*	-.118
Student type[c]	.064 (.073)	.032
Age[d]	-.326 (.073)**	-.160
Personal relevance	.116 (.039)*	.118
Uncertainty	-.021 (.036)	-.021
Critical voice	-.005 (.037)	-.005
Shared control[e]	.031 (.071)	.016
Student negotiation	.032 (.038)	.032
Intrinsic value	.028 (.043)	.028
Test anxiety	.193 (.035)**	.195
Self-efficacy	.415 (.040)**	.421
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.000 (.000)	
Student level variance (σ^2_{e0})	.666 (.039)**	
% of variance explained	31.0	
-2loglikelihood (IGLS deviance)	1417.8	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Performance-avoidance goals

The eleven-explanatory variable model explained 24.4% of variance in the performance-avoidance goal (Table 7.27). Test anxiety (β = 0.421, p < .001), and self-efficacy (β = 0.252, p < .001) were positive predictors of performance-avoidance. Unlike the result in Study 1, student type (β = -0.089, p < .05) was a negative predictor, with selective school students reporting to have less performance-avoidance than regular students. There was no significant variance of performance-avoidance goals attributable to class membership. No other variables acquired significance. The Study 1 results for performance-avoidance also showed test anxiety and self-efficacy to be positive predictors.

Table 7.27

Multilevel Regression Analysis Model Results for Performance-Avoidance[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.040 (.104)	-
Gender[b]	-.008 (.076)	-.008
Student type[c]	-.178 (.088)*	-.089
Age[d]	.088 (.089)	.043
Personal relevance	.053 (.042)	.053
Uncertainty	-.013 (.038)	-.013
Critical voice	-.037 (.040)	-.036
Shared control[e]	.001 (.075)	.001
Student negotiation	.045 (.041)	.044
Intrinsic value	.015 (.046)	.015
Test anxiety	.424 (.037)**	.421
Self-efficacy	.253 (.043)**	.252
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.013 (.012)	
Student level variance (σ^2_{e0})	.741 (.045)**	
% of variance explained	24.4	
-2loglikelihood (IGLS deviance)	1488.5	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

7.3.6 Regression Analyses: Environmental and Personal Predictors of Self-Regulated Learning

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environmental and personal factors with each of the constructs that represented self-regulated learning in the study, namely cognitive strategy and regulatory strategy use. In Study 2 the classroom environmental factors included the constructivist pedagogy dimensions; the personal factors included the personal achievement goals and the motivational beliefs of intrinsic value, self-efficacy and test anxiety. In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors of self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). As for the regressions employed above for the personal achievement goals, each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1). Four interactions were introduced for this set of regression analyses in order to ascertain the effects (that is, the interaction) of multiple goal models on self-regulated learning. Each approach goal was combined with its avoidance counterpart (mastery-approach X mastery-avoidance, performance-approach X performance-avoidance) and each approach goal combined (mastery-approach X performance-approach) and each the interaction of each avoidance goal (mastery-avoidance X performance-avoidance). As described above, shared control was transformed into a dichotomous categorical variable due to its non-normal distribution characteristics (0 = low, 1 = high).

Regulatory strategies

The nineteen-explanatory variable model explained 52.4% of variance in the use of regulatory strategies (Table 7.28). Positive predictors of regulatory strategies were: student negotiation ($\beta = 0.138$, $p < .001$), intrinsic value ($\beta = 0.299$, $p < .001$), self-efficacy ($\beta = 0.189$, $p < .001$), mastery-approach ($\beta = 0.261$, $p < .001$), and performance-avoidance ($\beta = 0.083$, $p < .05$). Gender was a positive predictor of regulatory strategy use ($\beta = 0.072$, $p < .05$), with females reporting to use more regulatory strategies than males. Age was also a positive predictor of regulatory strategy use ($\beta = 0.083$, $p < .05$), with juniors reporting to have greater regulatory strategy use than seniors. There was no significant variance of regulatory strategy use attributable to class membership. No other variables acquired significance. The Study 1 results for regulatory strategy use also showed student negotiation, intrinsic value, self-efficacy, mastery-approach, performance-avoidance and gender to be positive predictors.

Table 7.28

Multilevel Regression Analysis Model Results for Regulatory Strategy Use[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	-.310 (.090)	-
Gender[b]	.143 (.061)*	.072
Student type[c]	.153 (.080)	.076
Age[d]	.172 (.082)*	.083
Personal relevance	-.005 (.034)	-.005
Uncertainty	.091 (.030)8	.091
Critical voice	.004 (.032)	.004
Shared control[e]	.103 (.060)	.052
Student negotiation	.140 (.033)**	.138
Intrinsic value	.300 (.040)**	.299
Test anxiety	.031 (.034)	.031
Self-efficacy	.189 (.037)**	.189
Mastery-approach	.263 (.039)**	.261
Mastery-avoidance	.008 (.035)	.008
Performance-approach	.005 (.038)	.005
Performance-avoidance	.083 (.036)*	.083
Mastery-approach X Mastery-avoidance	.010 (.031)	.010
Mastery-approach X Performance-approach	.035 (.031)	.035
Performance-approach X Performance-avoidance	.022 (.031)	.022
Mastery-avoidance X Performance avoidance	-.045 (.031)	-.045
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.018 (.011)	
Student level variance (σ^2_{e0})	.455 (.027)**	
% of variance explained	52.4	
-2loglikelihood (IGLS deviance)	1212.9	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Cognitive strategies

The nineteen-explanatory variable model explained 32.5% of variance in the use of cognitive strategies (Table 7.29). Positive predictors of cognitive strategies were: shared control ($\beta = 0.052$, $p < .001$), student negotiation ($\beta = 0.138$, $p < .05$), intrinsic value ($\beta = 0.299$, $p < .05$), self-efficacy ($\beta = 0.189$, $p < .001$), mastery-approach ($\beta = 0.261$, $p < .001$), and performance-avoidance ($\beta = 0.083$, $p < .001$). Gender was a positive predictor of cognitive strategy use ($\beta = 0.072$, $p < .001$), with females reporting to use more cognitive strategies than males. There was no significant variance of cognitive strategy use attributable to class membership. No other variables acquired significance. The Study 1 results for cognitive strategy use also showed intrinsic value, self-efficacy, mastery-approach, performance-avoidance and gender to be positive predictors.

The regression analyses presented above were used to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals and self-regulated learning for high school science students. Synopses of the significant predictors of personal achievement goals and self-regulated learning as yielded by the regression analyses are presented in Table 7.30.

Table 7.29

Multilevel Regression Analysis Model Results for Cognitive Strategy Use[a] (Study 2)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	-.419 (.106)	-
Gender[b]	.347 (.073)**	.072
Student type[c]	.095 (.094)	.076
Age[d]	.085 (.095)	.083
Personal relevance	.014 (.040)	-.005
Uncertainty	.050 (.036)	.091
Critical voice	-.029 (.038)	.004
Shared control[e]	.297 (.072)**	.052
Student negotiation	.083 (.039)*	.138
Intrinsic value	.139 (.047)*	.299
Test anxiety	.110 (.040)*	.031
Self-efficacy	.178 (.044)**	.189
Mastery-approach	.179 (.046)**	.261
Mastery-avoidance	-.033 (.042)	.008
Performance-approach	.002 (.045)	.005
Performance-avoidance	.144 (.042)**	.083
Mastery-approach X Mastery-avoidance	-.009 (.037)	.010
Mastery-approach X Performance-approach	.072 (.037)	.035
Performance-approach X Performance-avoidance	.017 (.037)	.022
Mastery-avoidance X Performance avoidance	.001 (.037)	-.045
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.023 (.015)	
Student level variance (σ^2_{e0})	.645 (.039)**	
% of variance explained	32.5	
-2loglikelihood (IGLS deviance)	1414.3	

Note. n = 583 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior; [e]Shared control is coded 0 = low and 1 = high. * $p < .05$. ** $p < .001$.

Table 7.30

Synopsis of Significant Predictors of Personal Achievement Goals and Self-Regulated Learning for High School Science Students (Study 2)

Mastery-approach	Mastery-avoidance	Performance-approach	Performance-avoidance	Cognitive strategy use	Regulatory strategy use
personal relevance (+)	gender[a] (-)	gender[a] (-)	student type[b] (-)	gender[a] (+)	gender[a] (+)
student negotiation (+)	student type[b] (-)	age (-)	test anxiety (+)	shared control[b] (+)	age[b] (+)
critical voice (+)	age[c] (+)	personal relevance (+)	self-efficacy (+)	student negotiation (+)	student negotiation (+)
shared control (-)	shared control[d] (+)	test anxiety (+)		intrinsic value (+)	intrinsic value (+)
intrinsic value (+)	test anxiety (+)	self-efficacy (+)		self-efficacy (+)	self-efficacy (+)
self-efficacy (+)	self-efficacy (+)			mastery-approach (+)	mastery-approach (+)
				performance-avoidance (+)	performance-avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior; [d]Shared control is coded 0 = low and 1 = high. All relationships are significant at a minimum of $p < .05$.

7.3.7 Structural Equation Modelling Analyses: Environmental and Personal Predictors of Self-Regulated Learning

Structural equation modelling was used to analyse the simultaneous relationships between the explanatory and response variables; Study 2 thereby replicating the procedures employed in Study 1. The multilevel multiple regression analyses revealed most of the variance of the response variables, namely personal achievement goals and cognitive and regulatory strategy use, was attributed to the student-level. Furthermore, the base variance components models showed that the majority of variance of the classroom learning environment variables was also attributed to the student-level. Although the variances of many of these explanatory variables were statistically significant at the classroom-level, the amounts were relatively modest, ranging from 2.2 to 7.2%. Consequently, these results vindicate a single-level structural equation modelling approach for the data rather than a two-level structural equation modelling approach. In addressing the applicability of the structural equation modelling, the variances attributed to the classifier variables, namely gender, student age and student type, were removed. This was achieved by fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 (Rowe, 2006; Rowe & Hill, 1998; Rowe & Rowe, 1999), with the classifier variables of gender, student age and student type assigned as fixed explanatory variables; the residuals of the other variables are allowed to be random thus yielding a variance-covariance matrix of these variables which can be used for structural equation modelling. Unlike in Study 1, however, the residuals of the classroom learning environment dichotomous variable share control were allowed to be random since it was a significant explanatory variable in the above regressions. None of the multiple goal constructs were included in the structural equation modelling for substantive reasons. The results of fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 are displayed in Table 7.31.

Table 7.31

Results of Fitting a Student-Level Multivariate Model for the Classroom Learning Environment and Personal Constructs - Normalised Data (Study 2)

Fixed part of model		Random part of model															
Variable	Estimates (s.e.)	Variable		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gender[a]	-.028 (.031)	1.	Mastery-approach	**.967**	*.230*	*.402*	*.232*	*.579*	*.578*	*.387*	*.376*	*.147*	*.217*	*.084*	*.263*	*-.015*	*.440*
Student type[b]	-.023 (.032)	2.	Mastery-avoidance	.225	**1.004**	*.358*	*.427*	*.175*	*.219*	*.168*	*.083*	*.027*	*.055*	*.130*	*.069*	*.295*	*.260*
Age[c]	-.113 (.032)**	3.	Performance-approach	.374	.343	**.943**	*.412*	*.304*	*.335*	*.262*	*.261*	*.089*	*.067*	*.139*	*.117*	*.110*	*.453*
		4.	Performance-avoidance	.226	.432	.396	**1.003**	*.137*	*.255*	*.288*	*.120*	*.027*	*.003*	*.053*	*.081*	*.386*	*.218*
		5.	Intrinsic value	.555	.170	.278	.131	**.971**	*.587*	*.377*	*.452*	*.125*	*.232*	*.177*	*.250*	*-.034*	*.449*
		6.	Regulatory strategies	.565	.223	.318	.258	.575	**.996**	*.669*	*.349*	*.215*	*.203*	*.178*	*.352*	*.030*	*.471*
		7.	Cognitive strategies	.378	.173	.248	.291	.368	.668	**.996**	*.248*	*.142*	*.117*	*.227*	*.268*	*.141*	*.329*
		8.	Personal relevance	.364	.085	.244	.122	.439	.348	.248	**.994**	*.240*	*.201*	*.166*	*.221*	*.003*	*.264*
		9.	Uncertainty	.137	.028	.074	.028	.115	.213	.141	.236	**.989**	*.214*	*.040*	*.194*	*.013*	*.126*
		10.	Critical voice	.205	.057	.053	.006	.219	.200	.117	.196	.208	**.968**	*.145*	*.200*	*-.043*	*.121*
		11.	Shared control[d]	.034	.067	.056	.027	.079	.088	.114	.080	.016	.070	**.247**	*.181*	*.022*	*.150*
		12.	Student negotiation	.251	.072	.103	.083	.238	.349	.266	.217	.189	.194	.088	**.974**	*.057*	*.102*
		13.	Test anxiety	-.019	.298	.098	.386	-.039	.033	.143	.004	.013	-.040	.012	.058	**.986**	*-.172*
		14.	Self-efficacy	.426	.260	.431	.217	.435	.467	.327	.259	.121	.116	.071	.098	-.170	**.990**

Note. n = 583 (effective sample size); [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior; [d]Shared control (low) is coded 0. Residual variance estimates (in bold) are on the diagonal with covariance estimates given below the diagonal.Pearson product moment Correlation estimates are given above the diagonal in italics. * $p < .05$. ** $p < .001$.

The variance-covariance matrix displayed in Table 7.31 was used in the structural equation modelling. Note that the variance-covariance matrix of the variables has been 'purged' (Rowe, 2006) of the variance attributed to the classifier variables thus increasing the generalisability of the structural equation modelling analyses.

The hypothesised self-regulated learning structural equation model is presented in Figure 7.1. This was an empirically-based model, using the significant relations determined in the Study 1 final self-regulated learning structural equation model. Using the maximum likelihood method of estimation via LISREL 8.72 (Jöreskog & Sörbom, 2005) showed, however, this initial model provided an unsatisfactory fit of the data with $\chi^2 = 172.6$ ($df = 45$, $p < .001$), RMSEA = 0.0722, SRMR = 0.0424, GFI = 0.958, AGFI = 0.903, CFI = 0.964, and NFI = 0.952 (Table 7.32). Revision of the initial model and the subsequent modelling was based upon the results obtained from the multilevel multiple regressions reported above and by investigating the suggested modification indices within substantive grounds using the maximum likelihood method of estimation via LISREL 8.72. This approach resulted in the final self-regulated learning structural equation model providing a satisfactory fit of the data with $\chi^2 = 49.0$ ($df = 36$, $p = .072$), RMSEA = 0.0251, SRMR = 0.0191, GFI = 0.988, AGFI = 0.965, CFI = 0.996, and NFI = 0.986 (Table 7.32). Using generalised least squares used as the estimation method also revealed the model to satisfactorily fit the data with $\chi^2 = 46.5$ ($df = 36$, $p = .113$), RMSEA = 0.0289, SRMR = 0.0201, GFI = 0.989, AGFI = 0.967, CFI = 0.981, and NFI = 0.928 (Table 7.32).

For clarity, the final model is presented over three figures (Figures 7.2 to 7.4). The standardised direct effects path model for the classroom learning environment variables is displayed in Figure 7.2. As hypothesised, the constructivist pedagogical dimensions had significant relations with personal achievement goals and self-regulated learning. Of these dimensions, student negotiation was a significant positive predictor of mastery-approach ($\gamma = 0.108$, $p < .01$) and intrinsic value ($\gamma = 0.139$, $p < .01$) while personal relevance was a positive predictor of intrinsic value (γ

= 0.408, $p < .001$). Student negotiation also had positive associations with regulatory strategy use ($\gamma = 0.197$, $p < .001$). Shared control had positive associations with cognitive strategy use ($\gamma = 0.121$, $p < .001$).

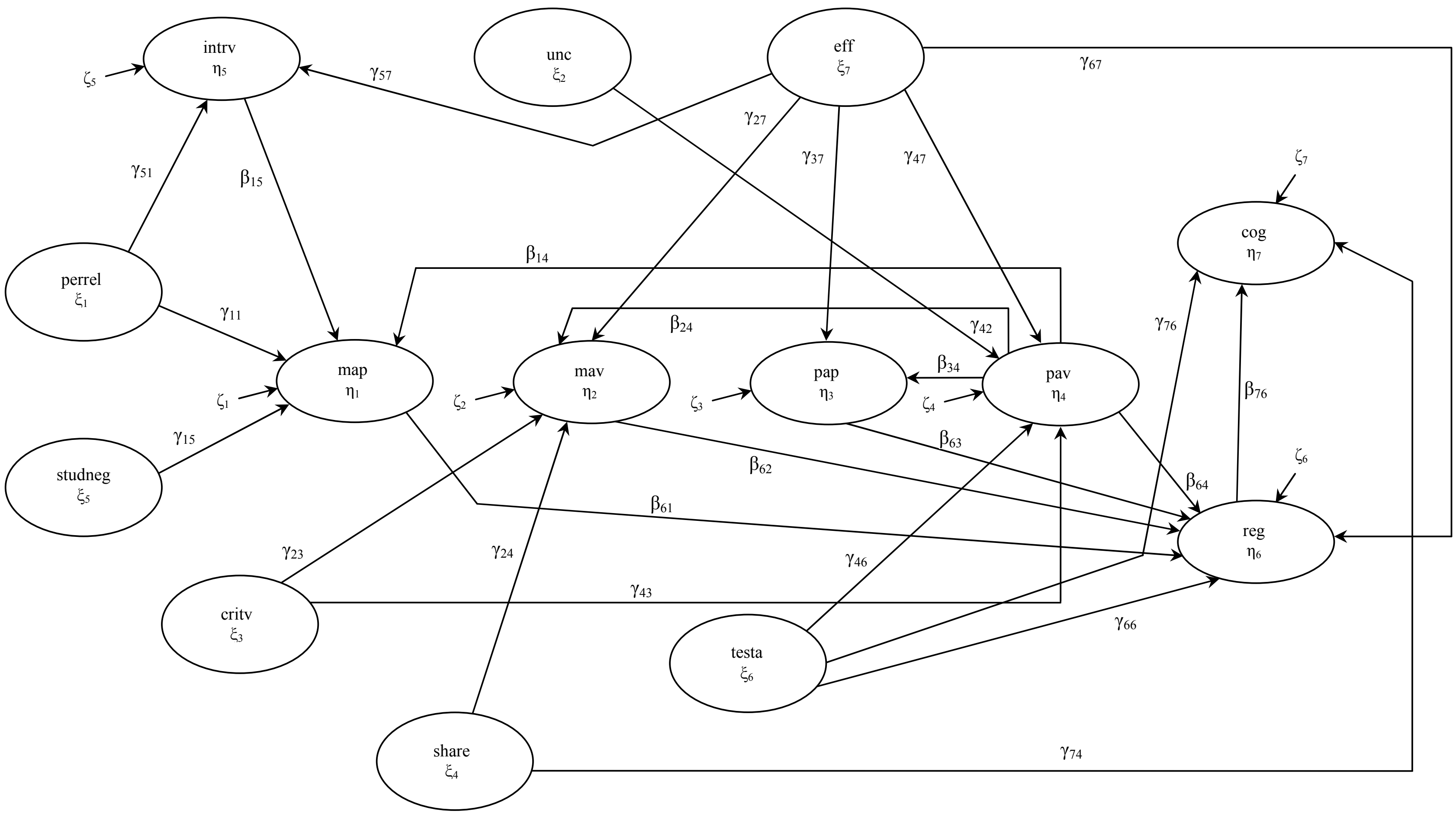

Figure 7.1. Hypothesised self-regulated learning structural equation model. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); shared control (share); student negotiation (studneg); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg).

Table 7.32

Self-Regulated Learning Structural Equation Model Fit Indices (Study 2)

Variable	χ^2	*df*	*p*	GFI	AGFI	NFI	CFI	SRMR	RMSEA
Hypothesised model	172.6	45	.000	.958	.903	.952	.964	.0424	.0722
Revised model[a]	49.0	36	.072	.988	.965	.986	.996	.0191	.0251
Revised model[b]	46.5	36	.113	.989	.967	.928	.981	.0201	.0289

Note. n = 583; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; p = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; SRMR = standardised root mean square residual; RMSEA = root mean square error of approximation; [a]Maximum likelihood used as the estimation method; [b]Generalised least squares used as the estimation method.

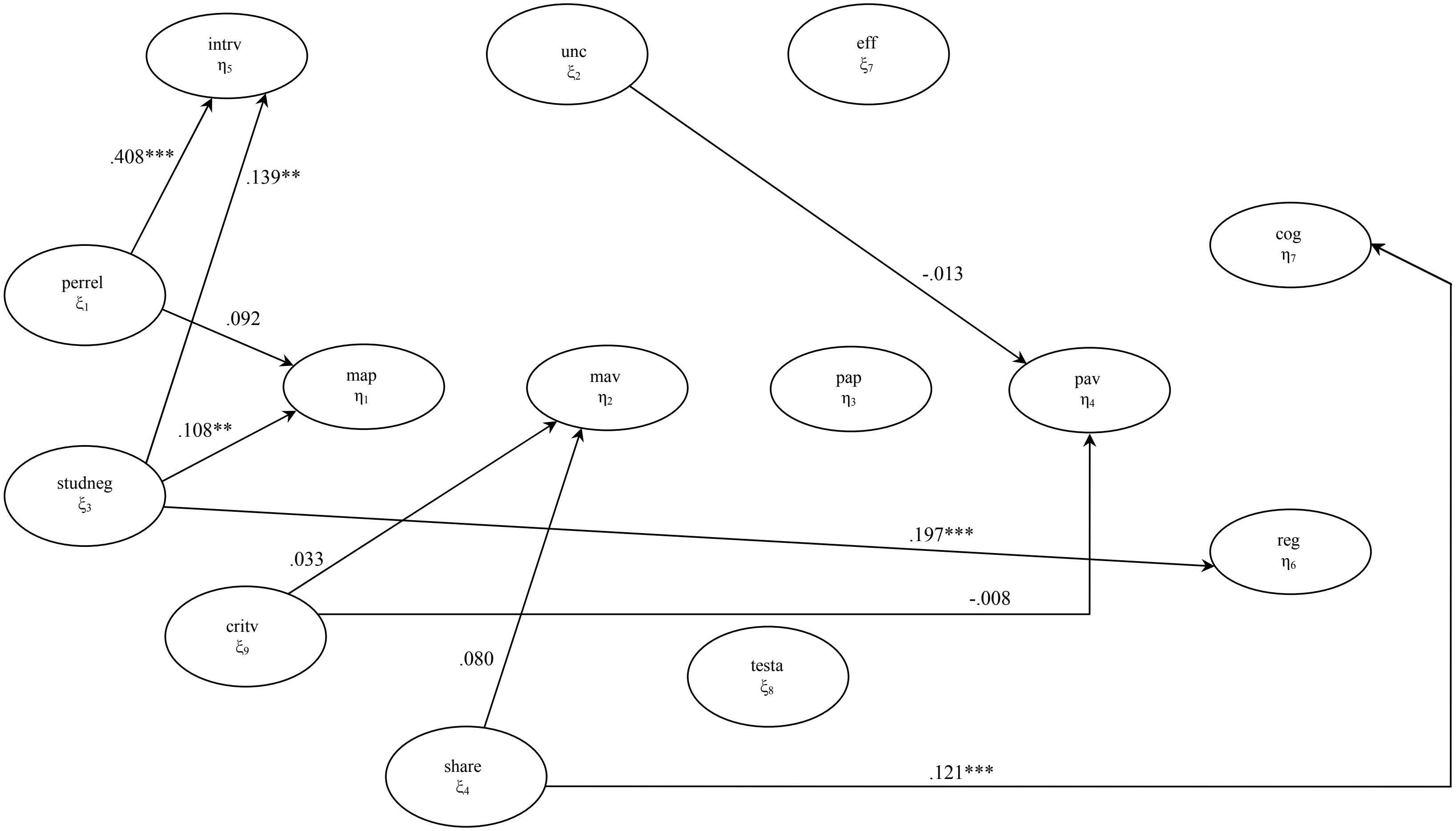

Figure 7.2. Revised structural equation model displaying the standardised direct effects for the classroom learning environment variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); shared control (share); student negotiation (studneg); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

The standardised direct effects path model for the motivational belief variables is displayed in Figure 7.3. As hypothesised, intrinsic value was a positive predictor of master-approach ($\beta = 0.501$, $p < .001$); it was also found to have positive associations with regulatory strategy use ($\beta = 0.344$, $p < .001$) and negative associations with cognitive strategy use ($\beta = -0.148$, $p < .01$). As found in Study 1, self-efficacy was an influential explanatory variable for personal achievement goals and self-regulated learning. Self-efficacy was a significant positive predictor of mastery-approach ($\gamma = 0.140$, $p < .05$), mastery-avoidance ($\gamma = 0.217$, $p < .001$), performance-approach ($\gamma = 0.286$, $p < .001$), and performance-avoidance ($\gamma = 0.389$, $p < .001$). Self-efficacy also positively predicted intrinsic value ($\gamma = 0.362$, $p < .001$) and regulatory strategy use ($\gamma = 0.205$, $p < .001$). As expected, test anxiety was a significant positive predictor of performance-avoidance ($\gamma = 0.584$, $p < .001$) and mastery-avoidance ($\gamma = 0.190$, $p < .01$), and had non-significant negative relations with mastery-approach ($\gamma = -0.086$). Test anxiety was also a positive predictor of cognitive strategy use ($\gamma = 0.132$, $p < .001$) and had null relations with regulatory strategy use ($\gamma = 0.030$).

The standardised direct effects path model for the personal achievement goals and self-regulated learning variables is displayed in Figure 7.4. Regulatory strategy use was positively predicted by mastery-approach ($\beta = 0.262$, $p < .001$) and performance-avoidance ($\beta = 0.170$, $p < .05$). Null relations with regulatory strategy use were found for mastery-avoidance ($\beta = -0.051$) and performance-approach ($\beta = -0.065$). The only significant predictor of cognitive strategy use was regulatory strategy use ($\beta = 0.861$, $p < .001$). The rather large amount of covariance between cognitive and regulatory strategy use indicated that these two variables were highly related. As found in Study 1, a significant amount of covariance was found to exist between the other achievement goals. Performance-avoidance was found to positively predict mastery-approach ($\beta = 0.213$, $p < .01$), mastery-avoidance ($\beta = 0.457$, $p < .001$) and performance-approach ($\beta = 0.381$, $p < .001$). Unlike Study 1, Study 3 also found significant associations between the other personal achievement goals. There was some reciprocality between the approach goals with mastery-approach positively predicting performance-approach ($\beta = 0.206$, $p < .01$) but performance-approach having no significant influence on mastery-approach ($\beta =$

-0.020). These results indicate that most students endure some form of avoidance with respect to external competence-related issues and this is irrespective of students' other achievement goal orientations. The variances of the endogenous variables explained by the revised model (Figures 7.3 and 7.4) were as follows: mastery-approach (54%), mastery-avoidance (44%) performance-approach (43%), performance-avoidance (40%), intrinsic value (45%), cognitive strategy use (66%), and regulatory strategy use (61%). These totals were considerably more than those obtained using multilevel multiple regression analyses. The standardised direct, indirect and total effects for the revised self-regulated learning structural equation model using maximum likelihood as the estimation method are presented in Table 7.33. Almost identical results were obtained using generalised least squares as the estimation method and these are presented in Table 7.34.

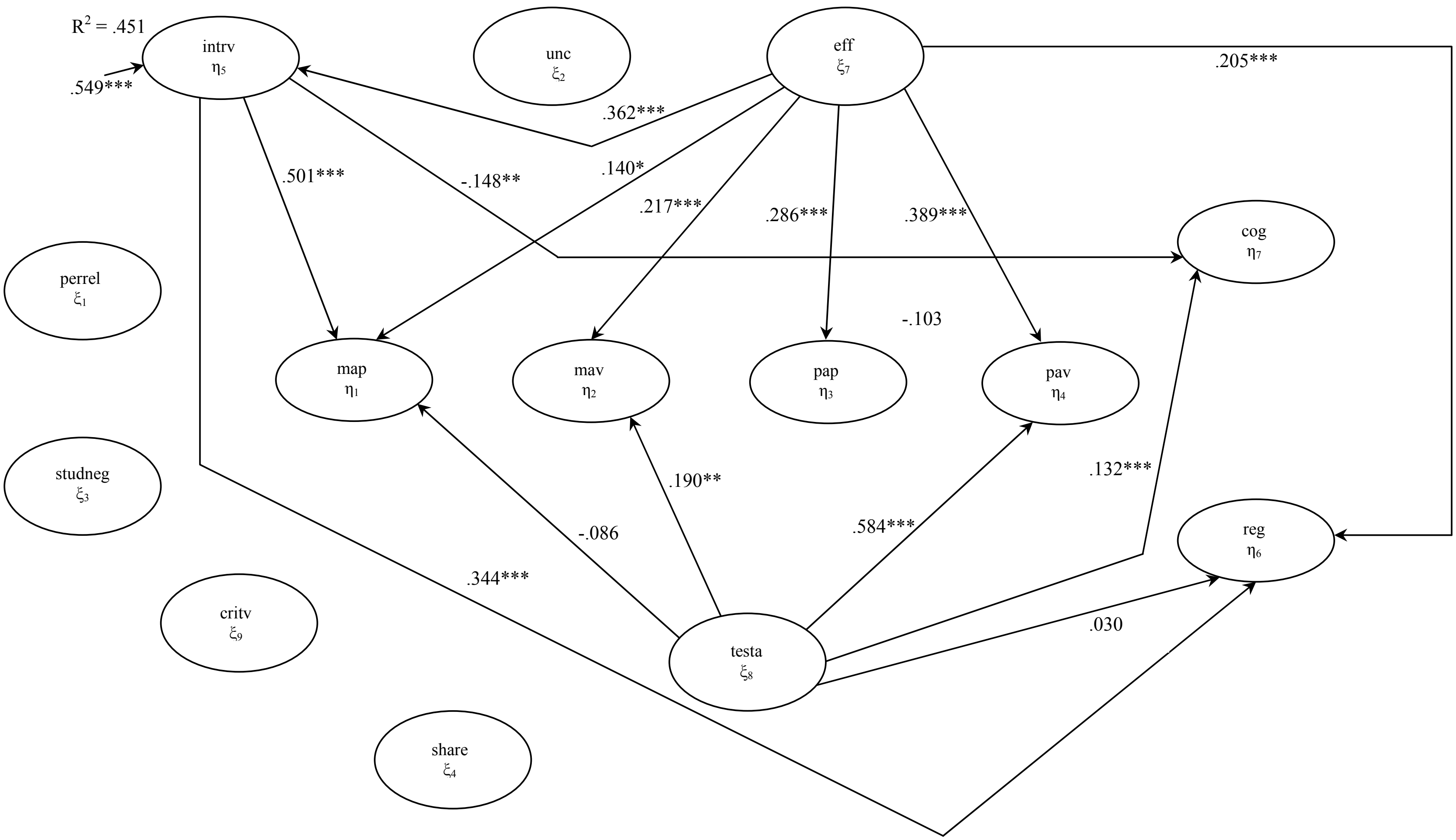

Figure 7.3. Revised structural equation model displaying the standardised direct effects for the motivational belief variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); shared control (share); student negotiation (studneg); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

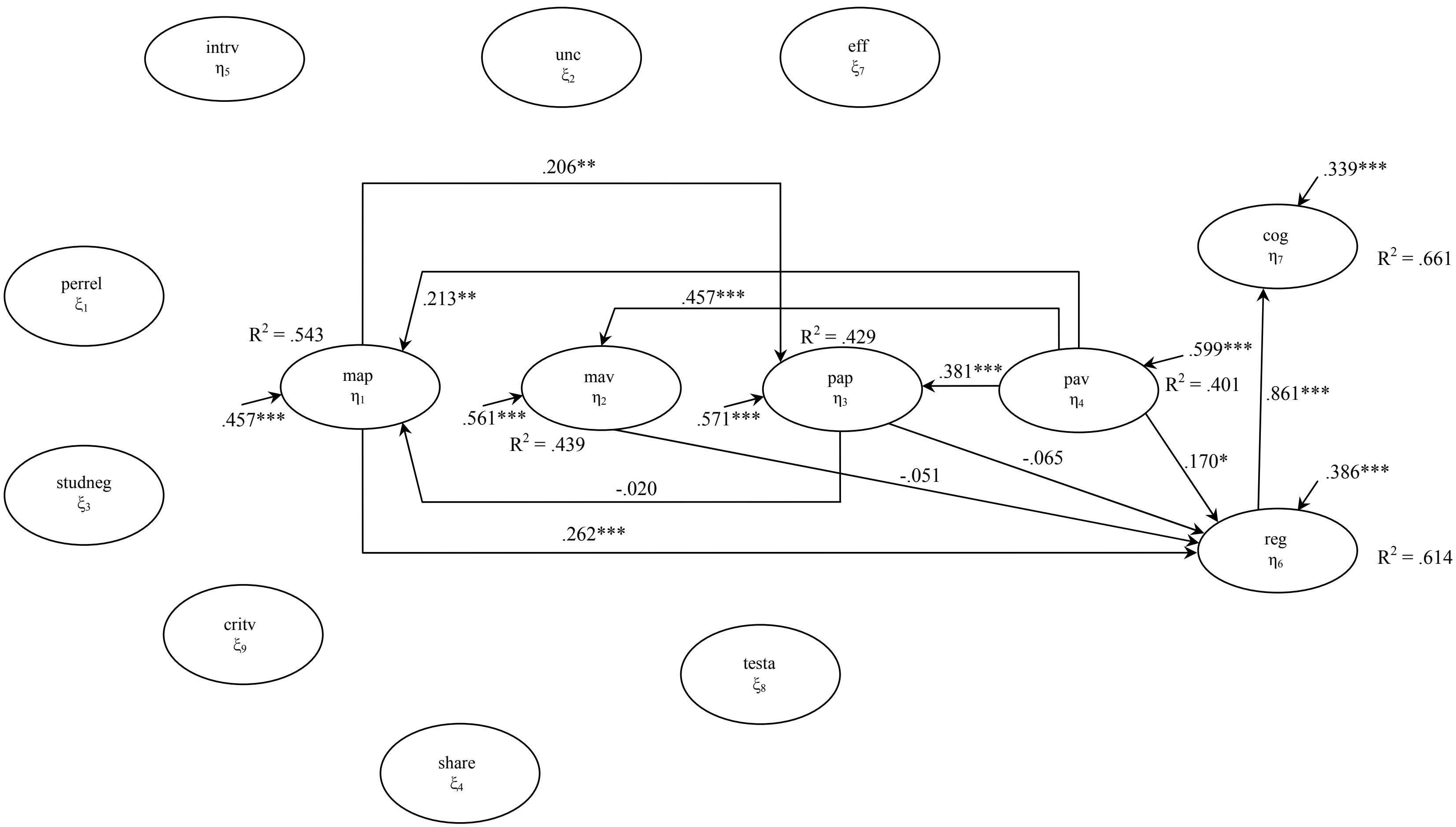

Figure 7.4. Revised structural equation model displaying the standardised direct effects for the personal achievement goals and self-regulated learning variables. The exogenous variables are symbolised as: personal relevance (perrel); uncertainty (uncert); critical voice (critv); shared control (share); student negotiation (studneg); self-efficacy (eff); test anxiety (testa). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); intrinsic value (intrv); cognitive strategy use (cog); regulatory strategy use (reg). * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7.33

Self-Regulated Learning Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Personal relevance on:	Mastery-approach	.092	.203***	.295***
	Performance-approach	-	.061*	.061*
	Intrinsic value	.408***	-	.408***
	Regulatory strategies	-	.214***	.214***
	Cognitive strategies	-	.124***	.124***
Uncertainty on:	Mastery-approach	-	-.003	-.003
	Mastery-avoidance	-	-.006	-.006
	Performance-approach	-	-.006	-.006
	Performance-avoidance	-.013	-	-.013
	Regulatory strategies	-	-.002	-.002
	Cognitive strategies	-	-.002	-.002
Critical voice on:	Mastery-approach	-	-.002	-.002
	Mastery-avoidance	.033	-.004	.029
	Performance-approach	-	-.003	-.003
	Performance-avoidance	-.008	-	-.008
	Regulatory strategies	-	-.003	-.003
	Cognitive strategies	-	-.003	-.003
Shared control on:	Mastery-avoidance	.080	-	.080
	Regulatory strategies	-	-.004	-.004
	Cognitive strategies	.121***	-.004	.118***
Student negotiation on:	Mastery-approach	.108**	.069**	.177***
	Performance-approach	-	.037*	.037*
	Intrinsic value	.139**	-	.139**
	Regulatory strategies	.197***	.092***	.289***
	Cognitive strategies	-	.228***	.228***
Test anxiety on:	Mastery-approach	-.086	.120**	.034
	Mastery-avoidance	.190**	.267***	.457***
	Performance-approach	-	.229***	.229***
	Performance-avoidance	.584***	-	.584***
	Regulatory strategies	.030	.070*	.100**
	Cognitive strategies	.132***	.086**	.218***

Table 7.33 *Continued*

Effect		Direct effect	Indirect effect	Total effects
Self-efficacy on:	Mastery-approach	.140*	.254***	.394***
	Mastery-avoidance	.217***	.178***	.395***
	Performance-approach	.286***	.229***	.515***
	Performance-avoidance	.389***	-	.389***
	Intrinsic value	.362***	-	.362***
	Regulatory strategies	.205***	.240***	.445***
	Cognitive strategies	-	.330***	.330***
Mastery-approach on:	Mastery-approach	-	-.004	-.004
	Performance-approach	.206**	-.001	.206**
	Regulatory strategies	.262***	-.014	.248***
	Cognitive strategies	-	.213***	.213***
Mastery-avoidance on:	Regulatory strategies	-.051	-	-.051
	Cognitive strategies	-	-.044	-.044
Performance-approach on:	Mastery-approach	-.020	.000	-.020
	Performance-approach	-	-.004	-.004
	Regulatory strategies	-.065	-.005	-.070
	Cognitive strategies	-	-.060	-.060
Performance-avoidance on:	Mastery-approach	.213**	-.009	.205***
	Mastery-avoidance	.457***	-	.457***
	Performance-approach	.381***	.042*	.423***
	Regulatory strategies	.170*	.003	.172**
	Cognitive strategies	-	.148**	.148**
Intrinsic value on:	Mastery-approach	.501***	-.002	.499***
	Performance-approach	-	.103**	.103**
	Regulatory strategies	.344***	.124***	.468***
	Cognitive strategies	-.148**	.403***	.255***
Regulatory strategies on:	Cognitive strategies	.861***	-	.861***

Note. n = 583 (effective sample size); [a]Maximum likelihood used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7.34

Self-Regulated Learning Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Personal relevance on:	Mastery-approach	.105	.209***	.313***
	Performance-approach	-	.067*	.067*
	Intrinsic value	.428***	-	.428***
	Regulatory strategies	-	.230***	.230***
	Cognitive strategies	-	.135***	.135***
Uncertainty on:	Mastery-approach	-	-.003	-.003
	Mastery-avoidance	-	-.007	-.007
	Performance-approach	-	-.006	-.006
	Performance-avoidance	-.014	-	-.014
	Regulatory strategies	-	-.003	-.003
	Cognitive strategies	-	-.002	-.002
Critical voice on:	Mastery-approach	-	.001	.001
	Mastery-avoidance	.013	.002	.015
	Performance-approach	-	.002	.002
	Performance-avoidance	.004	-	.004
	Regulatory strategies	-	.000	.000
	Cognitive strategies	-	.000	.000
Shared control on:	Mastery-avoidance	.082	-	.082
	Regulatory strategies	-	-.005	-.005
	Cognitive strategies	.118***	-.004	.113**
Student negotiation on:	Mastery-approach	.108**	.066**	.174***
	Performance-approach	-	.037*	.037*
	Intrinsic value	.136**	-	.136**
	Regulatory strategies	.194***	.092***	.286***
	Cognitive strategies	-	.229***	.229***
Test anxiety on:	Mastery-approach	-.095	.127**	.033
	Mastery-avoidance	.176**	.288***	.464***
	Performance-approach	-	.233***	.233***
	Performance-avoidance	.589***	-	.589***
	Regulatory strategies	.025	.075*	.100**
	Cognitive strategies	.133***	.087**	.220***

Table 7.34 *Continued*

Effect		Direct effect	Indirect effect	Total effects
Self-efficacy on:	Mastery-approach	.139*	.255***	.395***
	Mastery-avoidance	.215***	.190***	.404***
	Performance-approach	.286***	.233***	.519***
	Performance-avoidance	.388***	-	.388***
	Intrinsic value	.361***	-	.361***
	Regulatory strategies	.197***	.246***	.442***
	Cognitive strategies	-	.331***	.331***
Mastery-approach on:	Mastery-approach	-	-.003	-.003
	Performance-approach	.213**	-.001	.212**
	Regulatory strategies	.270***	-.016	.255***
	Cognitive strategies	-	.222***	.222***
Mastery-avoidance on:	Regulatory strategies	-.060	-	-.060
	Cognitive strategies	-	-.052	-.052
Performance-approach on:	Mastery-approach	-.016	.000	-.016
	Performance-approach	-	-.003	-.003
	Regulatory strategies	-.069	-.004	-.073
	Cognitive strategies	-	-.064	-.064
Performance-avoidance on:	Mastery-approach	.222**	-.007	.216***
	Mastery-avoidance	.488***	-	.488***
	Performance-approach	.384***	.046*	.430***
	Regulatory strategies	.187*	.000	.186**
	Cognitive strategies	-	.163**	.163**
Intrinsic value on:	Mastery-approach	.491***	-.002	.489***
	Performance-approach	-	.104**	.104**
	Regulatory strategies	.350***	.125***	.475***
	Cognitive strategies	-.153**	.415***	.262***
Regulatory strategies on:	Cognitive strategies	.873***	-	.873***

Note. $n = 583$ (effective sample size); [a]Generalised least squares used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

7.4 DISCUSSION

As an auxiliary investigation, Study 2 served to examine the interdependent relations of the constructivist pedagogical dimensions, students' personal achievement goals, motivational beliefs, and self-regulated learning at the trait-level for the sample of students studied in the context-level analyses (Study 3, Chapters 8 to 12). Study 2 was also used to examine the consistency of the measurement and structural properties of the constructs with respect to those obtained in Study 1 (Chapter 6).

The first focus of discussion concerns the consistency of the measurement properties of the constructs across Studies 1 and 2. There was a high degree of consistency in the interpretation of the items by the students forming the samples in Studies 1 and 2. Very similar results were obtained in the exploratory factor analyses and the one-factor congeneric models for the constructs associated with constructivist pedagogical dimensions, personal achievement goals, motivational beliefs and self-regulated learning in Studies 1 and 2. The differences that did occur between Studies 1 and 2 involved the items associated with personal achievement goals and self-regulated learning and future research should address the psychometric properties of these questionnaires. Areas worthy of consideration include the items designed to measure mastery-avoidance and the items distinguishing between cognitive and regulatory strategy use both within and out of the classroom. Overall, however, there was support for the 2 X 2 achievement goals framework. There were slight differences between the two studies for the item loadings and the inter-item error covariances of the composite variables but these results are somewhat expected since the aim of one-factor congeneric measurement models using structural equation modelling is to maximise the fit of indicator items and account for the impact of measurement error variance. Some variation amongst these parameters is expected across samples and across studies when considering that data are gathered from psychological-based self-reporting questionnaire items using high school students. The reader is referred to the results for the details regarding the minor differences reported amongst the variables for Studies 1 and 2. Like that reported in Study 1, modest amounts of variance were attributed to the classroom-level for the classroom environment variables (2.2 to 7.2%) and personal-based constructs (0 to 13.6%) in Study 2. Thus, the majority of variance for the constructs investigated occurred at the personal-level.

The second focus of discussion attends to the structural relations between the environmental and personal predictors of achievement goals across Studies 1 and 2. Study 2 complimented the Study 1 findings of personal relevance and student negotiation having positive associations with mastery-approach in the regression analyses. In Study 2, only student negotiation attained significance as a positive predictor of mastery-approach in the SEM although personal relevance bordered on being significant whereas in Study 1 both these variables were positive predictors of mastery-approach. These results demonstrate the potential importance of personal relevance and student negotiation towards fostering mastery-approach goals in high school science students.

Regarding the personal factors affecting mastery-approach, intrinsic value was again found to be a highly significant and positive predictor of mastery-approach in the regression and SEM analyses, a result commensurate with that of Study 1. Indeed, Study 2 also found intrinsic value to mediate the impact of personal relevance upon mastery-approach. Unlike Study 1, however, self-efficacy was found to have positive associations with mastery-approach in both regression and SEM analyses; Study 1 only found self-efficacy significant in the regression analyses. These findings support previous research that has shown self-efficacy and mastery-approach to have positive associations (Kaplan & Maehr, 1999; Kaplan & Midgley, 1999; Middleton et al., 2004; Middleton, & Midgley, 1997; Patrick et al., 1999; Roeser et al., 1996; Skaalvik, 1997). A positive relationship was also found between performance-avoidance and mastery-approach goals using SEM, a result supporting that found in Study 1. Like Study 1, the relationship between performance-avoidance and mastery-approach in Study 2 was, although significant, small ($\beta = 0.213$, $p < .01$) compared with the relations between performance-avoidance and the other achievement goals: mastery-avoidance ($\beta = 0.457$, $p < .001$) and performance-approach ($\beta = 0.381$, $p < .001$). This result again demonstrates the potential interactions of achievement goals and the orthogonal nature of achievement goals.

It was hypothesised that there would be null relations between shared control and mastery-avoidance. However, shared control was the only environmental factor to have significant impact upon mastery-avoidance in the Study 2 regression analyses. In Study 1, critical voice was a negative predictor of mastery-avoidance whereas in Study 2 shared control was a positive predictor of mastery-avoidance. The Study 2 result implies that students who have greater control in their learning and activities in the high school science classroom will also experience greater mastery-avoidance. This result tentatively supports the theory of mastery-avoidance (Elliot, 1999; Pintrich, 2000b), whereby students avoid situations that lead to personal failure such as not acquiring personally set standards of learning achievement. As in Study 1, the SEM analyses indicated self-efficacy and performance-avoidance to be significant positive personal predictors of mastery-avoidance. Study 2 also found test anxiety to be a significant positive personal predictor of mastery-avoidance. Students that report greater mastery-avoidance and hence have high learning expectations may be expected to have a concurrent increase in anxiety-related issues.

For performance-approach, personal relevance as a positive predictor was the only environmental factor to have significant relations in the regression analyses. Null relations between personal relevance and performance-approach were found in the Study 1 regression analyses, supporting the hypothesised relations between these two constructs as it was expected that personal relevance would have more affiliation with mastery-related goals than performance-related goals. Null relations between personal relevance and performance-approach were found, however, in the Study 2 SEM analyses. Of the personal factors affecting performance-approach, test anxiety and self-efficacy were positive predictors in the regression analyses, similar to that reported in Study 1. In the SEM analyses for both studies, only self-efficacy was a significant positive predictor along with performance-avoidance. Study 2 also found significant positive associations between mastery-approach and performance-approach in the SEM analyses with mastery-approach attaining significance as a positive predictor of performance-approach; the reciprocated path between these two achievement goals, however, was not significant. This result demonstrates that students may accommodate both types of approach goals, and that students can have high orientations for both goals.

For performance-avoidance, only the personal factors of self-efficacy and test anxiety were significant predictors, both having positive associations with performance-avoidance in the regression and SEM analyses. These results were the same in Study 1. No environmental factors were significant predictors of performance-avoidance in Study 2, unlike Study 1 which found uncertainty to positively predict performance-avoidance.

The third focus of discussion concerns the results attained for the associations between the environmental and personal predictors of self-regulated learning for high school science students. The limitations of the items representing cognitive and regulatory strategy use were outlined in Study 1 and will not be addressed here. Of the environmental factors affecting cognitive strategy use in Study 2, shared control and student negotiation were positive predictors in the regression analyses. Of these, only shared control attained significance in the SEM analyses, being a positive predictor of cognitive strategy use. Hence students who perceived having a greater say in their learning in the high school science classroom also reported greater use of cognitive strategies. These findings differed to those obtained in Study 1, in which no environmental factors were found to influence cognitive strategy use. However, this finding is not unexpected given the slight incongruity between the two studies with respect to the predictor items for cognitive strategy use (see 7.3 Results). Despite having slight differences in predictor item loadings for regulatory strategy use, Studies 1 and 2 found student negotiation to have positive relations with regulatory strategy use in the regression and SEM analyses. This result supported the hypothesis that students who perceive their classroom as one supportive of peer interaction and discussion of ideas would also utilise greater self-regulated learning.

As for Study 1, Study 2 found several personal factors to affect self-regulated learning. Common to both studies were the positive associations of intrinsic value, self-efficacy, mastery-approach and performance-avoidance with cognitive strategy use in the regression analyses. However, both studies found only test anxiety and regulatory strategy use to be significant positive predictors of cognitive strategy use in the SEM analyses. Study 2 also found intrinsic value to be a negative predictor of cognitive strategy use. It is surprising that intrinsic value would have a direct negative relations with cognitive strategy use given the adaptive associations intrinsic value has had with environmental and personal constructs in both studies. Perhaps a more valid interpretation of this result could be found in considering regulatory strategy use as mediating the impact of intrinsic value upon cognitive strategy use; such relations supported by the results of the final SEM analysis for Study 2. These relations demonstrated intrinsic value to positively predict regulatory strategy use which in turn had positive relations with cognitive strategy use. Thus, the impact of intrinsic value on students' use of cognitive strategies is dependent upon students' use of regulatory strategies, with greater use of regulatory strategies implying a greater use of cognitive strategies.

Both studies found with intrinsic value, self-efficacy, mastery-approach and performance-avoidance to have positive relations with regulatory strategy use in the regression analyses. Study 1 also found mastery-avoidance to be a negative predictor of regulatory strategy use. In the SEM analyses, both studies found self-efficacy, mastery-approach, and performance-avoidance to be positive predictors of regulatory strategy use. Unlike Study 1, test anxiety, mastery-avoidance and performance-approach did not attain significant negative relations with regulatory strategy use in Study 2. Thus, both studies have demonstrated the importance of students' efficacy beliefs and their achievement goal orientations upon self-regulated learning.

7.5 LIMITATIONS

There were several limitations associated with the research conducted in Study 2. As for Study 1, the methodology employed was a single-administration questionnaire protocol that assessed students' trait-based interpretations of environmental and personal constructs. This correlational-based protocol was limited in that it relied on students' one-off reporting of their environmental and personal variables to ascertain the relations between these variables. This and the other limitations of using the trait-based measures that were described in Study 1 (Chapter 6) are applicable to Study 2.

Due to the chronological sequence of the studies, Study 2 did not incorporate the constructs of achievement goal structures and classroom metacognitive structure.

The absence of these classroom learning environment constructs may have influenced the statistical relations attained in Study 2, in particular the SEM models, and confined the classroom learning environment variables used for the investigation to just the constructivist pedagogical dimensions.

A potential limitation in this study concerned the administration of the questionnaires by the classroom teacher instead of a third party such as a “researcher”. Since students were asked to report their perceptions of a variety of personal and environmental features in the questionnaires, the administering of the questionnaires by the classroom teacher may have impacted upon students’ attitude to the study. For example, students may have answered the questionnaires in accordance with what they envisaged the teacher expected of them or in retaliation to what they thought the teacher expected of them. These problems were offset by requesting the questionnaires to be filled in anonymously and having the teacher refer to the “researchers” in third party terms when administering the questionnaires. The effect of the latter was seen during rostering of the questionnaire data, with some students writing notes to the “researchers”.

7.6 SUMMARY

In summary, Study 2 addressed the following three research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Three: What associations exist between high school science students’ perceptions of their learning environment characteristics, students’ personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?
>
> Research Question Five: What associations exist between high school science students’ subpopulation variables, students’ personal achievement goals and their self-regulated learning at the trait-level?

The analyses used in Study 2 were the exact same format as those used in Study 1 (Chapter 6) except the classroom learning environmental constructs of classroom achievement goal structures and the classroom metacognitive structure were not measured in Study 2. The classroom learning environment and personal-based constructs investigated in Study 2 formed the trait-level profile of students that participated in the context-level analyses (Study 3, Chapters 8 to 12). A single-administration questionnaire protocol was adopted with students completing three questionnaires during one of their science lessons in the middle of the school year. As in Study 1, there was support for the 2 X 2 achievement goals framework although the performance-avoidance goal construct reflected concern tendencies rather than avoidance behaviour. Like the results in Study 1, the multilevel multiple regression analyses found the bulk of variance for all constructs to be attributed to the personal-level with large amounts of intra-class variation for students' perception of their classroom learning environment variables and, as expected, their personal-based variables. These results therefore justified a single-level SEM model approach in examining the simultaneous interdependent relations amongst the variables. This study focused on presenting a structural equation model that was applicable to the general high school student and thus controlled for the variance associated with gender, age and student type (regular or selective high school student).

The following statistically significant relationships were found to exist for Research Questions Three and Five. These relationships were found to be almost identical to those obtained in Study 1 thus demonstrating the reliability of the findings.

7.6.1 Research Question Three: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' learning environment characteristics (constructivist pedagogical dimensions) and students' personal achievement goals were as follows. Mastery-approach was positively predicted by personal relevance, student negotiation and critical voice; it was negatively predicted by shared control. Mastery-avoidance was positively predicted by shared control. Performance-approach was positively predicted by personal relevance.

The relations found between students' learning environment characteristics (constructivist pedagogical dimensions) and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by shared control and student negotiation. Regulatory strategy use was positively predicted by student negotiation.

The relations found between students' motivational beliefs and students' personal achievement goals were as follows. Mastery-approach was positively predicted by intrinsic value and self-efficacy. Mastery-avoidance was positively predicted by self-efficacy and test anxiety. Performance-approach was positively predicted by self-efficacy. Performance-avoidance was positively predicted by self-efficacy and test anxiety.

The relations found between students' motivational beliefs and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by test anxiety and negatively predicted by intrinsic value. Regulatory strategy use was positively predicted by intrinsic value and self-efficacy. Intrinsic value was positively predicted by self-efficacy.

The relations found between students' personal achievement goals and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by mastery-approach and performance-avoidance. Regulatory strategy use was positively predicted by mastery-approach and performance-avoidance.

7.6.2 Research Question Three: Statistically Significant Associations found using Structural Equation Modelling Analyses

The relations found between students' learning environment characteristics (constructivist pedagogical dimensions) and students' personal achievement goals were as follows. Mastery-approach was positively predicted by student negotiation.

The relations found between students' learning environment characteristics (constructivist pedagogical dimensions) and students' motivational beliefs were as follows. Intrinsic value was positively predicted by personal relevance and the student negotiation.

The relations found between students' learning environment characteristics (constructivist pedagogical dimensions) and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by shared control. Regulatory strategy use was positively predicted by student negotiation.

The relations found between students' motivational beliefs and students' personal achievement goals were as follows. Mastery-approach was positively predicted by intrinsic value and self-efficacy. Mastery-avoidance was positively predicted by self-efficacy and test anxiety. Performance-approach was positively predicted by self-efficacy. Performance-avoidance was positively predicted by self-efficacy and test anxiety. Intrinsic value was positively predicted by self-efficacy.

The relations found between students' motivational beliefs and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by test anxiety and negatively predicted by intrinsic value. Regulatory strategy use was positively predicted by intrinsic value and self-efficacy.

The relations found between students' personal achievement goals and students' self-regulated learning were as follows. Cognitive strategy use was positively predicted by regulatory strategy use. Regulatory strategy use was positively predicted by mastery-approach and performance-avoidance. Performance-avoidance positively predicted mastery-approach, mastery-avoidance and performance-approach. Performance-approach was positively predicted by mastery-approach.

7.6.3 Research Question Five: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' subpopulation variables and students' personal achievement goals were as follows. Females reported less mastery-avoidance and less performance-approach goal orientations than males. Selective high school students reported lower mastery-avoidance and performance-avoidance orientations than regular high school students. Junior students reported higher mastery-avoidance orientations than seniors. Seniors reported higher performance-approach orientations than juniors.

The relations found between students' subpopulation variables and students' self-regulated learning were as follows. Females reported greater use of cognitive and regulatory strategies than males. Junior students reported greater use of regulatory strategies than seniors.

Study 2 formed the trait-level profile of students who formed the sample investigated in Study 3 (Chapters 8 to 12) and had almost identical limitations to those reported for Study 1 (Chapter 6), which used the same trait-based measures and procedures. Several of the limitations associated with trait-based analyses were addressed in Study 3, which examined the relations between personal-based variables in specified classroom learning contexts and in doing so investigated the utility of a "context hypothesis".

Chapter 8

STUDY 3: AIMS

8.1 STUDY 3: AIMS

Studies 1 and 2 examined the relations between students' perceptions of their high school science learning environments, students' motivational components, their self-regulated learning, and subpopulation variables at the trait-level. As described in Chapter 3, there are several potential problems relating to validity and calibration issues when using single-administration self-report questionnaire procedures in examining such relations at the trait-level. Firstly, trait-like reports may yield data that reflects dispositional tendencies rather than what students actually do in the classroom, or indeed perceive of their classroom. Secondly, students may report on significant classroom events, proximal or distal, rather than provide an authentic trait-level representation. For example, students asked to report their achievement goals before end-of-course exams may differ to their reports if asked after exams. Thirdly, the constructs reported on may be affected by developmental factors, with the students' reporting of their constructs changing over time. For example, does a student's self-efficacy depend upon historical experiences or is it significantly affected by relatively recent events? Another validity-related aspect concerns the reference of indicator items. Constructs composed of items having within-class referrals and items that have outside-class referrals may yield inconsistent data as students may interpret their within-class experiences differently to their outside-class experiences. In the present research, the indicator items of the self-regulated learning constructs asked students to report on the self-regulated learning they employed both within and outside the classroom and this may partly explain the variation between Studies 1 and 2 with regards to the indicator items of cognitive and regulatory strategy use. Indeed, all the other constructs used in the present research had their items consistently refer to within-class experiences and these constructs had a high degree of uniformity regarding the indicator item loadings across the studies. Future studies should take into account the homology of indicator items with respect to the target experiences students are to report upon.

The present research contends that the aforementioned problems associated with trait-level analyses of students' experiences in classrooms may be addressed by examining the relations between the variables of concern at a context-level and thus introduced a “context hypothesis”. In so doing, the present research proposes that classrooms are composed of particular micro-learning events or contexts that are identifiable in quantitative and qualitative terms. On the basis of the amount of teacher- and student-regulation involved, four types of contexts may be identified in the high school science classroom: teacher explanation, teacher-led discussion, group work, and computer-use (see Figure 5.1). Teacher explanation, it is proposed, has the most teacher-regulation and least student-regulation of the four learning events, while computer-use has the least teacher-regulation and most student-regulation of the four learning events. To reiterate that presented in Chapter 5, a “context” hypothesis contends that:

(1) constructs such as achievement goals, competence perceptions and self-regulated learning functionally exist in specified classroom contexts;
(2) viable relations exist between such constructs in contexts;
(3) the salience of these constructs and their sub-constructs depends on the type of context; and
(4) the calibration-associated issues with students’ reporting of constructs in contexts will be improved as compared with trait-level reports.

Context approaches to studying achievement goals have begun to receive attention (Barron & Harackiewicz, 2001; Harackiewicz & Sansone, 1991; Linnenbrink, 2002; Senko, 2002).

Study 3 examined the relations between students’ motivational components, their self-regulated learning, and subpopulation variables at the context-level, applying a context hypothesis to investigating these relations in two specified classroom contexts: teacher-discussion and group work (although teacher explanation and computer use contexts were also studied, space restrictions excludes the reporting of the findings for these contexts in the present research). In so doing, Study 3 addressed the following research questions.

Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?

Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?

Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Research Question Seven: What are students' perspectives with regards to the impact classroom activities have upon the adoption of achievement goals?

The hypothesised relations between these variables were presented in Chapter 5. Study 3 comprised of three mini-studies, with two mini-studies examining the relations between task efficacy, achievement goals, self-regulated learning, maladaptive strategy use, and subpopulation variables in a specified classroom context: Study 3A (teacher-led discussion) and Study 3B (group work). Study 3C was qualitative in nature, with students being interviewed regarding their perceptions of the features of the science classroom that affects their achievement goals. It was postulated that these two types of micro-learning contexts were specific to constructivist-related learning contexts in high school science classrooms. The context-level analyses were conducted using two types of questionnaires that were administered by the class teacher during two separate micro-learning events (teacher-led discussion and group work) experienced by the students in their normal science lessons.

8.2 RESEARCH DESIGN

The parent sample of high school science students for Study 3 was described in Study 2, which examined the trait-level relations of students' perceptions of their high school science learning environments, students' motivational components, their self-regulated learning, and subpopulation variables. However, not all classes or students who participated in Study 2 took part in the context-level analyses conducted in Study 3. The relevant numbers of students and classes that participated in the Study 3 context-level analyses are presented in the subsequent sections. Students were asked to complete context-level questionnaires during the middle of the second and third terms of the school year in their science lessons after experiencing the specific learning context. By this time of the school year students' relationships with class peers and class teacher were well established. The questionnaires were administered by the class teacher when deemed appropriate with regards to the micro-learning event experienced by students. Since the students' science teacher was administering the questionnaires, students' names were not requested thereby making the responses anonymous. Teachers were provided with a suggested protocol by the researcher, who visited each teacher and trained him or her on how to administer the questionnaires. The researcher kept in contact with the teachers throughout the study administration procedure and collected the questionnaires after completion.

Each of the context-level questionnaires consisted of one six-item task efficacy scale, four six-item achievement goal scales, one seven-item regulatory strategy use scale, one seven-item maladaptive strategy use scale, and one two-item perceived ability scale. Each of the context-level questionnaires was piloted in the appropriate learning context with a year 9 science class that did not take part in the final research. After students completed the revised questionnaire, the researcher held discussions with students regarding the readability and clarity of the items. This resulted in a small number of amendments to the items. Students indicated their responses to the final questionnaire items on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me). As reported in Study 2, written parental permission was required for students to participate in the study. Students were informed that participation was voluntary and their responses would be kept confidential. Despite providing written parental permission, a small number of students declined to participate in the study.

The methods and results for each of the quantitative mini-studies (Studies 3A and 3B) are presented over the next two chapters (Chapters 9 and 10). A discussion on the quantitative findings from these two mini-studies is presented in Chapter 11. Chapter 12 reports the findings from the qualitative-based mini-study, in which students involved in the Study 3 quantitative analyses were interviewed about the impact of classroom activities upon their achievement goals.

Chapter 9

STUDY 3A: TEACHER-LED DISCUSSION

9.1 PARTICIPANTS AND PROCEDURE

A sample of 451 high school science students (237 males and 214 females) was assembled from eight different New South Wales State education system high schools serving the Sydney metropolitan area. Each school was co-educational, catered for students from years 7 to 12, randomly chosen from state high schools in the Sydney area and invited to participate. Six schools were classified as regular (250 students) and served as the sample from the regular high school population. The regular students' sample comprised of 13 classes ranging in size from 8 to 25 students (mean class size = 19.2). Of this sample, 20 (9 males and 11 females) were in year 7, 87 (46 males and 41 females) were in year 8, 74 (34 males and 40 females) were in year 9, and 13 (8 males and 5 females) were in year 10. All of these junior classes were completing a general science curriculum. 56 (31 males and 25 females) were in year 11 completing a senior science curriculum. Two schools were classified as selective (201 students) and served as the sample from the selective high school population. The selective students' sample comprised of 10 classes ranging in size from 13 to 26 students (mean class size = 20.1). Of this sample, 26 (16 males and 10 females) were in year 8 and 70 (35 males and 35 females) were in year 9, completing a general science curriculum. 105 (58 males and 47 females) were in year 11 completing a senior science curriculum.

Students were asked to complete the Science Classroom Cognitive Processes and Motivation Questionnaire – Teacher-Led Discussion (Appendix D) during the middle of the third term of the school year in one of their science lessons after encountering an appropriate teacher-led discussion event.

9.2 MEASURES

The Science Classroom Cognitive Processes and Motivation Questionnaire – Teacher-Led Discussion (TLDQ) consisted of the following scales.

Task efficacy. The task efficacy scale was designed to measure students' perceptions of their efficacy for learning during a teacher explanation context and consisted of six items (e.g., “I like listening to what the other students ask and say in the discussion”). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Perceived ability. One scale comprising of two items was used to measure students’ perceptions of their relative ability in their science class (e.g., “What is your ability level in this science class?”) and students indicated their responses on a seven-point Likert scale ranging from 1 (very low) to 7 (very high).

Personal achievement goals. Four six-item scales ascertained the following personal achievement goals: mastery-approach (e.g., “Understanding is very important to me and this was why I focused on the discussion”); mastery-avoidance (e.g., “I avoided answering questions that I felt I didn’t have the correct answer for”); performance-approach (e.g., “I answered questions to show that I am really good”); and performance-avoidance (e.g., “I was worried when the other students demonstrated they knew more than me”). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Regulatory strategy use. One scale was used to measure students’ self-reported use of adaptive self-regulated learning strategies during teacher explanation and consisted of seven items (e.g., “I constantly thought about the topic and the discussion and tried to make sense of it all”). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Maladaptive strategy use. Students’ use of maladaptive strategies during teacher explanation was assessed by one seven-item scale (e.g., “I couldn’t be bothered asking questions since I wasn’t ready to learn”). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

9.3 RESULTS

9.3.1 Preliminary Analyses: Exploratory Factor Analyses and Confirmatory Factor Analyses

As for Studies 1 (Chapter 6) and 2 (Chapter 7), exploratory factor analyses (EFA) were conducted on the items relevant to a priori construct predictions. Principal axis factoring with an oblique rotation method was conducted using the sample of high school science students (n = 451). Principal axis was chosen as the factor extraction method on the assumption that the data would have some deviation from being normally distributed. Oblique rotation was used on the assumption that there would be a degree of correlation between the factors.

Personal achievement goals. An initial EFA of the TLDQ questionnaire achievement goal items for the sample yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors; this solution accounted for 54.0 % of the total variance after the initial extraction for the unrotated solution. However, items 10, 18 and 20 crossloaded and were removed. After removal of these unreliable items, the subsequent EFA revealed items 13, 24 and 27 to have negative loadings on their factors; these were also removed. The final EFA of the Teacher-Led Discussion questionnaire achievement goal items for the sample (n = 451) yielded three factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Bartlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis accounted for 60.0 % of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) The four factors represented the hypothesised personal achievement goals of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. All items loaded above 0.35 on their primary factor and just one of the items crossloaded (item 30) in the final EFA solution.

Confirmatory factor analysis using PRELIS 8.72 (Jöreskog & Sörbom, 2005) and LISREL 8.72 (Jöreskog & Sörbom, 2005) was employed to compare three first-order models. The three-factor model comprised of mastery-approach and performance-approach with the indicator items being in accordance with that classified by the Teacher-led Discussion Questionnaire (TLDQ), and the avoidance factor, which was composed of all mastery-avoidance and performance-avoidance items from the TLDQ. Four-factor Model A comprised of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance with the indicator items being accordance with that classified by the TLDQ. Four-factor Model B comprised of the four factors and their items as identified in the final EFA: mastery-approach (items 11, 19, 21, 22, 23), mastery-avoidance (items 25, 26, 28, 29), performance-approach (items 7, 8, 9, 12), performance-avoidance (items 14, 15, 16, 17, 30). The results of the CFAs comparing the three first-order achievement goals models are displayed in Table 9.1. Of the three models, Four-factor Model B provided a significantly better fit of the data with $\chi^2 = 466.2$ ($df = 129$, $p < .001$), RMSEA = 0.0762, RMR = 0.125, AGFI = 0.945, CFI = 0.887, and NNFI = 0.866. Consequently, Four-factor Model B was used in the one-factor congeneric measurement models for achievement goals. These analyses verified the existence of the four types of achievement goals during a teacher-led discussion context.

Competence perceptions and self-regulated learning. An initial EFA of the competence perception and self-regulated learning items yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors; this solution accounted for 57.5 % of the total variance after the initial extraction for the unrotated solution. One of the items (item 5) crossloaded and subsequently was removed from the analysis. The final factor solution analysis for the sample (n = 451) contained four factors, accounting for 58.1 % of the total variance after the initial extraction for the unrotated solution. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Bartlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. (See the author for complete results of the final EFA solution.) Two factors represented the hypothesised self-regulated learning constructs for the context, namely regulatory strategy use and maladaptive strategy use, while the third and fourth factors represented task efficacy and perceived ability. All items loaded above 0.35 on their primary factor and none of the items crossloaded (> 0.32 on two or more factors) in the final EFA solution.

Table 9.1

Personal Achievement Goals during Teacher-Led Discussion: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	557.3	132	.000	-	-	.0846	.161	.936	.858	.835
Four-factor model A	517.1	129	.000	40.2***	3	.0818	.151	.939	.870	.846
Four-factor model B	466.2	129	.000	50.9	-	.0762	.125	.945	.887	.866

Note. $n = 451$; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance items. Four-factor Model A: TLDQ mastery-approach, TLDQ mastery-avoidance, TLDQ performance-approach, TLDQ performance-avoidance. Four-factor Model B: EFA mastery-approach, EFA mastery-avoidance, EFA performance-approach, EFA performance-avoidance. *** $p < .001$.

9.3.2 Preliminary Analyses: One-factor Congeneric Measurement Model Analyses

Fitted one-factor congeneric measurement models were used to form the composite variables that represent the constructs investigated in Study 3. These analyses were performed in the same way as those in Studies 1 and 2, using PRELIS 8.72 to compute the inter-item polychoric correlations and asymptotic covariance matrices for the ordinal data scales, which were then analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation models (Jöreskog, 2002).

The results of the measurement properties attained from fitting one-factor congeneric models are presented in Tables 9.2 and 9.3. Items found to have small partial regression weights and large measurement error variance (> 0.90) were eliminated since these were either inappropriate indicator items for the latent variable or were inappropriately worded and thus introduced a large amount of inconsistency when interpreted by students. These items may be of interest to researchers associated with the relevant questionnaire design and modifications. The one-factor congeneric model for a latent variable was repeated if items were eliminated from its embryonic model; the results obtained are therefore devoid of poor fitting indicator items. All of the composite scales exhibited satisfactory composite scale parameter results. The composite score reliability coefficients (r_c) ranged from 0.696 to 0.875; the variance estimate of items attributed to the composite variable ($\hat{\lambda}_c$) ranged from 0.825 to 0.923; and, the variance estimate of items attributed to measurement error ($\hat{\theta}_c$) ranged from 0.122 to 0.297. The mastery-avoidance scale had the weakest composite scale reliability (0.696) but was included in the final analyses. The relevant goodness of fit indices of each composite scale are presented in Table 9.4; these were also satisfactory.

Table 9.2

Personal Achievement Goals during Teacher-Led Discussion: Composite Scale Parameters (Study 3A)

Composite Variable	Item Weights							TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
	map1[a] (19)[b]	map2 (20)	map3 (21)	map4 (22)	map5 (23)	map6 (24)	pap5 (11)					
Mastery-approach	.258[c]	-	.145	.257	.320	-	.176	3[e], 1	.828	.903	.169	.806
	.223[d]	-	.125	.222	.277	-	.152					
	mav1 (25)	mav2 (26)	mav3 (27)	mav4 (28)	mav5 (29)							
Mastery-avoidance	.198	.418	-	.380	.104			5, 1	.696	.825	.297	.713
	.180	.380	-	.345	.095							
	pap1 (7)	pap2 (8)	pap3 (9)	pap4 (10)	pap6 (12)							
Performance-approach	.223	.494	.201	-	.169			6, 3	.815	.882	.177	.824
	.205	.454	.185	-	.155							
	pav1 (13)	pav2 (14)	pav3 (15)	pav4 (16)	pav5 (17)	pav6 (18)	mav6 (30)					
Performance-avoidance	-	.044	.390	.235	.272	.272	.192	4, 2	.814	.886	.179	.784
	-	.039	.344	.207	.240	.240	.169					

Note. $n = 451$; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of item attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of item attributed to measurement error; α = Cronbach's alpha estimate.

Table 9.3

Personal Achievement Goals during Teacher-Led Discussion: Composite Scale Parameters (Study 3A)

Composite Variable	Item Weights							TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
	te1[a] (1)[b]	te2 (2)	te3 (3)	te4 (4)	te5 (5)	te6 (6)	-					
Task efficacy	.272[c]	.597	.053	.136	-	-	-	3[e], 1	.770	.863	.223	.791
	.257[d]	.564	.050	.129	-	-	-					
	psr1 (31)	psr2 (32)	psr3 (33)	psr4 (34)	psr5 (35)	psr6 (36)	psr7 (37)					
Regulatory strategy use	.209	.238	.150	.192	.248	.140	.091	3, 1 6, 1 6, 4 7, 6	.812	.896	.186	.813
	.165	.188	.118	.151	.196	.110	.072					
	nsr1 (38)	nsr2 (39)	nsr3 (40)	nsr4 (41)	nsr5 (42)	nsr6 (43)	nsr7 (44)					
Maladaptive strategy use	.126	.252	.071	.123	.060	.374	.184	3, 1 3, 2 6, 2 6, 5 7, 5	.875	.923	.122	.874
	.106	.212	.060	.103	.050	.314	.155					

Note. n = 451; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of item attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of item attributed to measurement error; α = Cronbach's alpha estimate.

Table 9.4

Teacher-Led Discussion Constructs: One-Factor Congeneric Model Fit Indices (Study 3A)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Mastery-approach	5	4.609	4	.330	.998	.993	.0224	.0184
Mastery-avoidance	4	.001	1	.972	1.00	1.00	.0000	.0000
Performance-approach	4	2.032	1	.154	.999	.992	.0094	.0479
Performance-avoidance	5	1.149	4	.886	1.00	.999	.00674	.0000
Task efficacy	4	.650	1	.420	1.00	.998	.00621	.0000
Regulatory strategy use	7	9.620	7	.474	.997	.993	.0208	.0000
Maladaptive strategy use	7	12.771	9	.173	.997	.991	.0233	.0305

Note. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

9.3.3 Descriptive Statistics

The distributional properties of the composite scales were then examined for use in multilevel multiple regression and structural equation modelling analyses. Analyses using PRELIS showed no systematic patterns for the missing data and thus a listwise method was employed in dealing with missing data. Descriptive statistics and univariate normality tests of the raw composite scale data are presented in Table 9.5. These results show that the composite scale data, even after completion of the one-factor congeneric modelling analyses described above, was not normally distributed with some composites exhibiting significant skewness and kurtosis. Normalised values of the raw composite scale scores were achieved using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b), which rescores the raw composite scale scores on the basis of normal equivalent deviates in accordance with the original score rankings (Rowe, 2003, 2006). The resultant descriptive statistics and univariate normality tests of the normalised composite scale data are shown in Tables 9.6 to 9.8. This process resulted in all composite scales having distributional properties close to being normal distributed with insignificant skewness and kurtosis. The normalised composite scale scores were used in multilevel multiple regression and structural equation modelling analyses. Despite satisfactorily achieving normality for independent composites, multivariate normality tests were still significant. Four multiple goal constructs (Mastery-approach X Mastery-avoidance, Mastery-approach X Performance-approach, Performance-approach X Performance-avoidance, Mastery-avoidance X Performance-avoidance) were formed from the relevant composite scales in order to investigate the impact of multiple achievement goals. The composite scale scores for each of these were also normalised (Table 9.7).

Table 9.5

Teacher-Led Discussion Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 3A)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	4.555	1.193	1-7	1-7	-.373	-3.178	.001	.198	.913	.361	10.94	.004
Mastery-avoidance	3.427	1.252	1-6.8	1-7	-.034	-.302	.763	-.587	-3.582	.000	12.92	.002
Performance-approach	3.210	1.393	1-7	1-7	.274	2.367	.018	-.523	-3.033	.002	14.80	.001
Performance-avoidance	2.895	1.219	1-6.4	1-7	.342	2.929	.003	-.433	-2.332	.020	14.02	.001
Task efficacy	4.882	1.308	1-7	1-7	-.572	-4.697	.000	.115	.592	.554	22.42	.000
Regulatory strategy use	4.525	1.113	1-7	1-7	-.250	-2.167	.030	.535	2.013	.044	8.75	.013
Maladaptive strategy use	2.867	1.266	1-7	1-7	.599	4.893	.000	-.051	-.124	.901	23.96	.000
Perceived ability	4.619	1.223	1-7	1-7	-.151	-1.323	.186	.051	.327	.744	1.86	.395

Note. n = 451.

Table 9.6

Teacher-Led Discussion Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 3A)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	-.001	.992	-2.540 – 2.287	-.022	-.194	.846	-.216	-.960	.337	.959	.619
Mastery-avoidance	.004	.989	-2.032 – 3.059	.078	.683	.495	-.226	-1.020	.308	1.505	.471
Performance-approach	.007	.977	-1.792 – 2.540	.109	.957	.339	-.374	-1.927	.054	4.629	.099
Performance-avoidance	.007	.982	-1.850 – 3.059	.115	1.007	.314	-.287	-1.370	.171	2.890	.236
Task efficacy	-.004	.984	-2.540 – 1.970	-.070	-.610	.542	-.311	-1.516	.129	2.672	.263
Regulatory strategy use	.000	.994	-2.476 – 2.540	.005	.040	.968	-.173	-.727	.467	.531	.767
Maladaptive strategy use	.005	.987	-1.990 – 3.059	.086	.750	.453	-.239	-1.094	.274	1.759	.415
Perceived ability	-.005	.969	-2.617 – 1.866	-.093	-.819	.413	-.279	-1.324	.185	2.424	.298

Note. $n = 451$.

Table 9.7

Teacher-Led Discussion Multiple Goal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 3A)

Variable[a]	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach X Mastery-avoidance	.000	.999	-3.059 – 3.059	.000	.000	1.00	-.055	-.145	.885	.021	.990
Mastery-approach X Performance-approach	.000	.999	-3.059 – 2.845	-.009	-.080	.937	-.067	-.198	.843	.045	.978
Performance-approach X Performance-avoidance	.000	.999	-3.059 – 3.059	-.007	-.062	.950	-.054	-.137	.891	.023	.989
Mastery-avoidance X Performance-avoidance	.000	.999	-3.059 – 3.059	-.007	-.058	.954	-.052	-.129	.898	.020	.990

Note. [a]Multiple goals were formed initially using personal goals normalised data and then normalised.

Table 9.8

Multivariate Normality Tests for Normalised Data (Study 3A Teacher Led Discussion)

Variables measured	Effective sample size	Skewness			Kurtosis			Skewness and Kurtosis	
		value	z-score	*p*	value	z-score	*p*	χ^2	*p*
All	451	46.39	42.17	.000	283.1	16.05	.000	2036	.000

Variance-covariance relations of the normalised composite scales are found in Table 9.9. Although Pearson product-moment correlations are invalid measures when data are not-normally distributed and ordinal (Jöreskog, 1990; Rowe, 2006), they may be of interest when the composite scale scores satisfy normal distribution properties, as in the case of this study. Correlations among the variables are presented in Table 9.10. Note the similarity between the correlation values with those obtained for the covariances amongst the variables. There was support for the hypothesised relations amongst the variables. Regulatory strategy use had positive relations with task efficacy, mastery-approach, performance-approach and perceived ability, and had negative relations with mastery-avoidance and maladaptive strategy use. Maladaptive strategy use had positive relations with mastery-avoidance, performance-avoidance and performance-approach, and had negative relations with mastery-approach and perceived ability. With regards to the relations amongst the achievement goals, mastery-approach had positive associations with performance-approach only. Performance-approach also had positive relations with mastery-avoidance and performance-avoidance. Mastery-avoidance had positive associations with performance-avoidance. Females reported to have lower mastery-approach goals, lower performance-approach goals and be less efficacious at teacher-led discussion than males; they also reported to be of lower ability. Selective students reported to have lower avoidance and lower performance-approach goals than regular students. Juniors had lower mastery-approach goals and to be lower in task efficacy than seniors.

Table 9.9

Variance-Covariance Estimates for Variables - Normalised Data (Study 3A Teacher-Led Discussion)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mastery-approach	.983														
2. Mastery-avoidance	-.052	.977													
3. Performance-approach	.332	.226	.955												
4. Performance-avoidance	.085	.511	.490	.965											
5. Task efficacy	.530	-.059	.175	-.097	.969										
6. Regulatory strategy use	.742	-.119	.325	.036	.509	.988									
7. Maladaptive strategy use	-.292	.470	.147	.474	-.316	-.319	.975								
8. Perceived ability	.353	-.161	.218	-.073	.257	.426	-.292	.939							
9. Mastery-approach x Mastery-avoidance	-.243	.103	-.105	-.013	-.106	-.245	.090	-.112	.998						
10. Mastery-approach x Performance-approach	-.148	-.080	-.018	-.048	-.020	-.128	-.026	-.002	.265	.997					
11. Performance-approach x Performance-avoidance	-.115	-.048	-.070	-.014	.007	-.046	.060	.044	.251	.021	.997				
12. Mastery-avoidance x Performance-avoidance	-.044	-.058	-.038	.015	.095	-.008	.108	-.001	.076	.083	.268	.997			
13. Gender[a]	-.129	-.036	-.338	-.049	-.130	-.145	.024	-.256	.006	.023	.043	-.001	1.00		
14. Student type[b]	-.064	-.065	-.359	-.130	.026	-.038	-.106	-.018	.085	-.019	-.037	-.026	-.048	1.00	
15. Age[c]	-.131	.007	.049	.012	-.200	-.110	.006	.034	.056	.060	.118	.066	.066	-.476	1.00

Note. n = 451; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior.

Table 9.10

Intercorrelations among Variables - Normalised Data (Study 3A Teacher-Led Discussion) Pearson Product Moment Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mastery-approach	-														
2. Mastery-avoidance	-.053	-													
3. Performance-approach	.343**	.234**	-												
4. Performance-avoidance	.087	.526**	.510**	-											
5. Task efficacy	.543**	-.060	.182**	-.100*	-										
6. Regulatory strategy use	.753**	-.122**	.334**	.037	.520**	-									
7. Maladaptive strategy use	-.298**	.482**	.152**	.489**	-.325**	-.324**	-								
8. Perceived ability	.367**	-.168**	.239**	-.077	.270**	.442**	-.306**	-							
9. Mastery-approach x Mastery-avoidance	-.245**	.105*	-.108*	-.014	-.108*	-.247**	.091	-.115*	-						
10. Mastery-approach x Performance-approach	-.150**	-.081*	-.018	-.048	-.020	-.129**	-.027	-.002	.266**	-					
11. Performance-approach x Performance-avoidance	-.116*	-.048	-.072	-.014	.007	-.047	.061	.046	.251**	.021	-				
12. Mastery-avoidance x Performance-avoidance	-.044	-.059	-.039	.016	.097*	-.009	.110*	-.001	.077	.083	.269**	-			
13. Gender[a]	-.104*	-.029	-.276**	-.040	-.106*	-.116*	.019	-.210**	.005	.018	.034	-.001	-		
14. Student type[b]	-.051	-.052	-.291**	-.104*	.021	-.030	-.085	-.015	.067	-.015	-.029	-.021	-.030	-	
15. Age[c]	-.102*	.006	.038	.009	-.156**	-.086	.005	.027	.043	.047	.092	.052	.041	-.310**	-

Note. $n = 451$; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .01$.

9.3.4 Regression Analyses: Preliminary Multilevel Regression Modelling Analyses

Multilevel multiple regression analyses using *MLwiN* 2.0 were used in the same way as reported in Studies 1 (Chapter 6) and 2 (Chapter 7) to assess the hypothesised relationships relations between task efficacy, achievement goals, self-regulated learning, maladaptive strategy use, and subpopulation variables in the specified classroom context of teacher-led discussion. The data collected for this study came from a total of 23 classes clustered within eight schools. Consequently, the multilevel analyses of this study were constrained to a two-level hierarchy, with students at the first level and their classroom membership forming the second level.

The multilevel variance components models for all variables are reported in Table 9.11. The variance of residuals attributed to the class-level ranged from 0 to 10.7% while the variance attributed to the personal-level ranged from 89.3 to 100%. As for Studies 1 and 2, these results indicate that much of the variance associated with the reporting of the constructs under study in the present research is accounted for at the personal level and not to classroom-level differences.

The second type of multilevel variance components models incorporated the subpopulation variables of age (junior or senior), gender and school type (regular or selective) as fixed effects explanatory variables ("classifier variables") with the residual variance of the construct under focus being partitioned into the level 1 (student-level) and level 2 (class-level) units with no other explanatory variables involved.. The results of these analyses are reported in Table 9.12. For each construct the incorporation of the classifier variables significantly improved the fit of the model beyond the initial multilevel variance components model. The variance of residuals attributed to the class-level ranged from 0 to 7.7% and the variance accounted for at the personal-level ranged from 92.3 to 100%. These results indicate that most of the variance associated with these constructs is accounted for at the personal level and not to classroom-level differences.

Table 9.11

Personal Constructs: Base Variance Components Models (Study 3A Teacher-Led Discussion)

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_{T}
Mastery-approach	.002 (.080)	.098 (.043)	10.0	.885 (.060)	90.0	.983
Mastery-avoidance	.004 (.046)	.000 (.000)*	0	.975 (.065)	100	.975
Performance-approach	.017 (.080)	.102 (.043)	10.7	.853 (.058)	89.3	.955
Performance-avoidance	.016 (.058)	.029 (.023)*	3.0	.934 (.064)	97.0	.963
Task efficacy	.005 (.077)	.091 (.040)	9.4	.877 (.060)	90.6	.968
Regulatory strategy use	.010 (.073)	.073 (.036)	7.4	.916 (.063)	92.6	.989
Maladaptive strategy use	.017 (.063)	.043 (.027)*	4.4	.930 (.064)	95.6	.973
Perceived ability	-.005 (.046)	.000 (.000)*	0	.937 (.062)	100	.937

Table 9.11 *Continued*

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach X Mastery-avoidance	-.001 (.052)	.010 (.018)*	1.0	.985 (.067)	99.0	.995
Mastery-approach X Performance-approach	-.012 (.064)	.043 (.027)*	4.3	.953 (.065)	95.7	.996
Performance-approach X Performance-avoidance	.000 (.047)	.000 (.000)*	0	.995 (.066)	100	.995
Mastery-avoidance X Performance-avoidance	-.001 (.053)	.014 (.019)*	1.4	.981 (.067)	98.6	.995

Note. n = 451. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test); [b]

Table 9.12

Personal Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 3A Teacher-Led Discussion)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach	.301 (.156)	-.248 (.155)*	-.161 (.090)*	-.166 (.153)*	.074 (.035)	7.7	.882 (.060)	92.3
Mastery-avoidance	.096 (.109)	-.021 (.102)*	-.060 (.093)*	-.112 (.098)*	.000 (.000)*	0	.971 (.065)	100
Performance-approach	.608 (.110)	-.094 (.104)*	-.551 (.084)	-.621 (.110)	.012 (.015)*	1.5	.781 (.053)	98.5
Performance-avoidance	.186 (.122)	-.050 (.117)*	-.084 (.092)*	-.228 (.114)	.018 (.020)*	1.9	.932 (.064)	98.1
Task efficacy	.292 (.148)	-.305 (.147)	-.172 (.090)*	-.048 (.145)*	.061 (.031)	6.5	.874 (.060)	93.5
Regulatory strategy use	.290 (.146)	-.206 (.144)*	-.203 (.091)	-.136 (.142)*	.055 (.030)*	5.7	.909 (.062)	94.3
Maladaptive strategy use	.121 (.134)	-.053 (.131)*	.017 (.092)*	-.182 (.128)*	.035 (.025)*	3.6	.930 (.064)	96.4
Perceived ability	.158 (.105)	.065 (.098)*	-.410 (.089)	-.022 (.094)*	.000 (.000)*	0	.894 (.060)	100

Table 9.12 *Continued*

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach X Mastery-avoidance	-.180 (.110)	.148 (.103)*	.010 (.094)*	.180 (.099)*	.000 (.000)*	0	.987 (.066)	100
Mastery-approach X Performance-approach	-.098 (.139)	.110 (.136)*	.037 (.093)*	.005 (.134)*	.041 (.027)*	4.1	.952 (.065)	95.9
Performance-approach X Performance-avoidance	-.150 (.110)	.188 (.103)*	.061 (.094)*	.000 (.099)*	.000 (.000)*	0	.986 (.066)	100
Mastery-avoidance X Performance-avoidance	-.057 (.120)	.106 (.114)*	-.008 (.094)*	-.016 (.110)*	.012 (.018)*	1.2	.980 (.067)	98.8

Note. n = 451; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

9.3.5 Regression Analyses: Personal Predictors of Self-Regulated Learning during Teacher-Led Discussion

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between the personal factors with regulatory and maladaptive strategy use during teacher-led discussion. The personal factors that were the focus of this study included achievement goals (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance), the competence perceptions (task efficacy, perceived ability) and the four multiple goal constructs (mastery-approach X mastery-avoidance, mastery-approach X performance-approach, performance-approach X performance-avoidance, mastery-avoidance X performance-avoidance). In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors of self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). Each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1).

Regulatory strategies

The thirteen-explanatory variable model explained 62.8% of variance in the use of regulatory strategies (Table 9.13). Positive predictors of regulatory strategy use were: mastery-approach ($\beta = 0.565$, $p < .001$), performance-approach ($\beta = 0.102$, $p < .05$), task-efficacy ($\beta = 0.141$, $p < .001$) and perceived ability ($\beta = 0.157$, $p < .001$). Mastery-avoidance ($\beta = -0.074$, $p < .05$) was the only significant negative predictor of regulatory strategy use. There was no significant variance of regulatory strategy use attributable to class membership. No other variables acquired significance.

Maladaptive strategy use

The thirteen-explanatory variable model explained 46.1% of variance in the use of maladaptive strategies (Table 9.14). Positive predictors of maladaptive strategy use were: mastery-avoidance ($\beta = 0.275$, $p < .001$), performance-avoidance ($\beta = 0.295$, p

< .001). Of the multiple goal variables investigated, the mastery-avoidance X performance-avoidance interaction was a significant positive predictor of maladaptive strategy use ($\beta = 0.121$, $p < .001$). Negative predictors of maladaptive strategy use were: mastery-approach ($\beta = -0.186$, $p < .001$), task-efficacy ($\beta = -0.179$, $p < .001$) and perceived ability ($\beta = -0.136$, $p < .001$). There was no significant variance of maladaptive strategy use attributable to class membership. No other variables acquired significance.

Table 9.13

Multilevel Regression Analysis Model Results for Regulatory Strategy Use[a] (Study 3A Teacher-Led Discussion)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	-.028 (.073)	-
Gender[b]	.034 (.061)	.017
Student type[c]	.052 (.067)	.026
Age[d]	-.013 (.067)	-.006
Mastery-approach	.566 (.039)**	.565
Mastery-avoidance	-.074 (.035)*	-.074
Performance-approach	.104 (.041)*	.102
Performance-avoidance	.002 (.041)	.002
Task efficacy	.142 (.037)**	.141
Perceived ability	.161 (.034)**	.157
Mastery-approach X Mastery-avoidance	-.058 (.032)	-.058
Mastery-approach X Performance-approach	-.031 (.030)	-.031
Performance-approach X Performance-avoidance	.030 (.031)	.030
Mastery-avoidance X Performance avoidance	.002 (.030)	.002
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.002 (.006)	
Student level variance (σ^2_{e0})	.366 (.025)**	
% of variance explained	62.8	
-2loglikelihood (IGLS deviance)	829.0	

Note. n = 451 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .001$.

Table 9.14

Multilevel Regression Analysis Model Results for Maladaptive Strategy Use[a] (Study 3A Teacher-Led Discussion)

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.144 (.095)	-
Gender[b]	-.031 (.073)	-.016
Student type[c]	-.091 (.089)	-.046
Age[d]	-.135 (.089)	-.066
Mastery-approach	-.185 (.046)**	-.186
Mastery-avoidance	.274 (.042)**	.275
Performance-approach	.053 (.048)	.052
Performance-avoidance	.297 (.048)**	.295
Task efficacy	-.180 (.044)**	-.179
Perceived ability	-.139 (.040)**	-.136
Mastery-approach X Mastery-avoidance	-.021 (.038)	-.021
Mastery-approach X Performance-approach	-.022 (.036)	-.022
Performance-approach X Performance-avoidance	.042 (.037)	.043
Mastery-avoidance X Performance avoidance	.120 (.036)**	.121
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.010 (.011)	
Student level variance (σ^2_{e0})	.514 (.035)**	
% of variance explained	46.1	
-2loglikelihood (IGLS deviance)	987.2	

Note. n = 451 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .001$.

Aiken and West's (1991) simple slope analysis was used to interpret the mastery-avoidance X performance-avoidance interaction ($\beta = 0.121$, $p < .001$). In accordance with this protocol, the effect of mastery-avoidance on maladaptive strategy use was plotted at low (one standard deviation below mean), medium (mean) and high levels (one standard deviation above mean) of performance-avoidance goal values in order to examine how performance-avoidance goals moderate the relations between mastery-avoidance and maladaptive strategy use. Figure 9.1 displays the resultant plots. There was a significant difference between the high level and low level performance-avoidance slopes thus indicating the moderating effect of performance-avoidance goals on mastery-avoidance. The figure shows that the impact of mastery-avoidance goals on maladaptive strategy use depends on the performance-avoidance goal orientation of the students. An increase in both mastery-avoidance and performance-avoidance goals corresponds with an increase in maladaptive strategy use; students that report themselves as high in performance-avoidance goals have a correspondingly greater increase in maladaptive strategy use than students who report they have low performance-avoidance goals.

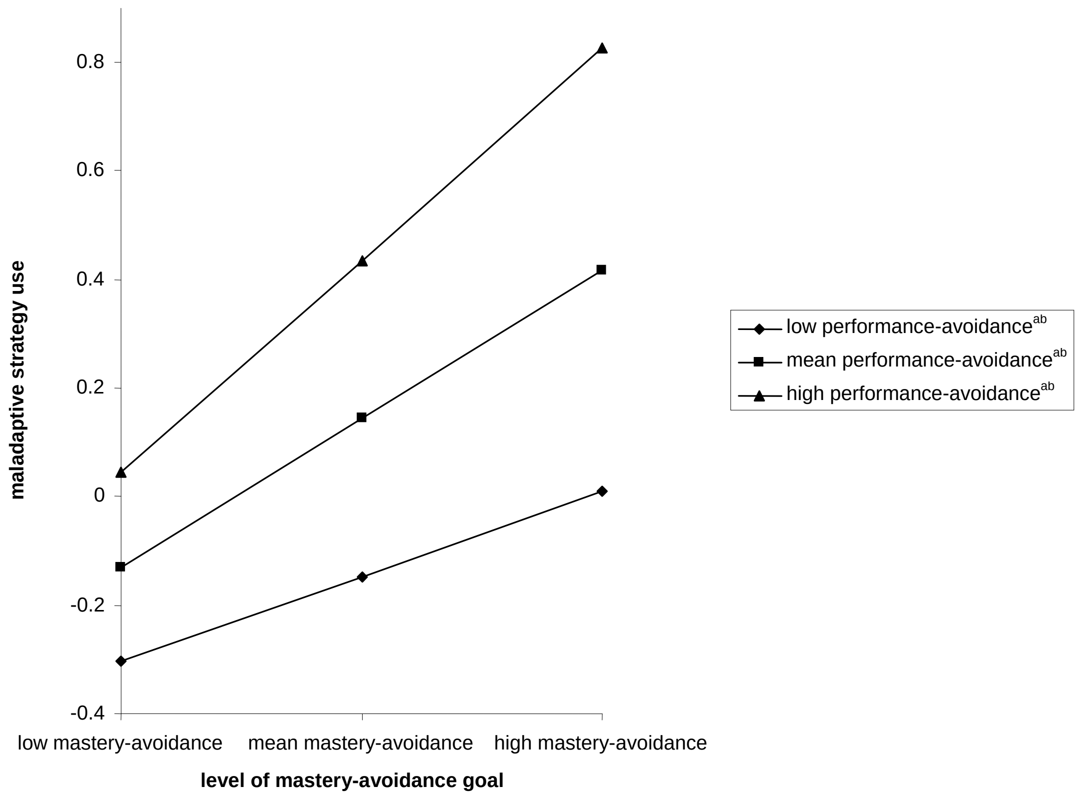

Figure 9.1. Plots of the mastery-avoidance goal X performance-avoidance goal interaction. [a]Slopes significantly differ at $p < .01$; [b]Slope is significant at $p < .001$.

The regression analyses presented above were used to assess the hypothesised relationships between achievement goals, competence perceptions and self-regulated learning for high school science students in the context of a teacher-led discussion learning context. Synopses of the significant predictors of self-regulated learning as yielded by the regression analyses are presented in Table 9.15.

Table 9.15

Synopsis of Significant Predictors of Self-Regulated Learning for High School Science Students during Teacher-Led Discussion (Study 3A)

Regulatory strategy use	Maladaptive strategy use
mastery-approach (+)	mastery-approach (-)
mastery-avoidance (-)	mastery-avoidance (+)
performance-approach (+)	performance-avoidance (+)
task efficacy (+)	task efficacy (-)
perceived ability (+)	perceived ability (-)
	mastery-avoidance X performance avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship. All relationships are significant at a minimum of $p < .05$.

9.3.6 Structural Equation Modelling Analyses: Personal Predictors of Self-Regulated Learning during Teacher-Led Discussion

Structural equation modelling was used to analyse the simultaneous relationships between the explanatory (task-efficacy, perceived ability, mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) and response (regulatory strategy use, maladaptive strategy use) variables. The multilevel multiple regression analyses revealed the majority of the response variable variance was attributed to the student-level. As such, these results vindicate a single-level structural equation modelling approach for the data rather than a two-level structural equation modelling approach. In addressing the applicability of the structural equation modelling, the variances attributed to the classifier variables, namely gender, student age and student type, were removed. This was achieved by fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 (Rowe, 2006; Rowe & Hill, 1998; Rowe & Rowe, 1999), with the classifier variables of gender, student age and student type assigned as fixed explanatory variables; the residuals of the other variables are allowed to be random thus yielding a variance-covariance matrix of these variables which can be used for structural equation modelling. As a result of attaining significance in the multilevel multiple regression analyses, the mastery-avoidance X performance-avoidance variable was also declared as a classifier variable. However, none of the multiple goal constructs were included in the structural equation modelling for substantive reasons. The results of fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 are displayed in Table 9.16.

Table 9.16

Results of Fitting a Student-Level Multivariate Model for the Classroom Learning Environment and Personal Constructs - Normalised Data (Study 3A)

Fixed part of model		Random part of model								
Variable	Estimates (s.e.)	Variable	1	2	3	4	5	6	7	8
Gender[a]	-.168 (.041)**	1. Mastery-approach	**.965**	*-.053*	*.343*	*.087*	*.753*	*-.298*	*.543*	*.367*
Student type[b]	-.126 (.043)*	2. Mastery-avoidance	-.056	**.983**	*.234*	*.526*	*-.122*	*.482*	*-.060*	*-.168*
Age[c]	-.107 (.045)*	3. Performance-approach	.293	.199	**.893**	*.510*	*.334*	*.152*	*.182*	*.230*
Mastery-avoidance X performance-avoidance	.045 (.021)	4. Performance-avoidance	.073	.511	.456	**.957**	*.037*	*.489*	*-.100*	*-.077*
		5. Regulatory strategy use	.723	-.124	.285	.024	**.968**	*-.324*	*.520*	*.442*
		6. Maladaptive strategy use	-.301	.472	.115	.468	-.328	**.970**	*-.325*	*-.306*
		7. Task efficacy	.507	-.067	.131	-.113	.487	-.330	**.941**	*.270*
		8. Perceived ability	.334	-.166	.178	-.086	.406	-.303	.234	**.917**

Note. n = 451 (effective sample size); [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior. Residual variance estimates (in bold) are on the diagonal with covariance estimates given below the diagonal. Pearson product moment Correlation estimates are given above the diagonal in italics. * $p < .05$. ** $p < .001$.

The variance-covariance matrix displayed in Table 9.16 was used in the structural equation modelling. Note that the variance-covariance matrix of the variables has been 'purged' (Rowe, 2006) of the variance attributed to the classifier variables thus increasing the generalisability of the structural equation modelling analyses.

The hypothesised self-regulated learning structural equation model is presented in Figure 9.2. The model was based upon theoretical relations between the variables. Using the maximum likelihood method of estimation via LISREL 8.72 (Jöreskog & Sörbom, 2005) showed, however, this initial model provided an unsatisfactory fit of the data with $\chi^2 = 375.1$ ($df = 13$, $p < .001$), RMSEA = 0.251, SRMR = 0.150, GFI = 0.830, AGFI = 0.528, CFI = 0.751, and NFI = 0.9747 (Table 9.17). Revision of the initial model and the subsequent modelling was based upon the results obtained from the multilevel multiple regressions reported above and by investigating the suggested modification indices within substantive grounds using the maximum likelihood method of estimation via LISREL 8.72. This approach resulted in the final self-regulated learning structural equation model providing a satisfactory fit of the data with $\chi^2 = .015$ ($df = 1$, $p = .902$), RMSEA = 0.0000, SRMR = 0.0003, GFI = 1.00, AGFI = 1.00, CFI = 1.00, and NFI = 1.00 (Table 9.17). Using generalised least squares used as the estimation method also revealed the model to satisfactorily fit the data with $\chi^2 = .015$ ($df = 1$, $p = .557$), RMSEA = 0.0000, SRMR = 0.0021, GFI = 1.00, AGFI = 0.995, CFI = 1.00, and NFI = 0.999 (Table 9.17).

For clarity, the final model is presented over three figures (Figures 9.3 to 9.5). The standardised direct effects path model for the competence perception variables is displayed in Figure 9.3. As hypothesised, the competence perception variables of task efficacy and perceived ability had significant relations with personal achievement goals and self-regulated learning. Of these relations, task efficacy was a significant positive predictor of mastery-approach ($\gamma = 0.577$, $p < .001$) and performance-approach ($\gamma = 0.130$, $p < .05$), and was a negative predictor of performance-avoidance ($\gamma = -0.280$, $p < .001$) and maladaptive strategy use ($\gamma = -0.162$, $p < .05$). Perceived ability also had positive associations with mastery-approach ($\gamma = 0.171$, $p < .001$) and performance-approach ($\gamma = 0.182$, $p < .001$), and was a negative predictor of mastery-avoidance ($\gamma = -0.122$, $p < .05$), performance-avoidance ($\gamma = -0.145$, $p < .001$) and maladaptive strategy use ($\gamma = -0.105$, $p < .05$).

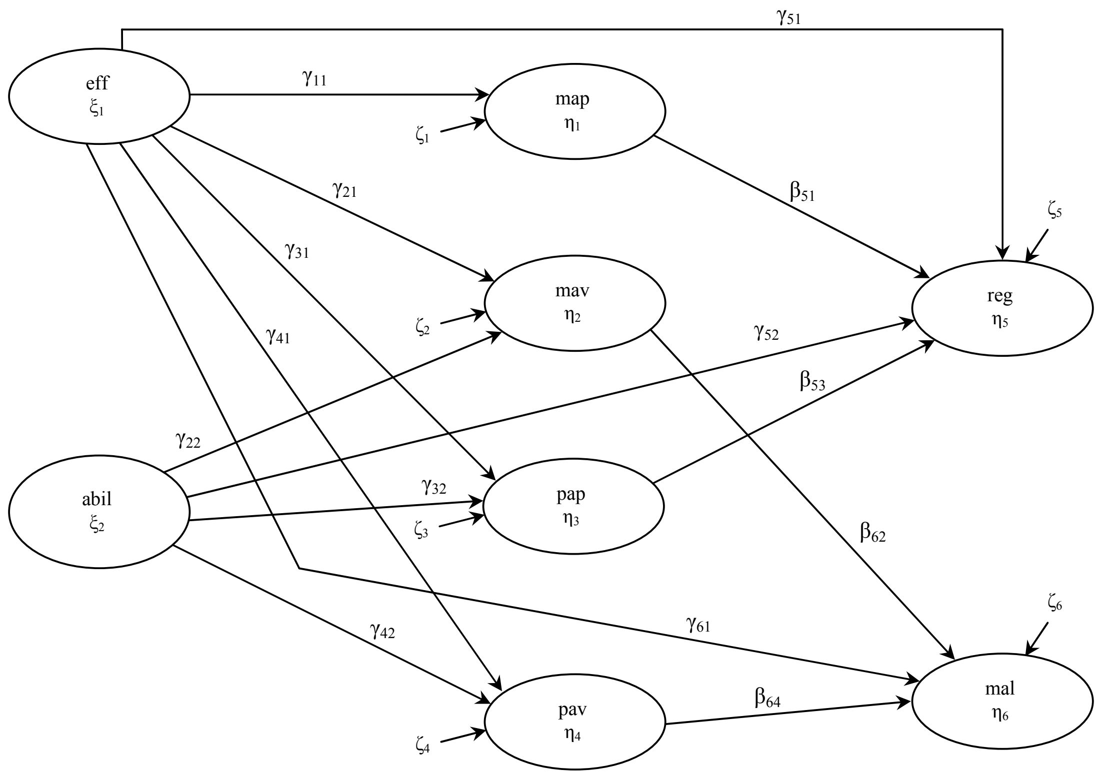

Figure 9.2. Hypothesised structural equation model under study. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal).

Table 9.17

Self-Regulated Learning Structural Equation Model Fit Indices (Teacher-Led Discussion)

Variable	χ^2	*df*	*p*	GFI	AGFI	NFI	CFI	SRMR	RMSEA
Hypothesised model	375.1	13	.000	.830	.528	.747	.751	.150	.251
Revised model[a]	.015	1	.902	1.00	1.00	1.00	1.00	.0003	.0000
Revised model[b]	.015	1	.902	1.00	1.00	1.00	1.00	.0003	.0000

Note. n = 451; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; SRMR = standardised root mean square residual; RMSEA = root mean square error of approximation; [a]Maximum likelihood used as the estimation method; [b]Generalised least squares used as the estimation method.

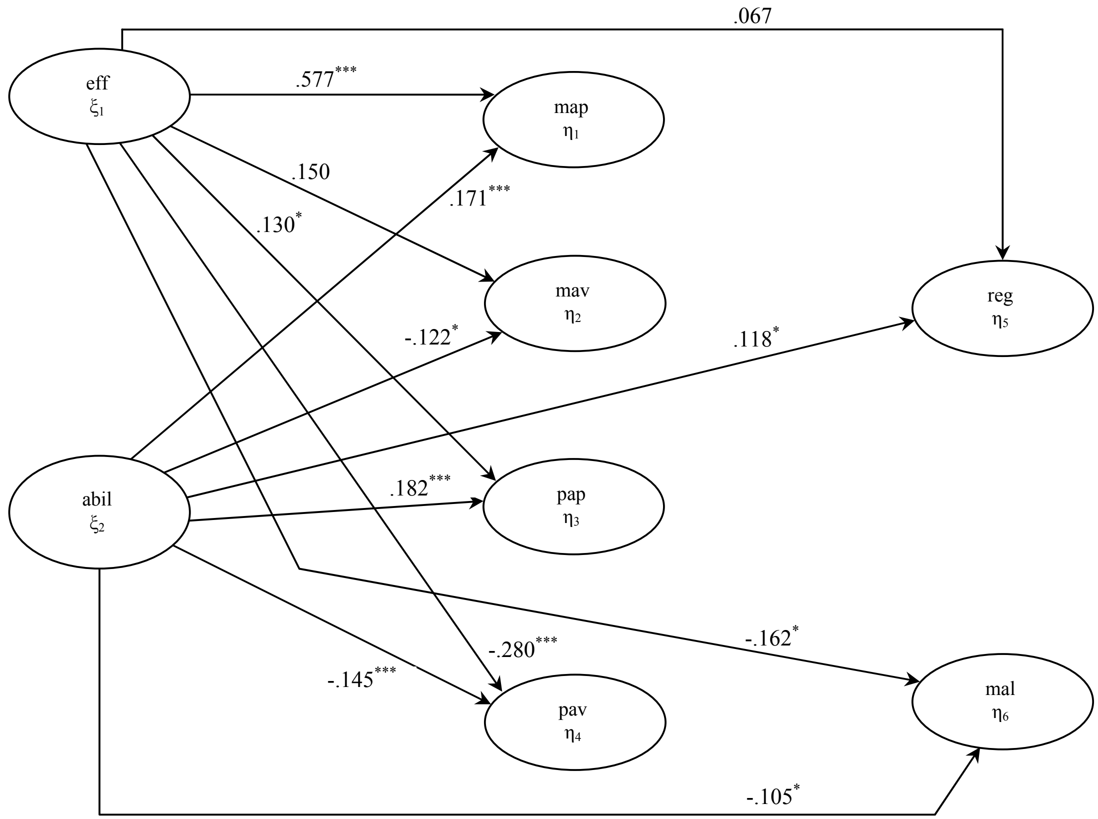

Figure 9.3. Revised structural equation model displaying the standardised direct effects for the competence perception variables. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

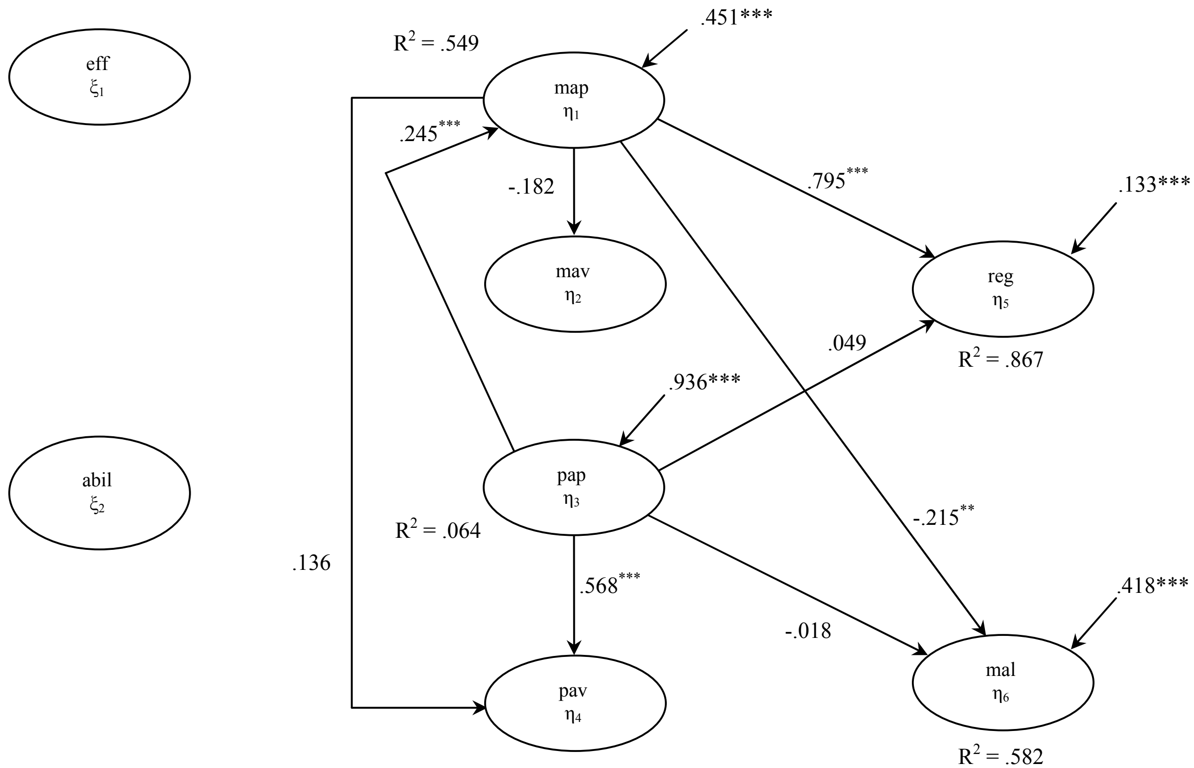

Figure 9.4. Revised structural equation model displaying the standardised direct effects for mastery-approach and performance-approach achievement goals. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

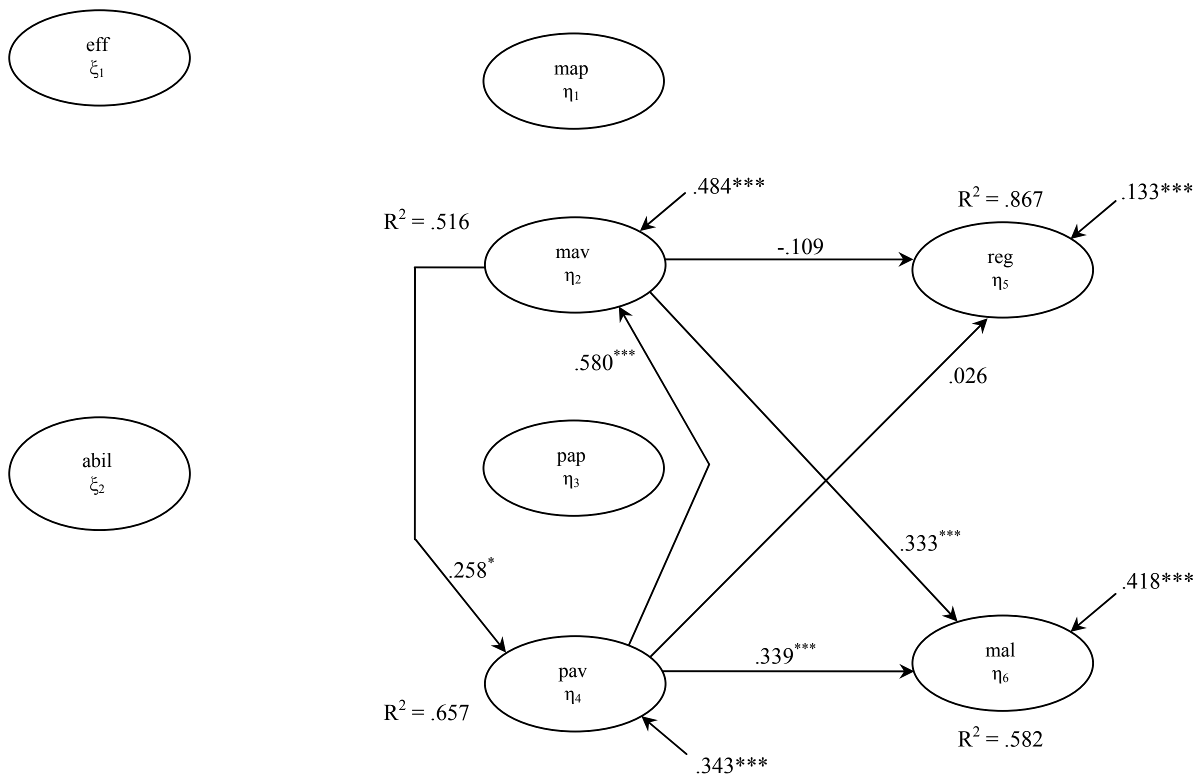

Figure 9.5. Revised structural equation model displaying the standardised direct effects for mastery-avoidance and performance-avoidance achievement goals. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

The standardised direct effects path model for the mastery-approach and performance-approach variables is displayed in Figure 9.4. Regulatory strategy use was positively predicted by mastery-approach (β = 0.795, p < .001), but had null relations with performance-approach (β = 0.049). Maladaptive strategy use was negatively predicted by mastery-approach (β = -0.215, p < .01) and had null relations with performance-approach (β = -0.018). As found in Studies 1 and 2, a significant amount of covariance was found to exist between the achievement goals. Performance-approach was found to positively predict mastery-approach (β = 0.245, p < .001) and performance-avoidance (β = 0.568, p < .001). Mastery-approach had null relations with mastery-avoidance (β = -0.182) and performance-avoidance (β = 0.136).

The standardised direct effects path model for the mastery-avoidance and performance-avoidance variables is displayed in Figure 9.5. Regulatory strategy use had null relations with both avoidance goals, mastery-avoidance (β = -0.109) and performance-avoidance (β = 0.026). Maladaptive strategy use had positive relations with both avoidance goals, mastery-avoidance (β = 0.333, p < .001) and performance-avoidance (β = 0.339, p < .001). Regarding the covariance between the achievement goals, reciprocal relations were found between the avoidance goals with performance-avoidance positively predicting mastery-avoidance (β = 0.580, p < .001) and mastery-avoidance positively predicting performance-avoidance (β = 0.258, p < .05).

The variances of the endogenous variables explained by the revised model (Figures 9.3 to 9.5) were as follows: mastery-approach (55%), mastery-avoidance (52%), performance-approach (6%), performance-avoidance (66%), regulatory strategy use (87%), and maladaptive strategy use (58%). These totals were considerably more than those obtained using multilevel multiple regression analyses. However, the variance explaining performance-approach was extremely low. The standardised direct, indirect and total effects for the revised self-regulated learning structural equation model using maximum likelihood as the estimation method are presented in Table 9.18. Almost identical results were obtained using generalised least squares as the estimation method and these are presented in Table 9.19.

An integrated discussion of these results with those obtained in the group work context analysis is presented in Chapter 11.

Table 9.18

Self-Regulated Learning during Teacher-Led Discussion Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Task efficacy on:	Mastery-approach	.577***	.032*	.609***
	Mastery-avoidance	.150	-.188**	-.038
	Performance-approach	.130*	-	.130*
	Performance-avoidance	-.280***	.147*	-.133*
	Regulatory strategy use	.067	.491***	.558***
	Maladaptive strategy use	-.162*	-.191**	-.353***
Perceived ability on:	Mastery-approach	.171***	.045**	.215***
	Mastery-avoidance	-.122*	-.076	-.198***
	Performance-approach	.182***	-	.182***
	Performance-avoidance	-.145**	.082	-.063
	Regulatory strategy use	.118**	.200***	.319***
	Maladaptive strategy use	-.105*	-.137***	-.242***
Mastery-approach on:	Mastery-avoidance	-.182	.061	-.122
	Performance-avoidance	.136	-.031	.105
	Regulatory strategy use	.795***	.016	.811***
	Maladaptive strategy use	-.215**	-.005*	-.220**
Mastery-avoidance on:	Mastery-avoidance	-	.176**	.176**
	Performance-avoidance	.258*	.045	.303*
	Regulatory strategy use	-.109	-.011	-.121
	Maladaptive strategy use	.333***	.161*	.494***
Performance-approach on:	Mastery-approach	.245***	-	.245***
	Mastery-avoidance	-	.357***	.357***
	Performance-avoidance	.568***	.126***	.693***
	Regulatory strategy use	.049	.174**	.223***
	Maladaptive strategy use	-.018	.301***	.284***
Performance-avoidance on:	Mastery-avoidance	.580***	.102**	.682***
	Performance-avoidance	-	.176**	.176**
	Regulatory strategy use	.026	-.070	-.044
	Maladaptive strategy use	.339**	.286***	.626***

Note. n = 451 (effective sample size); [a]Maximum likelihood used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 9.19

Self-Regulated Learning during Teacher-Led Discussion Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Task efficacy on:	Mastery-approach	.577***	.032*	.609***
	Mastery-avoidance	.150	-.188**	-.038
	Performance-approach	.130*	-	.130*
	Performance-avoidance	-.280***	.147*	-.133*
	Regulatory strategy use	.067	.491***	.558***
	Maladaptive strategy use	-.162	-.191**	-.353***
Perceived ability on:	Mastery-approach	.171***	.045**	.215***
	Mastery-avoidance	-.122*	-.076	-.198***
	Performance-approach	.182***	-	.182***
	Performance-avoidance	-.145**	.082	-.063
	Regulatory strategy use	.118**	.200***	.319***
	Maladaptive strategy use	-.105**	-.137***	-.242***
Mastery-approach on:	Mastery-avoidance	-.182	.061	-.122*
	Performance-avoidance	.136	-.031	.105
	Regulatory strategy use	.795***	.016	.811***
	Maladaptive strategy use	-.215**	-.005*	-.220**
Mastery-avoidance on:	Mastery-avoidance	-	.176**	.176**
	Performance-avoidance	.258*	.045	.303*
	Regulatory strategy use	-.109	-.011	-.121
	Maladaptive strategy use	.333***	.161*	.494***
Performance-approach on:	Mastery-approach	.245***	-	.245***
	Mastery-avoidance	-	.357***	.357***
	Performance-avoidance	.568***	.126***	.693***
	Regulatory strategy use	.049	.174**	.223***
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Performance-avoidance on:	Mastery-avoidance	.580***	.102**	.682***
	Performance-avoidance	-	.176**	.176**
	Regulatory strategy use	.026	-.070	-.044
	Maladaptive strategy use	.339**	.286***	.626***

Note. n = 451 (effective sample size); [a]Generalised least squares used used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Chapter 10

STUDY 3B: GROUP WORK

10.1 PARTICIPANTS AND PROCEDURE

A sample of 476 high school science students (247 males and 229 females) was assembled from nine different New South Wales State education system high schools serving the Sydney metropolitan area. Each school was co-educational, catered for students from years 7 to 12, randomly chosen from state high schools in the Sydney area and invited to participate. Seven schools were classified as regular (259 students) and served as the sample from the regular high school population. The regular students' sample comprised of 14 classes ranging in size from 5 to 27 students (mean class size = 18.5). Of this sample, 22 (11 males and 11 females) were in year 7, 100 (57 males and 43 females) were in year 8, 71 (33 males and 38 females) were in year 9, and 11 (7 males and 4 females) were in year 10. All of these junior classes were completing a general science curriculum. 55 (28 males and 27 females) were in year 11 completing a senior science curriculum. Two schools were classified as selective (217 students) and served as the sample from the selective high school population. The selective students' sample comprised of 10 classes ranging in size from 15 to 27 students (mean class size = 21.7). Of this sample, 26 (13 males and 13 females) were in year 8 and 71 (37 males and 36 females) were in year 9, completing a general science curriculum. 118 (61 males and 57 females) were in year 11 completing a senior science curriculum.

Students were asked to complete the Science Classroom Cognitive Processes and Motivation Questionnaire – Group Work (Appendix E) during the middle of the third term of the school year in one of their science lessons after encountering an appropriate group work learning event.

10.2 MEASURES

The Science Classroom Cognitive Processes and Motivation Questionnaire – Group Work (GWQ) consisted of the following scales.

Task efficacy. The task efficacy scale was designed to measure students' perceptions of their efficacy for learning during a group work context and consisted of six items (e.g., "I don't mind learning with the other students in a group"). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Perceived ability. One scale comprising of two items was used to measure students' perceptions of their relative ability in their science class (e.g., "What is your ability level in this science class?") and students indicated their responses on a seven-point Likert scale ranging from 1 (very low) to 7 (very high).

Personal achievement goals. Four six-item scales ascertained the following personal achievement goals: mastery-approach (e.g., "I liked learning with others because they asked and answered questions and that process helped me to understand"); mastery-avoidance (e.g., "I only took part when I was comfortable with the discussion topic"); performance-approach (e.g., "I tried to do better than the others at this task"); and performance-avoidance (e.g., "I didn't want to do anything in front of others that may result in a mistake"). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Regulatory strategy use. One scale was used to measure students' self-reported use of adaptive self-regulated learning strategies during group work and consisted of seven items (e.g., "I challenged what the others were saying in order to check if we were on the right track"). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

Maladaptive strategy use. Students' use of maladaptive strategies during group work was assessed by one seven-item scale (e.g., “When I got stuck I gave up”). Students indicated their responses on a seven-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

10.3 RESULTS

10.3.1 Preliminary Analyses: Exploratory Factor Analyses and Confirmatory Factor Analyses

As for Studies 1 (Chapter 6) and 2 (Chapter 7), exploratory factor analyses (EFA) were conducted on the items relevant to a priori construct predictions. Principal axis factoring with an oblique rotation method was conducted using the sample of high school science students (n = 451). Principal axis was chosen as the factor extraction method on the assumption that the data would have some deviation from being normally distributed. Oblique rotation was used on the assumption that there would be a degree of correlation between the factors.

Personal achievement goals. An initial EFA of the Group Work questionnaire achievement goal items for the sample (n = 476) yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors; this solution accounted for 53.3 % of the total variance after the initial extraction for the unrotated solution. Two of the four factors represented the hypothesised personal achievement goals of mastery-approach and performance-approach. The third factor accounted for a variety of mastery-avoidance and performance-avoidance items and was labelled as an avoidance goal. The fourth factor contained three reverse-coded items (items 10, 14 and 27) and was of no use in the final analyses. Items 10, 14 and 27 were subsequently removed and the EFA repeated. The final EFA of the Group Work questionnaire achievement goal items for the sample (n = 476) yielded four factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Bartlett’s Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis accounted for 57.0

% of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) The four factors represented the hypothesised personal achievement goals of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. All items loaded above 0.35 on their primary factor and one of the items crossloaded (item 30) in the final EFA solution.

Confirmatory factor analysis using PRELIS 8.72 (Jöreskog & Sörbom, 2005) and LISREL 8.72 (Jöreskog & Sörbom, 2005) was employed to compare three first-order models. The three-factor model comprised of mastery-approach and performance-approach with the indicator items being in accordance with that classified by the Group Work Questionnaire (GWQ), and the avoidance factor, which was composed of all mastery-avoidance and performance-avoidance items from the GWQ. Four-factor Model A comprised of mastery-approach, mastery-avoidance, performance-approach and performance-avoidance with the indicator items being in accordance with that classified by the GWQ. Four-factor Model B comprised of the four factors and their items as identified in the final EFA: mastery-approach (items 19, 20, 21, 22, 23, 24), mastery-avoidance (items 26, 28, 29, 30), performance-approach (items 7, 8, 9, 11, 12, 15, 25), performance-avoidance (items 13, 16, 17, 18). The results of the CFAs comparing the three first-order achievement goals models are displayed in Table 10.1. Of the three models, Four-factor Model B provided a significantly better fit of the data with $\chi^2 = 944.8$ ($df = 183$, $p < .001$), RMSEA = 0.0936, RMR = 0.266, AGFI = 0.932, CFI = 0.896, and NNFI = 0.880. Consequently, Four-factor Model B was used in the one-factor congeneric measurement models for achievement goals. These analyses verified the existence of the four types of achievement goals during group work.

Table 10.1

Personal Achievement Goals during Group Work: Results from Confirmatory Factor Analyses[a]

Variable	Fit index									
	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	RMSEA	RMR	AGFI	CFI	NNFI
Three-factor model	1093.9	186	.000	-	-	.101	.294	.922	.876	.860
Four-factor model A	1031.5	183	.000	62.4***	3	.0988	.289	.926	.884	.867
Four-factor model B	944.8	183	.000	86.7	-	.0936	.266	.932	.896	.880

Note. n = 476; [a]Weighted Least Squares used as the estimation method. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; RMSEA = root mean square error of approximation; RMR = root mean square residual; AGFI = adjusted goodness-of-fit index; CFI = goodness-of-fit index; NFI = non-normed fit index. Three-factor model: mastery-approach, performance-approach, avoidance items. Four-factor Model A: GWQ mastery-approach, GWQ mastery-avoidance, GWQ performance-approach, GWQ performance-avoidance. Four-factor Model B: EFA mastery-approach, EFA mastery-avoidance, EFA performance-approach, EFA performance-avoidance. *** $p < .001$.

Competence perceptions and self-regulated learning. An EFA of the competence perception and self-regulated learning items for the sample yielded five factors with eigenvalues greater than 1 as well as satisfying scree test requirements for four factors. The Kaiser-Meyer-Olkin of Sampling Adequacy (KMO) value was above 0.6 and Bartlett's Test of Sphericity value was significant; these results indicating the suitability of the correlation matrix of the items for factor analysis. The final factor solution analysis contained four factors, accounting for 55.6 % of the total variance after the initial extraction for the unrotated solution. (See the author for complete results of the final EFA solution.) Two factors represented the hypothesised self-regulated learning constructs for the group work context, namely regulatory strategy use and maladaptive strategy use, while the third and fourth factors represented task efficacy and perceived ability. All items loaded above 0.35 on their primary factor and one item (item 32) crossloaded (> 0.32 on two or more factors) in the final EFA solution. Although item 31 ("I got involved in the group discussion") loaded onto task efficacy in the final EFA, it was retained as a regulatory strategy use scale item.

10.3.2 Preliminary Analyses: One-Factor Congeneric Measurement Model Analyses

Fitted one-factor congeneric measurement models were used to form the composite variables that represent the constructs investigated in Study 3. These analyses were performed in the same way as those in Studies 1 and 2, using PRELIS 8.72 to compute the inter-item polychoric correlations and asymptotic covariance matrices for the ordinal data scales, which were then analysed by LISREL using weighted least squares (WLS) as the estimation method in the structural equation models (Jöreskog, 2002).

The results of the measurement properties attained from fitting one-factor congeneric models are presented in Tables 10.2 and 10.3. Items found to have small partial regression weights and large measurement error variance (> 0.90) were eliminated since these were either inappropriate indicator items for the latent variable or were inappropriately worded and thus introduced a large amount of inconsistency when interpreted by students. These items may be of interest to researchers associated with the relevant questionnaire design and modifications. The one-factor congeneric model for a latent variable was repeated if items were eliminated from its embryonic model; the results obtained are therefore devoid of poor fitting indicator items. All of the composite scales exhibited satisfactory composite scale parameter results. The composite score reliability coefficients (r_c) ranged from 0.714 to 0.919; the variance estimate of items attributed to the composite variable ($\hat{\lambda}_c$) ranged from 0.837 to 0.944; and, the variance estimate of items attributed to measurement error ($\hat{\theta}_c$) ranged from 0.079 to 0.281. The mastery-avoidance scale had the weakest composite scale reliability (0.714) but was included in the final analyses. The relevant goodness of fit indices of each composite scale are presented in Table 10.4; these were also satisfactory.

Table 10.2

Personal Achievement Goals during Group Work: Composite Scale Parameters (Study 3B)

Composite Variable	Item Weights								TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
	map1[a] (19)[b]	map2 (20)	map3 (21)	map4 (22)	map5 (23)	map6 (24)	-	-					
Mastery-approach	.142[c]	.174	.444	.209	.133	.027	-	-	6[e], 1 5, 4	.852	.918	.146	.815
	.126[d]	.154	.393	.185	.118	.024	-	-					
	mav2 (26)	mav3 (27)	mav4 (28)	mav5 (29)	mav6 (30)		-	-					
Mastery-avoidance	.174	-	.373	.057	.480		-	-	3, 1	.714	.837	.281	.676
	.161	-	.344	.053	.443		-	-					
	pap1 (7)	pap2 (8)	pap3 (9)	pap4 (10)	pap5 (11)	pap6 (12)	pav3[#] (15)	mav1[#] (25)					
Performance-approach	.069	.401	.270	-	-	.187	.104	.122	3[#], 1 1[#], 2	.871	.930	.128	.843
	.060	.348	.234	-	-	.162	.090	.106					
	pav1 (13)	pav2 (14)	pav4 (16)	pav5 (17)	pav6 (18)								
Performance-avoidance	.288	-	.291	.291	.268				-	.781	.869	.212	.741
	.253	-	.256	.256	.236								

Note. n = 476; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of item attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of item attributed to measurement error; α = Cronbach's alpha estimate.

Table 10.3

Personal Achievement Goals during Group Work: Composite Scale Parameters (Study 3B)

Composite Variable	Item Weights							TD	r_c	$\hat{\lambda}_c$	$\hat{\theta}_c$	α
	te1[a] (1)[b]	te2 (2)	te3 (3)	te4 (4)	te5 (5)	te6 (6)	-					
Task efficacy	.156[c]	.299	.235	.294	.048	.147	-	6[e], 5 3, 1	.804	.890	.193	.784
	.132[d]	.254	.199	.249	.041	.125	-					
	psr1 (31)	psr2 (32)	psr3 (33)	psr4 (34)	psr5 (35)	psr6 (36)	psr7 (37)					
Regulatory strategy use	-	.515	.075	.435	.125	.033	.082	3, 1 4, 1 6, 5	.782	.883	.217	.724
	-	.407	.059	.344	.098	.026	.065					
	nsr1 (38)	nsr2 (39)	nsr3 (40)	nsr4 (41)	nsr5 (42)	nsr6 (43)	nsr7 (44)					
Maladaptive strategy use	.151	.223	.248	.228	.092	.149	.038	7, 5	.919	.944	.079	.889
	.134	.198	.220	.202	.081	.132	.034					

Note. n = 476; [a]composite variable item label; [b]item questionnaire number; [c]factor score regression coefficient of item; [d]proportionally weighted factor score regression coefficient; TD = inter-item error covariances estimated; [e]composite variable item label number; r_c = composite scale reliability coefficient; $\hat{\lambda}_c$ = variance estimate of item attributed to the composite variable; $\hat{\theta}_c$ = variance estimate of item attributed to measurement error; α = Cronbach's alpha estimate.

Table 10.4

Group Work Constructs: One-Factor Congeneric Model Fit Indices (Study 3B)

Composite Variable	No. of items	χ^2	*df*	*p*	GFI	AGFI	RMR	RMSEA
Mastery-approach	6	10.34	7	.170	.997	.991	.0275	.0317
Mastery-avoidance	4	.411	1	.521	1.00	.998	.0065	.0000
Performance-approach	6	13.38	7	.0633	.996	.989	.0315	.0438
Performance-avoidance	4	.483	2	.785	1.00	.999	.00721	.0000
Task efficacy	6	6.134	7	.524	.998	.995	.0209	.0000
Regulatory strategy use	6	9.262	6	.159	.997	.990	.0295	.0338
Maladaptive strategy use	7	11.39	13	.578	.998	.995	.0240	.0000

Note. χ^2 = minimum fit function chi-square; *df* = degrees of freedom; *p* = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMR = root mean square residual; RMSEA = root mean square error of approximation.

10.3.3 Descriptive Statistics

The distributional properties of the composite scales were then examined for use in multilevel multiple regression and structural equation modelling analyses. Analyses using PRELIS showed no systematic patterns for the missing data and thus a listwise method was employed in dealing with missing data. Descriptive statistics and univariate normality tests of the raw composite scale data are presented in Table 10.5. These results show that the composite scale data, even after completion of the one-factor congeneric modelling analyses described above, was not normally distributed with some composites exhibiting significant skewness and kurtosis. Normalised values of the raw composite scale scores were achieved using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b), which rescores the raw composite scale scores on the basis of normal equivalent deviates in accordance with the original score rankings (Rowe, 2003, 2006). The resultant descriptive statistics and univariate normality tests of the normalised composite scale data are shown in Tables 10.6 to 10.8. This process resulted in all composite scales having distributional properties close to being normal distributed with insignificant skewness and kurtosis. The normalised composite scale scores were used in multilevel multiple regression and structural equation modelling analyses. Despite satisfactorily achieving normality for independent composites, multivariate normality tests were still significant (Table 10.8). Four multiple goal constructs (Mastery-approach X Mastery-avoidance, Mastery-approach X Performance-approach, Performance-approach X Performance-avoidance, Mastery-avoidance X Performance-avoidance) were formed from the relevant composite scales in order to investigate the impact of multiple achievement goals. The composite scale scores for each of these were also normalised (Table 10.7).

Table 10.5

Group Work Constructs: Descriptive Statistics and Univariate Normality Tests for Raw Data (Study 3B)

Variable	*M*	*SD*	Observed range	Possible range	Skewness			Kurtosis			Skewness and Kurtosis	
					value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	4.902	1.174	1-7	1-7	-.534	-4.537	.000	.694	2.507	.012	26.86	.000
Mastery-avoidance	3.178	1.233	1-7	1-7	.264	2.339	.019	-.326	-1.663	.096	8.238	.016
Performance-approach	4.320	1.380	1-7	1-7	-.356	-3.120	.002	-.424	-2.335	.020	15.18	.001
Performance-avoidance	2.950	1.229	1-7	1-7	.387	3.375	.001	-.349	-1.810	.070	14.67	.001
Task efficacy	4.936	1.070	1-7	1-7	-.362	-3.173	.002	.341	1.444	.149	12.15	.002
Regulatory strategy use	4.528	1.122	1-7	1-7	-.236	-2.103	.035	.068	.406	.685	4.59	.101
Maladaptive strategy use	2.722	1.363	1-7	1-7	.844	6.697	.000	.275	1.214	.225	46.32	.000
Perceived ability	4.575	1.241	1-7	1-7	-.052	-.465	.642	.100	.539	.590	.507	.776

Note. *n* = 476.

Table 10.6

Group Work Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 3B)

Variable	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach	-.001	.994	-2.732 – 2.347	-.026	-.238	.812	-.171	-.745	.456	.612	.737
Mastery-avoidance	.003	.990	-2.100 – 3.076	.067	.604	.546	-.205	-.929	.353	1.227	.541
Performance-approach	.001	.996	-2.495 – 2.732	.013	.116	.908	-.141	-.585	.559	.355	.837
Performance-avoidance	.006	.983	-1.859 – 3.076	.113	1.018	.309	-.283	-1.388	.165	2.964	.227
Task efficacy	-.002	.993	-3.076 – 2.207	-.052	-.468	.640	-.174	-.760	.447	.796	.672
Regulatory strategy use	.000	.998	-2.863 – 2.732	-.005	-.045	.965	-.087	-.306	.759	.096	.953
Maladaptive strategy use	.004	.985	-1.993 – 2.559	.066	.599	.549	-.300	-1.496	.135	2.598	.273
Perceived ability	-.006	.967	-2.732 – 1.803	-.109	-.981	.327	-.274	-1.337	.181	2.749	.253

Note. $n = 476$.

Table 10.7

Group Work Multiple Goal Constructs: Descriptive Statistics and Univariate Normality Tests for Normalised Data (Study 3B)

Variable[a]	*M*	*SD*	Range	Skewness			Kurtosis			Skewness and Kurtosis	
				value	z-score	*p*	value	z-score	*p*	χ^2	*p*
Mastery-approach X Mastery-avoidance	.000	1.000	-3.076 – 3.076	.001	.012	.990	-.041	-.088	.930	.008	.996
Mastery-approach X Performance-approach	.000	.999	-3.076 – 2.732	-.010	-.087	.930	-.070	-.223	.823	.057	.972
Performance-approach X Performance-avoidance	.000	1.00	-3.076 – 3.076	-.001	-.006	.995	-.040	-.081	.936	.007	.997
Mastery-avoidance X Performance-avoidance	.000	.999	-3.076 – 3.076	-.003	-.030	.976	-.044	-.100	.920	.011	.995

Note. [a]Multiple goals were formed initially using personal goals normalised data and then normalised.

Table 10.8

Multivariate Normality Tests for Normalised Data (Study 3B)

Variables measured	Effective sample size	Skewness			Kurtosis			Skewness and Kurtosis	
		value	z-score	*p*	value	z-score	*p*	χ^2	*p*
All	476	38.50	41.80	.000	219.9	16.25	.000	2011	.000

Variance-covariance relations of the normalised composite scales are found in Table 10.9. Although Pearson product-moment correlations are invalid measures when data are not-normally distributed and ordinal (Jöreskog, 1990; Rowe, 2006), they may be of interest when the composite scale scores satisfy normal distribution properties, as in the case of this study. Correlations among the variables are presented in Table 10.10. There was support for the hypothesised relations amongst the variables. Regulatory strategy use had positive relations with task efficacy, mastery-approach, performance-approach and perceived ability, and had negative relations with maladaptive strategy use. Maladaptive strategy use had positive relations with mastery-avoidance and performance-avoidance and had negative relations with mastery-approach, performance-approach and perceived ability. With regards to the relations amongst the achievement goals, mastery-approach had negative associations with mastery-avoidance. Performance-approach had positive relations with each of the other three achievement goals. Mastery-avoidance had positive associations with performance-avoidance. Females reported to have lower mastery-avoidance, lower performance-approach and lower performance-avoidance goals than males. Females also reported to be of lower ability. Selective students reported to have lower mastery-avoidance, lower performance-approach and lower performance-avoidance goals than regular students. Juniors had greater mastery-avoidance and greater performance-avoidance goals than seniors.

Table 10.9

Variance-Covariance Estimates for Variables - Normalised Data (Study 3B Group Work)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mastery-approach	.988														
2. Mastery-avoidance	-.106	.981													
3. Performance-approach	.299	.123	.991												
4. Performance-avoidance	-.023	.544	.350	.966											
5. Task efficacy	.581	-.168	.241	-.098	.985										
6. Regulatory strategy use	.602	-.058	.323	.001	.471	.996									
7. Maladaptive strategy use	-.353	.481	-.138	.346	-.308	-.315	.970								
8. Perceived ability	.215	-.108	.218	-.034	.202	.235	-.253	.934							
9. Mastery-approach x Mastery-avoidance	-.201	-.038	-.115	-.072	-.043	-.169	.077	-.003	.999						
10. Mastery-approach x Performance-approach	-.095	-.102	.137	-.007	.018	.009	.001	.013	.071	.997					
11. Performance-approach x Performance-avoidance	-.049	-.074	-.138	-.024	.051	-.060	.048	.037	.168	-.058	.999				
12. Mastery-avoidance x Performance-avoidance	-.093	-.020	-.082	.038	-.032	-.040	.116	.041	.029	-.034	.148	.998			
13. Gender[a]	.071	-.149	-.231	-.188	.056	-.002	-.078	-.217	-.008	-.033	.145	.019	1.00		
14. Student type[b]	-.012	-.128	-.383	-.180	-.018	-.062	.060	-.060	.003	-.159	.080	-.004	.021	1.00	
15. Age[c]	-.056	.118	.102	.144	.028	-.090	.055	.053	.091	.151	.005	.096	-.011	-.523	1.00

Note. *n* = 476; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior.

Table 10.10

Intercorrelations among Variables - Normalised Data (Study 3B Group Work) Pearson Product Moment Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mastery-approach	-														
2. Mastery-avoidance	-.107*	-													
3. Performance-approach	.302**	.124**	-												
4. Performance-avoidance	-.023	.559**	.358**	-											
5. Task efficacy	.589**	-.170**	.244**	-.100*	-										
6. Regulatory strategy use	.607**	-.058	.325**	.001	.475**	-									
7. Maladaptive strategy use	-.361**	.493**	-.140**	.357**	-.315**	-.320**	-								
8. Perceived ability	.223**	-.112*	.226**	-.036	.211**	.243**	-.265**	-							
9. Mastery-approach x Mastery-avoidance	-.202**	-.038	-.115*	-.074	-.044	-.170**	.078	-.003	-						
10. Mastery-approach x Performance-approach	-.096*	-.103*	.138**	-.007	.018	.009	.001	.013	.071	-					
11. Performance-approach x Performance-avoidance	-.049	-.075	-.139**	-.025	.051	-.060	.048	.038	.168**	-.058	-				
12. Mastery-avoidance x Performance-avoidance	-.093	-.020	-.082	.039	-.032	-.040	.117*	.042	.029	-.034	.148**	-			
13. Gender[a]	.057	-.120**	-.185**	-.152**	.045	-.002	-.063	-.179**	-.007	-.026	.116*	.015	-		
14. Student type[b]	-.010	-.103*	-.307**	-.146**	-.014	-.049	.048	-.049	.002	-.127**	.064	-.003	.014	-	
15. Age[c]	-.044	.092*	.080	.113*	.022	-.069	.043	.043	.070	.118**	.004	.075	-.007	-.343**	-

Note. n = 476; [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .01$.

10.3.4 Regression Analyses: Preliminary Multilevel Regression Modelling Analyses

Multilevel multiple regression analyses using *MLwiN* 2.0 were used in the same way as reported in Study 3A to assess the hypothesised relationships relations between task efficacy, achievement goals, self-regulated learning, maladaptive strategy use, and subpopulation variables in the specified classroom context of group work. The data collected for this study came from a total of 24 classes clustered within nine schools. Consequently, the multilevel analyses of this study were constrained to a two-level hierarchy, with students at the first level and their classroom membership forming the second level.

The multilevel variance components models for all variables are reported in Table 10.11. The variance of residuals attributed to the class-level ranged from 0 to 16.6% while the variance attributed to the personal-level ranged from 83.4 to 100%. As for Study 3A, these results indicate that much of the variance associated with the reporting of the constructs under study in the present research is accounted for at the personal level and not to classroom-level differences.

The second type of multilevel variance components models incorporated the subpopulation variables of age (junior or senior), gender and school type (regular or selective) as fixed effects explanatory variables ("classifier variables") with the residual variance of the construct under focus being partitioned into the level 1 (student-level) and level 2 (class-level) units with no other explanatory variables involved.. The results of these analyses are reported in Table 10.12. For each construct the incorporation of the classifier variables significantly improved the fit of the model beyond the initial multilevel variance components model. The variance of residuals attributed to the class-level ranged from 0 to 8.5% and the variance accounted for at the personal-level ranged from 91.5 to 100%. These results indicate that most of the variance associated with these constructs is accounted for at the personal level and not to classroom-level differences.

Table 10.11

Personal Constructs: Base Variance Components Models (Study 3B Group Work)

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_T
Mastery-approach	-.002 (.068)	.060 (.031)*	6.1	.928 (.062)	93.9	.988
Mastery-avoidance	.021 (.060)	.037 (.025)*	3.8	.943 (.063)	96.2	.980
Performance-approach	.019 (.093)	.163 (.060)	16.6	.819 (.054)	83.4	.982
Performance-avoidance	.023 (.069)	.066 (.033)*	6.9	.895 (.060)	93.1	.961
Task efficacy	-.012 (.074)	.084 (.038)	8.5	.902 (.060)	91.5	.986
Regulatory strategy use	.005 (.069)	.065 (.033)*	6.5	.930 (.062)	93.5	.995
Maladaptive strategy use	.015 (.063)	.045 (.027)*	4.6	.925 (.061)	95.4	.970
Perceived ability	-.020 (.061)	.042 (.026)*	4.5	.892 (.059)	95.5	.934

Table 10.11 *Continued*

Construct	Fixed part	Random Part (Residual variance)				
	Intercepts	Classroom level		Student level		Total variance
	β_{0j} (s.e.)	σ^2_{u0} (s.e.)[a]	%	σ^2_{e0} (s.e.)[a]	%	σ^2_{T}
Mastery-approach X Mastery-avoidance	.000 (.046)	.000 (.014)*	.8	.996 (.066)	100	.996
Mastery-approach X Performance-approach	-.007 (.055)	.023 (.021)*	2.3	.972 (.065)	97.7	.995
Performance-approach X Performance-avoidance	.000 (.046)	.000 (.000)*	0	.997 (.065)	100	.997
Mastery-avoidance X Performance-avoidance	.000 (.046)	.000 (.000)*	0	.996 (.065)	100	.996

Note. $n = 476$. [a]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

Table 10.12

Personal Constructs: Variance Components Models with Subpopulation Classifier Variables (Study 3B Group Work)

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach	.024 (.148)	-.100(.145)*	.115 (.090)*	-.050 (.143)*	.058 (.031)*	5.9	.925 (.061)	94.1
Mastery-avoidance	.113 (.124)	.138 (.118)*	-.233 (.089)	-.157 (.116)*	.022 (.020)*	2.3	.930 (.062)	97.7
Performance-approach	.464 (.148)	-.046 (.147)*	-.331 (.083)	-.593 (.145)	.068 (.032)	7.9	.796 (.053)	92.1
Performance-avoidance	.186 (.135)	.130 (.131)*	-.288 (.087)	-.239 (.128)*	.040 (.025)*	4.4	.876 (.058)	95.6
Task efficacy	-.098 (.162)	.061 (.161)*	.103 (.089)*	-.001 (.159)*	.084 (.038)	8.5	.899 (.060)	91.5
Regulatory strategy use	.196 (.146)	-.200 (.143)*	.006 (.090)*	-.164 (.140)*	.054 (.030)*	5.5	.930 (.062)	94.5
Maladaptive strategy use	-.060 (.136)	.128 (.131)*	-.126 (.089)*	.128 (.129)*	.038 (.025)*	4.0	.922 (.061)	96.0
Perceived ability	.116 (.126)	.078 (.121)*	.325 (.087)	-.052 (.119)*	.028 (.021)*	3.1	.873 (.058)	96.9

Table 10.12 *Continued.*

Construct	Fixed Part				Random Part (Residual variance)			
	Intercept	Age[a]	Gender[b]	Student type[c]	Classroom level		Student level	
	β_{0j} (s.e.)	β_1 (s.e.)[d]	β_2 (s.e.)[d]	β_3 (s.e.)[d]	σ^2_{u0} (s.e.)[d]	%	σ^2_{e0} (s.e.)[d]	%
Mastery-approach X Mastery-avoidance	-.127 (.110)	.167 (.101)*	-.013 (.091)*	.060 (.098)*	.000 (.000)*	0	.991 (.064)	100
Mastery-approach X Performance-approach	.000 (.109)	.175 (.100)*	-.049 (.090)*	-.195 (.109)*	.000 (.000)*	0	.972 (.063)	100
Performance-approach X Performance-avoidance	-.215 (.109)	.061 (.100)*	.230 (.091)	.145 (.097)*	.000 (.000)*	0	.979 (.063)	100
Mastery-avoidance X Performance-avoidance	-.149 (.110)	.174 (.101)*	.030 (.091)*	.050 (.097)*	.000 (.000)*	0	.990 (.064)	100

Note. n = 476; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]All results significant at $p < .05$ (two-tailed test) except *not significant at $p < .05$ (two-tailed test).

10.3.5 Regression Analyses: Personal Predictors of Self-Regulated Learning during Group Work

Multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between the personal factors with regulatory and maladaptive strategy use during group work. The personal factors that were the focus of this study included achievement goals (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance), the competence perceptions (task efficacy, perceived ability) and the four multiple goal constructs (mastery-approach X mastery-avoidance, mastery-approach X performance-approach, performance-approach X performance-avoidance, mastery-avoidance X performance-avoidance). In concordance with the base model presented in Chapter 5 (Figure 5.2) these environmental and personal factors were considered as predictors of self-regulated learning along with the subpopulation variables of age (junior or senior), gender and student type (regular or selective). Each of the subpopulation variables was considered in a dichotomous, nominal-level format and thus dummy coded for the analyses (age: senior = 0, junior = 1; gender: males = 0, females = 1; student type: regular = 0, selective = 1).

Regulatory strategies

The thirteen-explanatory variable model explained 42.6% of variance in the use of regulatory strategies (Table 10.13). Positive predictors of regulatory strategy use were: mastery-approach ($\beta = 0.446$, $p < .001$), performance-approach ($\beta = 0.127$, $p < .05$), task-efficacy ($\beta = 0.167$, $p < .01$) and perceived ability ($\beta = 0.085$, $p < .05$). Juniors reported using less regulatory strategies than seniors ($\beta = -0.077$, $p < .05$) and was the only significant negative predictor of regulatory strategy use. There was no significant variance of regulatory strategy use attributable to class membership. No other variables acquired significance.

Maladaptive strategy use

The thirteen-explanatory variable model explained 41.3% of variance in the use of maladaptive strategies (Table 10.14). Positive predictors of maladaptive strategy use were: mastery-avoidance ($\beta = 0.374$, $p < .001$), performance-avoidance ($\beta = 0.183$, p

< .001). Of the multiple goal variables investigated, the mastery-avoidance X performance-avoidance interaction was a significant positive predictor of maladaptive strategy use (β = 0.088, $p < .05$). Negative predictors of maladaptive strategy use were: mastery-approach (β = -0.186, $p < .001$), performance-approach (β = -0.124, $p < .05$) and perceived ability (β = -0.143, $p < .001$). There was no significant variance of maladaptive strategy use attributable to class membership. No other variables acquired significance.

Table 10.13

Multilevel Regression Analysis Model Results for Regulatory Strategy Use[a] *(Study 3B Group Work)*

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	.115 (.086)	-
Gender[b]	.013 (.073)	.007
Student type[c]	-.040 (.078)	-.020
Age[d]	-.160 (.078)*	-.077
Mastery-approach	.448 (.046)**	.446
Mastery-avoidance	.038 (.044)	.038
Performance-approach	.127 (.044)*	.127
Performance-avoidance	-.034 (.046)	-.033
Task efficacy	.168 (.045)**	.167
Perceived ability	.088 (.039)*	.085
Mastery-approach X Mastery-avoidance	-.053 (.036)	-.053
Mastery-approach X Performance-approach	.044 (.036)	.044
Performance-approach X Performance-avoidance	-.023 (.036)	-.023
Mastery-avoidance X Performance avoidance	.028 (.036)	.028
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.000 (.000)	
Student level variance (σ^2_{e0})	.571 (.037)**	
% of variance explained	42.6	
-2loglikelihood (IGLS deviance)	1083.9	

Note. n = 476 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .001$.

Table 10.14

Multilevel Regression Analysis Model Results for Maladaptive Strategy Use[a] *(Study 3B Group Work)*

Predictor variables	Unstandardised coefficients	Standardised coefficients
	β (s.e.)	Beta
Fixed part of model		
Constant ($\beta_{0j}x_0$)	-.041 (.090)	-
Gender[b]	-.062 (.073)	-.031
Student type[c]	.141 (.083)	.071
Age[d]	.011 (.083)	.005
Mastery-approach	-.184 (.046)**	-.186
Mastery-avoidance	.372 (.043)**	.374
Performance-approach	-.123 (.044)*	-.124
Performance-avoidance	.183 (.046)**	.183
Task efficacy	-.057 (.045)	-.057
Perceived ability	-.146 (.039)**	-.143
Mastery-approach X Mastery-avoidance	.036 (.036)	.037
Mastery-approach X Performance-approach	.055 (.036)	.056
Performance-approach X Performance-avoidance	.045 (.036)	.046
Mastery-avoidance X Performance avoidance	.087 (.035)*	.088
Random part of model (residual variance)		
Classroom level variance (σ^2_{u0})	.004 (.009)	
Student level variance (σ^2_{e0})	.565 (.038)**	
% of variance explained	41.3	
-2loglikelihood (IGLS deviance)	1082.0	

Note. n = 476 (effective sample size); [a]Iterative generalised least squares (IGLS) used as the estimation method; [b]Gender is coded 0 = male and 1 = female; [c]Student type is coded 0 = regular and 1 = selective; [d]Age is coded 0 = senior and 1 = junior. * $p < .05$. ** $p < .001$.

Aiken and West's (1991) simple slope analysis was used to interpret the mastery-avoidance X performance-avoidance interaction (β = 0.088, p < .05). In accordance with this protocol, the effect of mastery-avoidance on maladaptive strategy use was plotted at low (one standard deviation below mean), medium (mean) and high levels (one standard deviation above mean) of performance-avoidance goal values in order to examine how performance-avoidance goals moderate the relations between mastery-avoidance and maladaptive strategy use during group work. Figure 10.1 displays the resultant plots. There was a significant difference between the high level and low level performance-avoidance slopes thus indicating the moderating effect of performance-avoidance goals on mastery-avoidance. The figure shows that the impact of mastery-avoidance goals on maladaptive strategy use depends on the performance-avoidance goal orientation of the students. An increase in both mastery-avoidance and performance-avoidance goals corresponds with an increase in maladaptive strategy use; students that report themselves as high in performance-avoidance goals have a correspondingly greater increase in maladaptive strategy use than students who report they have low performance-avoidance goals. The results for this multiple goal effect were exactly the same as those found in the Teacher-Led Discussion study (Study 3A).

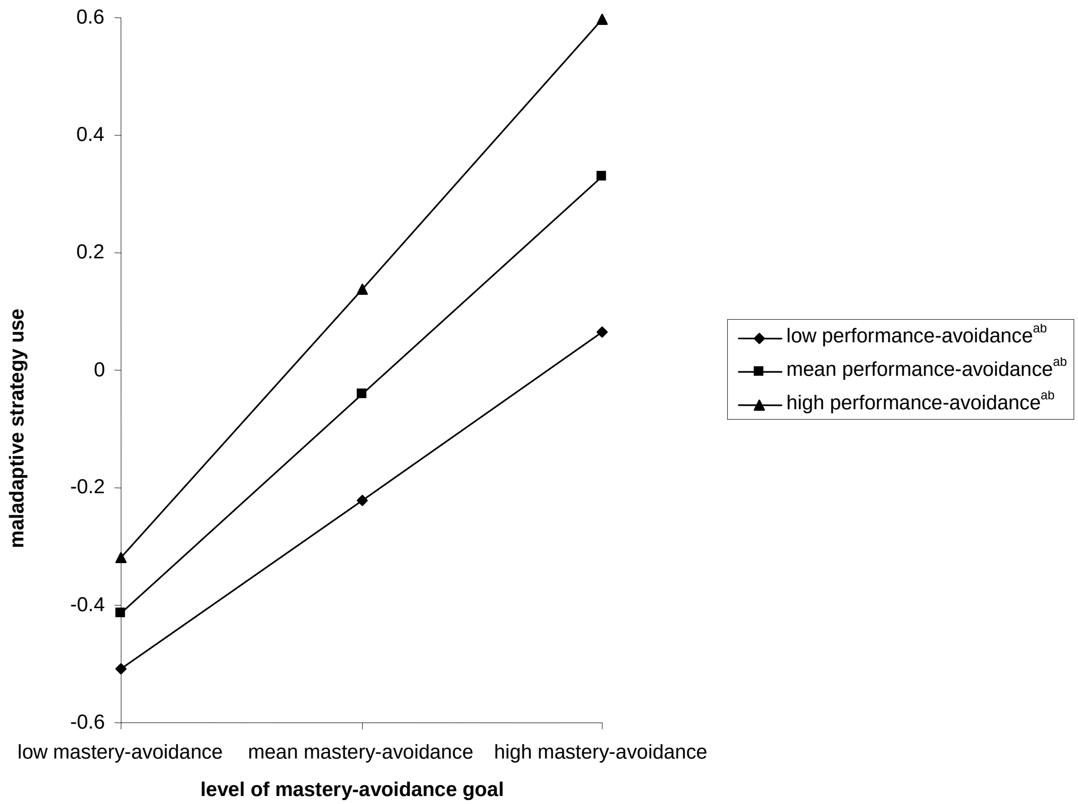

Figure 10.1. Plots of the mastery-avoidance goal X performance-avoidance goal interaction. [a]Slopes significantly differ at $p < .05$; [b]Slope is significant at $p < .001$.

The regression analyses presented above were used to assess the hypothesised relationships between achievement goals, competence perceptions and self-regulated learning for high school science students in the context of a group work learning context. Synopses of the significant predictors of self-regulated learning as yielded by the regression analyses are presented in Table 10.15.

Table 10.15

Synopsis of Significant Predictors of Self-Regulated Learning for High School Science Students during Group Work (Study 3B)

Regulatory strategy use	Maladaptive strategy use
age[a] (-)	mastery-approach (-)
mastery-approach (+)	mastery-avoidance (+)
performance-approach (+)	performance-approach (-)
task efficacy (+)	performance-avoidance (+)
perceived ability (+)	perceived ability (-)
	mastery-avoidance X performance avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship; [a]Age is coded 0 = senior and 1 = junior. All relationships are significant at a minimum of $p < .05$.

10.3.6 Structural Equation Modelling Analyses: Personal Predictors of Self-Regulated Learning during Group Work

Structural equation modelling was used to analyse the simultaneous relationships between the explanatory (task-efficacy, perceived ability, mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) and response (regulatory strategy use, maladaptive strategy use) variables. The multilevel multiple regression analyses revealed the majority of the response variable variance was attributed to the student-level. As such, these results vindicate a single-level structural equation modelling approach for the data rather than a two-level structural equation modelling approach. In addressing the applicability of the structural equation modelling, the variances attributed to the classifier variables, namely gender, student age and student type, were removed. This was achieved by fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 (Rowe, 2006; Rowe & Hill, 1998; Rowe & Rowe, 1999), with the classifier variables of gender, student age and student type assigned as fixed explanatory variables; the residuals of the other variables are allowed to be random thus yielding a variance-covariance matrix of these variables which can be used for structural equation modelling. As a result of attaining significance in the multilevel multiple regression analyses, the mastery-avoidance X performance-avoidance variable was also declared as a classifier variable. However, none of the multiple goal constructs were included in the structural equation modelling for substantive reasons. The results of fitting a multivariate, multilevel model to the data using *MLwiN* 2.02 are displayed in Table 10.16.

Table 10.16

Results of Fitting a Student-Level Multivariate Model for the Classroom Learning Environment and Personal Constructs - Normalised Data (Study 3B)

Fixed part of model		Random part of model								
Variable	Estimates (s.e.)	Variable	1	2	3	4	5	6	7	8
Gender[a]	-.147 (.038)	1. Mastery-approach	**1.007**	*-.107*	*.302*	*-.023*	*.607*	*-.361*	*.589*	*.223*
Student type[b]	-.069 (.041)	2. Mastery-avoidance	-.104	**.959**	*.124*	*.559*	*-.058*	*.493*	*-.170*	*-.112*
Age[c]	.038 (.042)**	3. Performance-approach	.289	.093	**.949**	*.358*	*.325*	*-.140*	*.244*	*.226*
Mastery-avoidance X performance-avoidance	.020 (.019)	4. Performance-avoidance	-.027	.518	.314	**.934**	*.001*	*.357*	*-.100*	*-.036*
		5. Regulatory strategy use	.616	-.063	.307	-.010	**1.002**	*-.320*	*.475*	*.243*
		6. Maladaptive strategy use	-.344	.469	-.159	.328	-.312	**.964**	*-.315*	*-.265*
		7. Task efficacy	.597	-.170	.227	-.105	.481	-.302	**.997**	*.211*
		8. Perceived ability	.213	-.129	.185	-.061	.227	-.266	.197	**.908**

Note. $n = 476$ (effective sample size); [a]Gender is coded 0 = male and 1 = female; [b]Student type is coded 0 = regular and 1 = selective; [c]Age is coded 0 = senior and 1 = junior. Residual variance estimates (in bold) are on the diagonal with covariance estimates given below the diagonal. Pearson product moment Correlation estimates are given above the diagonal in italics. * $p < .05$. ** $p < .001$.

The variance-covariance matrix displayed in Table 10.16 was used in the structural equation modelling. Note that the variance-covariance matrix of the variables has been ‘purged’ (Rowe, 2006) of the variance attributed to the classifier variables thus increasing the generalisability of the structural equation modelling analyses.

The hypothesised self-regulated learning structural equation model is presented in Figure 10.2. The model was based upon theoretical relations between the variables during group work situations. Using the maximum likelihood method of estimation via LISREL 8.72 (Jöreskog & Sörbom, 2005) showed, however, this initial model provided an unsatisfactory fit of the data with $\chi^2 = 296.6$ ($df = 15$, $p < .001$), RMSEA = 0.209, SRMR = 0.122, GFI = 0.872, AGFI = 0.646, CFI = 0.772, and NFI = 0.767 (Table 10.17). Revision of the initial model and the subsequent modelling was based upon the results obtained from the multilevel multiple regressions reported above and by investigating the suggested modification indices within substantive grounds using the maximum likelihood method of estimation via LISREL 8.72. This approach resulted in the final self-regulated learning structural equation model providing a satisfactory fit of the data with $\chi^2 = 4.8$ ($df = 3$, $p = .187$), RMSEA = 0.0356, SRMR = 0.0104, GFI = 0.997, AGFI = 0.970, CFI = 0.999, and NFI = 0.996 (Table 10.17). Using generalised least squares used as the estimation method also revealed the model to satisfactorily fit the data with $\chi^2 = 4.7$ ($df = 3$, $p = .194$), RMSEA = 0.0366, SRMR = 0.0107, GFI = 0.998, AGFI = 0.970, CFI = 0.995, and NFI = 0.987 (Table 10.17).

For clarity, the final model is presented over three figures (Figures 10.3 to 10.5). The standardised direct effects path model for the competence perception variables is displayed in Figure 10.3. As hypothesised, the competence perception variables of task efficacy and perceived ability had significant relations with personal achievement goals and self-regulated learning during group work. Of these relations, task efficacy was a significant positive predictor of mastery-approach ($\gamma = 0.677$, $p < .001$) and performance-approach ($\gamma = 0.241$, $p < .001$), and was a negative predictor of performance-avoidance ($\gamma = -0.141$, $p < .05$). Task efficacy had null relations with regulatory strategy use, maladaptive strategy use and mastery-avoidance. Perceived ability also had positive associations with performance-approach ($\gamma = 0.158$, $p < .01$) and was a negative predictor of mastery-avoidance ($\gamma = -0.096$, $p < .05$) and maladaptive strategy use ($\gamma = -0.114$, $p < .05$). Perceived ability had null relations with regulatory strategy use and performance-avoidance.

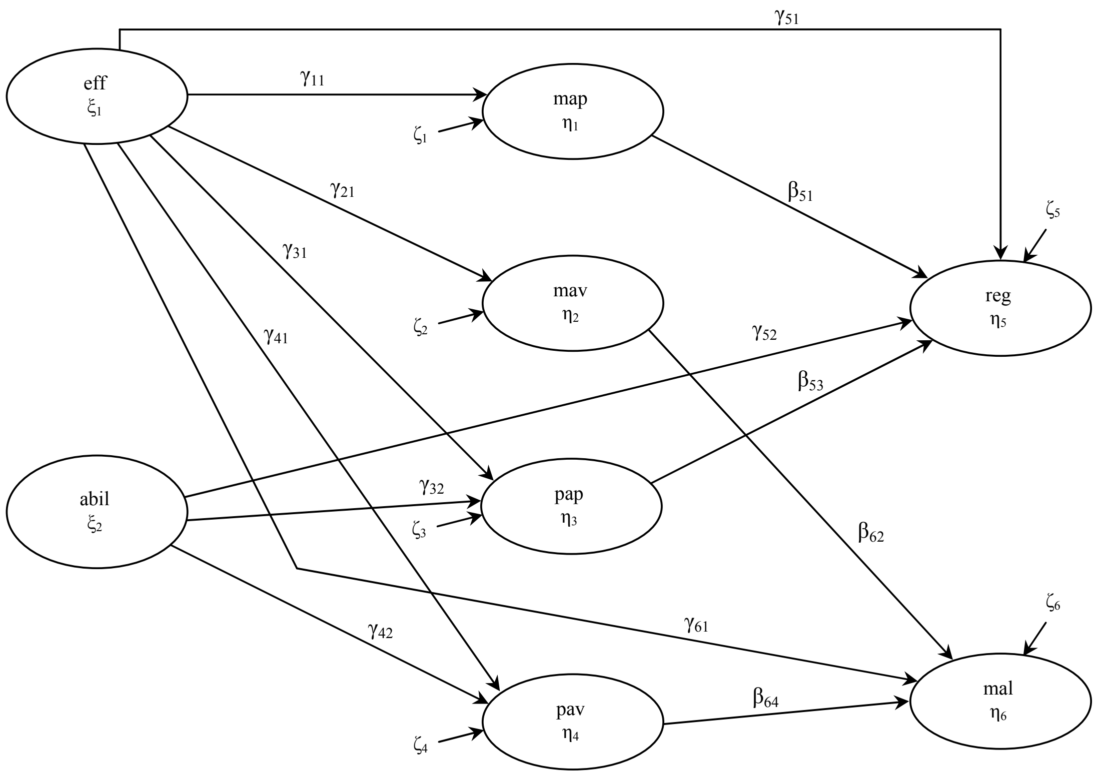

Figure 10.2. Hypothesised structural equation model under study. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal).

Table 10.17

Self-Regulated Learning Structural Equation Model Fit Indices (Study 3B Group Work)

Variable	χ^2	*df*	*p*	GFI	AGFI	NFI	CFI	SRMR	RMSEA
Hypothesised model	296.6	15	.000	.872	.646	.767	.772	.122	.209
Revised model[a]	4.8	3	.187	.997	.970	.996	.999	.0104	.0356
Revised model[b]	4.7	3	.194	.998	.970	.987	.995	.0107	.0366

Note. n = 476; χ^2 = minimum fit function chi-square; *df* = degrees of freedom; p = significance of difference between the observed and estimated population covariance matrices on the basis of the minimum fit function χ^2; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; NFI = normed fit index; CFI = comparative fit index; SRMR = standardised root mean square residual; RMSEA = root mean square error of approximation; [a]Maximum likelihood used as the estimation method; [b]Generalised least squares used as the estimation method.

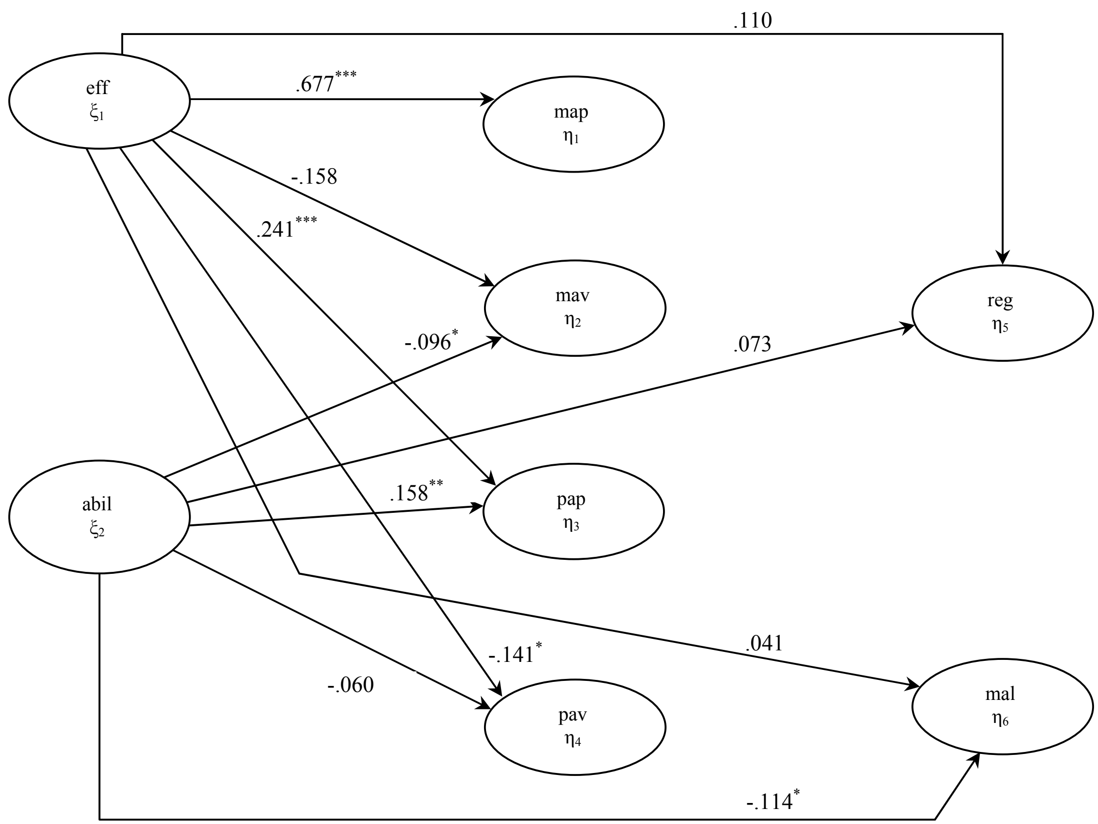

Figure 10.3. Revised structural equation model displaying the standardised direct effects for the competence perception variables. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

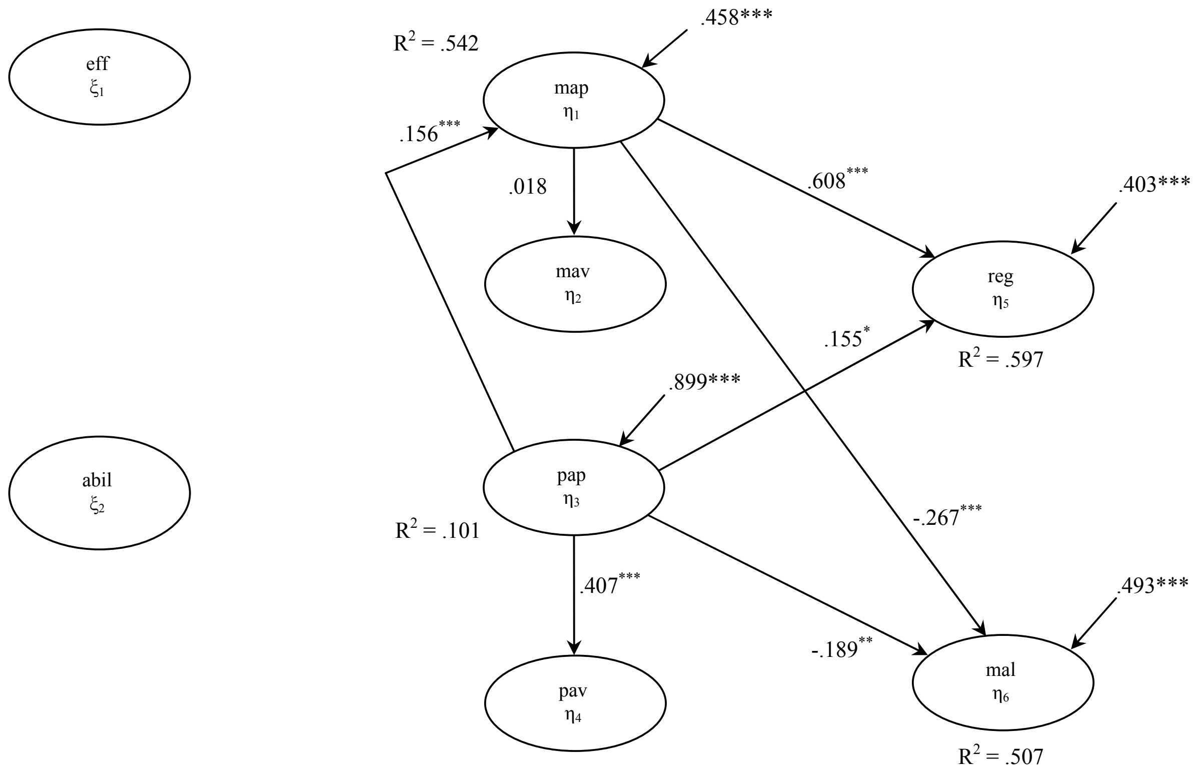

Figure 10.4. Revised structural equation model displaying the standardised direct effects for mastery-approach and performance-approach achievement goals. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

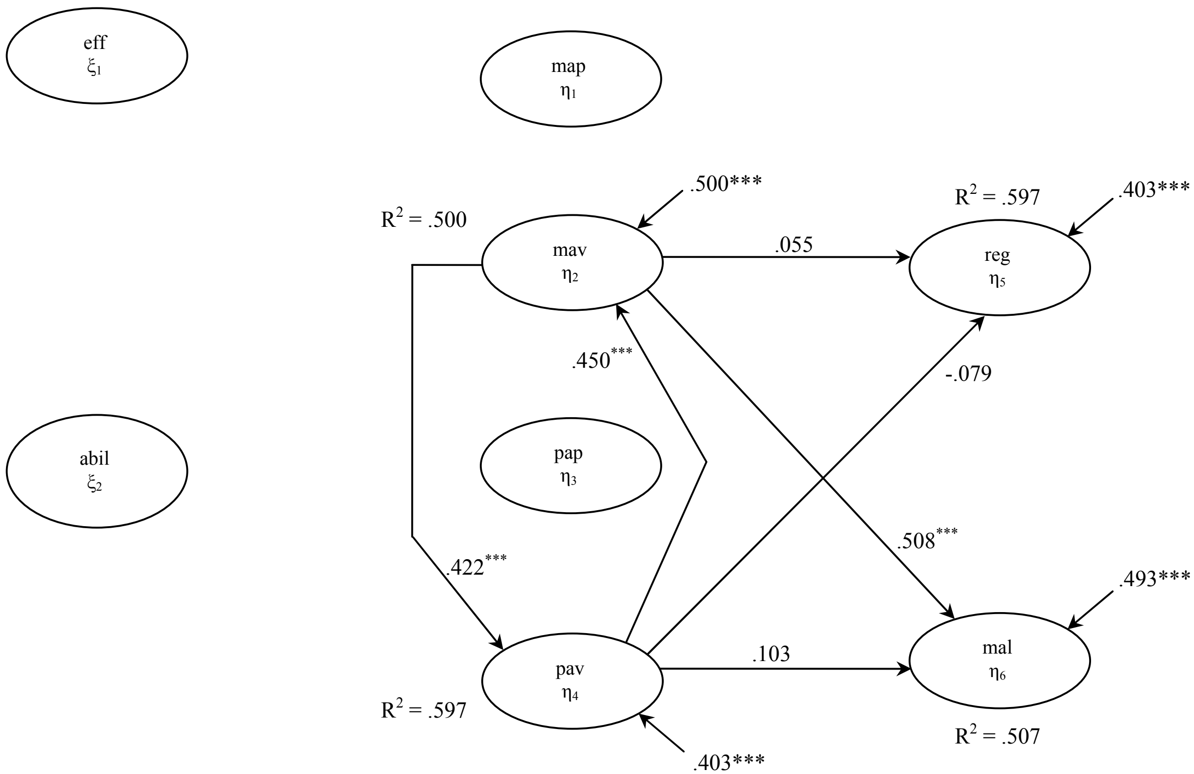

Figure 10.5. Revised structural equation model displaying the standardised direct effects for mastery-avoidance and performance-avoidance achievement goals. The exogenous variables are symbolised as: task-efficacy (eff); perceived ability (abil). The endogenous variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg); maladaptive strategy use (mal). * $p < .05$. ** $p < .01$. *** $p < .001$.

The standardised direct effects path model for the mastery-approach and performance-approach variables is displayed in Figure 10.4. Regulatory strategy use was positively predicted by mastery-approach (β = 0.608, $p < .001$) and performance-approach (β = 0.155, $p < .05$). Maladaptive strategy use was negatively predicted by mastery-approach (β = -0.267, $p < .001$) and performance-approach (β = -0.189, $p < .01$). A significant amount of covariance was found to exist between the achievement goals. Performance-approach was found to positively predict mastery-approach (β = 0.156, $p < .001$) and performance-avoidance (β = 0.407, $p < .001$). Mastery-approach had null relations with mastery-avoidance (β = 0.018).

The standardised direct effects path model for the mastery-avoidance and performance-avoidance variables is displayed in Figure 10.5. Regulatory strategy use had null relations with both avoidance goals, mastery-avoidance (β = 0.055) and performance-avoidance (β = -0.079). Maladaptive strategy use had positive relations with mastery-avoidance (β = 0.508, $p < .001$) and null relations with performance-avoidance (β = 0.103). As for Teacher-Led Discussion (Study 3A), reciprocal relations were found between the avoidance goals with performance-avoidance positively predicting mastery-avoidance (β = 0.450, $p < .001$) and mastery-avoidance positively predicting performance-avoidance (β = 0.422, $p < .001$).

The variances of the endogenous variables explained by the revised model (Figures 10.3 to 10.5) were as follows: mastery-approach (54%), mastery-avoidance (50%), performance-approach (10%), performance-avoidance (60%), regulatory strategy use (60%), and maladaptive strategy use (51%). These totals were considerably more than those obtained using multilevel multiple regression analyses. However, the variance explaining performance-approach was extremely low. The standardised direct, indirect and total effects for the revised self-regulated learning structural equation model using maximum likelihood as the estimation method are presented in Table 10.18. Almost identical results were obtained using generalised least squares as the estimation method and these are presented in Table 10.19.

An integrated discussion of these results with those obtained in the teacher-led discussion context analysis is presented in Chapter 11.

Table 10.18

Self-Regulated Learning during Group Work Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Task efficacy on:	Mastery-approach	.677***	.037**	.715***
	Mastery-avoidance	-.158	-.045	-.203**
	Performance-approach	.241***	-	.241***
	Performance-avoidance	-.141*	.012	-.129*
	Regulatory strategy use	.110	.471***	.581***
	Maladaptive strategy use	.041	-.353***	-.312***
Perceived ability on:	Mastery-approach	-	.025*	.025*
	Mastery-avoidance	-.096*	-.020	-.116*
	Performance-approach	.158**	-	.158**
	Performance-avoidance	-.060	.015	-.044
	Regulatory strategy use	.073	.036*	.109*
	Maladaptive strategy use	-.114**	-.100**	-.214***
Mastery-approach on:	Mastery-avoidance	.018	.004	.022
	Performance-avoidance	-	.009	.009
	Regulatory strategy use	.608***	.000	.609***
	Maladaptive strategy use	-.267***	.012	-.255**
Mastery-avoidance on:	Mastery-avoidance	-	.235***	.235***
	Performance-avoidance	.422***	.099*	.521***
	Regulatory strategy use	.055	-.028	.027
	Maladaptive strategy use	.508***	.173***	.681***
Performance-approach on:	Mastery-approach	.156***	-	.156***
	Mastery-avoidance	-	.230***	.230***
	Performance-avoidance	.407***	.097***	.504***
	Regulatory strategy use	.155*	.067	.222***
	Maladaptive strategy use	-.189**	.127*	-.062
Performance-avoidance on:	Mastery-avoidance	.450***	.106**	.556***
	Performance-avoidance	-	.235***	.235***
	Regulatory strategy use	-.079	.012	-.067
	Maladaptive strategy use	.103	.307***	.409***

Note. n = 476 (effective sample size); [a]Maximum likelihood used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 10.19

Self-Regulated Learning during Group Work Structural Equation Model Solution[a] Displaying Standardised Direct, Indirect and Total Effects

Effect		Direct effect	Indirect effect	Total effects
Task efficacy on:	Mastery-approach	.680***	.037**	.717***
	Mastery-avoidance	-.159	-.045	-.204**
	Performance-approach	.241***	-	.241***
	Performance-avoidance	-.141*	.012	-.129*
	Regulatory strategy use	.108	.477***	.584***
	Maladaptive strategy use	.044	-.357***	-.312***
Perceived ability on:	Mastery-approach	-	.025*	.025*
	Mastery-avoidance	-.096*	-.019	-.115*
	Performance-approach	.158**	-	.158**
	Performance-avoidance	-.059	.016	-.043
	Regulatory strategy use	.073	.037*	.110*
	Maladaptive strategy use	-.114**	-.100**	-.214***
Mastery-approach on:	Mastery-avoidance	.019	.004	.023
	Performance-avoidance	-	.010	.010
	Regulatory strategy use	.614***	.001	.614***
	Maladaptive strategy use	-.270***	.013	-.257**
Mastery-avoidance on:	Mastery-avoidance	-	.235***	.235***
	Performance-avoidance	.422***	.099*	.522***
	Regulatory strategy use	.056	-.029	.027
	Maladaptive strategy use	.515***	.173***	.688***
Performance-approach on:	Mastery-approach	.156***	-	.156***
	Mastery-avoidance	-	.230***	.230***
	Performance-avoidance	.407***	.097***	.505***
	Regulatory strategy use	.156*	.068	.223***
	Maladaptive strategy use	-.189**	.127*	-.062
Performance-avoidance on:	Mastery-avoidance	.450***	.106**	.556***
	Performance-avoidance	-	.235***	.235***
	Regulatory strategy use	-.081	.012	-.068
	Maladaptive strategy use	.099	.310***	.409***

Note. *n* = 476 (effective sample size); [a]Generalised least squares used as the estimation method. Dashes represent zero effects. * $p < .05$. ** $p < .01$. *** $p < .001$.

Chapter 11

STUDY 3: DISCUSSION OF THE QUANTITATIVE ANALYSES

11.1 DISCUSSION

Study 3 addressed the tenets of the context hypothesis introduced in Chapters 5 and 8. According to this view, achievement goals and their associated antecedents and consequences are measurable constructs during specified learning contexts. Furthermore, justifiable structural relations exist between the constructs, relations that are underpinned by the relevant extant theories pertinent to achievement goals (e.g., Elliot, 1999), self-efficacy (e.g., Bandura, 1986; Pajares, 2002) and self-regulated learning (e.g., Pintrich, 2000a). The learning contexts studied in Study 3 were based on those typically expected in high school science classrooms: teacher-led discussion and group work. These contexts, it is postulated, are commensurate with those contexts specified in constructivist learning environments (Driver et al., 1994; Howe & Berv, 2000; Tobin, 2000) and vary in terms of the degree of teacher regulation and student regulation experienced in each context (Figure 5.1, Chapter 5). It was also hypothesised that students' reporting of their achievement goals and self-regulated learning would have increased validity due to the proximity of their reporting with respect to the learning context encountered. Some of the limitations allied with Studies 1 and 2, particularly the reporting of relations between the self-regulated learning constructs and students' personal constructs, were intended to be addressed by measuring these constructs in specific, micro-learning events that occurred in situ in the science classroom. This study also attended to the validity issue associated with using self-regulated learning items that have a mixture of external and internal classroom referents such as the ones contained in the MSLQ, the trait-based questionnaire used in Studies 1 (Chapter 6) and 2 (Chapter 7) to measure the self-regulated learning constructs of cognitive strategy and regulatory strategy use. This area was addressed in Study 3 (Chapters 8 to 10) by using context-specific self-regulated learning items that reflected adaptive and maladaptive SRL behaviour.

The first focus of discussion regarding the Study 3 quantitative data reported in Chapters 9 and 10 concerns the measurement properties of the micro-learning event questionnaires and thus the salience of the constructs under consideration. With respect to these issues, Study 3 addressed the following research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?

> Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?

There was considerable support for the existence of achievement goals in the learning contexts with the achievement goals of mastery-approach and performance-approach reported with high composite scale reliability coefficients through both learning contexts (Table 11.1). However, the construct validity of avoidance goals was not as consistent. Although there was some form of avoidance goal identified by students in each learning context, the composite scale reliability coefficients for each of these was very low, hovering at the bare acceptable level of 0.700. Two reasons may account for the difference between the reliability of the avoidance goals and approach goals. Firstly, the indicator items used to assess student's avoidance goals were inappropriate for the context encountered. This study was the first known to examine achievement goals at a micro-level and while the approach goal items were successful with students identifying mastery-approach and performance-approach goals, perhaps more refining of the novel avoidance items is required in order to ascertain more accurately students' avoidance goals in specific learning contexts. A qualitative approach may also be useful in examining students' avoidance in specified learning contexts associated with science learning in high school classrooms. Secondly, students' reporting of their avoidance behaviour in specified learning contexts may be difficult for students to judge and therefore introduces a greater degree of item-misinterpretation amongst students. Of course the inconsistency in the avoidance goals measurement properties may be attributable to a combination of these two reasons. Nevertheless, a pattern did emerge in the results with respect to the avoidance goals identified. The hypothesised achievement goals of mastery-avoidance and performance-avoidance did emerge at statistically satisfying levels in the two learning contexts that potentially had the most peer interaction, namely teacher-led discussion and group work. In these learning contexts, students would have a basis for performance-avoidance as they are confronted with peer-associated standards of success and failure. While the mastery-avoidance goal was also satisfactorily reported in these contexts, it was less reliable than performance-avoidance.

Table 11.1

Personal Achievement Goals during High School Science Learning Contexts: Composite Scale Reliability Coefficient Results from Studies 3A and 3B

	Teacher-Led Discussion r_c	Group Work r_c
Mastery-approach	.828	.852
Mastery-avoidance	.696	.714
Performance-approach	.815	.871
Performance-avoidance	.814	.781

Note. r_c = composite scale reliability coefficient.

There were no construct validity problems associated with the a priori structure indicator items proposed to measure the competence perceptions of task-efficacy and perceived ability. Likewise the regulatory strategy use and maladaptive strategy use indicator items were also validated at the context level. All of these constructs had good levels of reliability thus demonstrating the salience of these at the context level of analysis.

Study 3 addressed two research questions concerning the relations of the constructs under consideration:

> Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

As in Studies 1 and 2, two statistical procedures were employed to analyse the structural relations amongst the context-level variables investigated in Study 3: multilevel multiple regression and structural equation modelling. For each learning context examined, the multilevel multiple regression analyses revealed that virtually all the variance associated with regulatory strategy use and maladaptive strategy use was attributable to the personal level. This result reflects the importance of personal-based factors in determining students' adaptive and maladaptive strategy use during classroom learning contexts. However, one limitation of the present research was the number of classrooms studied. A small number of classroom-level units were studied in the present research with the total number of classrooms investigated in the two mini studies ranging from 23 to 24 classes. The results of the present research, which has been the first to examine achievement goals and self-regulated learning at the context level, indicate potential for future larger scale classroom studies to also adopt a multilevel approach in order to confirm the importance of personal-based factors in students' use of self-regulated learning during classroom learning events and hence question the impact of the teacher and teaching methodology upon students' learning with reference to motivation, efficacy and self-regulated learning.

The first focus of discussion on the results obtained for the associations between high school science students' subpopulation variables, students' competence perceptions, achievement goals, regulatory strategy use and their maladaptive strategy use in micro-learning contexts concerns the subpopulation variables. As hypothesised, there were no differences obtained between gender towards the use of regulatory strategies and maladaptive strategies in the classroom contexts investigated. This result confirms previous research which has generally found no differences between males and females with regards to their use of self-regulated learning (Neber & Schommer-Aikins, 2002; Pajares et al., 2000; Pintrich & de Groot, 1990; Rao et al., 2000; Ryan & Patrick, 2001; Wolters et al., 1996; Wolters & Pintrich, 1998) although most of this work has focussed on trait-level analyses of students' self-regulated learning.

It was expected that selective high school science students would use more adaptive self-regulated learning strategies than regular students during classroom contexts. Contrary to that hypothesised, regular and selective high school science students did not differ on their self-reported use of regulatory and maladaptive strategies during the learning contexts. This result may point to the importance of intraclass efficacy-related and intraclass perceived ability issues on influencing students' behaviour in the classroom and thereby supports the tenets of a context hypothesis. In fact the only significant result pertaining to the effect of subpopulation variables was for age during group work, in which seniors reported using more regulatory strategies than juniors. This supports the hypothesis that seniors may be more mature in their approach to learning with others or are de-sensitised to the effects of working with peers.

The second focus of discussion concerns the structural relations between the competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use during the various learning contexts. For both forms of statistical analysis, multilevel multiple regression and structural equation modelling, competence perceptions and achievement goals were posited as predictors of regulatory and maladaptive strategy use during each learning context. With regards to the influence of the competence perceptions, the results of the regression analyses found support for the hypothesised relations between task efficacy and perceived ability with regulatory and maladaptive strategy use (Table 11.2). Both competence perceptions were expected to positively predict regulatory strategy use (Pajares, 2002; Schunk, 1990) and negatively predict maladaptive strategy use. Task efficacy was found to be a positive predictor of regulatory strategy use in each learning context. Task efficacy also was a negative predictor of maladaptive strategy use, but only for teacher-led discussion. Perceived ability was a positive predictor of regulatory strategy use in teacher-led discussion and group work contexts; it had negative relations with maladaptive strategy use in each learning context. Thus, students' perceptions of their efficacy and ability are important influences upon their self-regulated learning in learning contexts.

Table 11.2

Synopsis of Significant Predictors of Regulatory Strategy and Maladaptive Strategy use for High School Science Students during Classroom Learning Contexts using Multilevel Multiple Regression Analyses

Classroom learning context studied	Number of students	Number of classrooms	Regulatory strategy use	Maladaptive strategy use
Teacher-Led Discussion (Study 3A)	451	23	mastery-approach (+) performance-approach (+) task efficacy (+) perceived ability (+) mastery-avoidance (-)	mastery-approach (-) task efficacy (-) perceived ability (-) mastery-avoidance (+) performance-avoidance (+) mastery-avoidance X performance-avoidance (+)
Group work (Study 3B)	476	24	mastery-approach (+) performance-approach (+) task efficacy (+) perceived ability (+) age[a] (-)	mastery-approach (-) performance-approach (-) perceived ability (-) mastery-avoidance (+) performance-avoidance (+) mastery-avoidance X performance-avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship; [a]Age is coded 0 = senior and 1 = junior; [b]Gender is coded 0 = male and 1 = female. All relationships are significant at a minimum of $p < .05$.

The regression analyses also found support for the hypothesised relations between the achievement goals with regulatory and maladaptive strategy use (Table 11.2). Mastery-approach and performance-approach were found to both be positive predictors of regulatory strategy use in each learning context investigated. These relations were expected for mastery-approach as there is a considerable body of research that has found the mastery-approach goal to have adaptive qualities in terms of self-regulated learning at trait-level (Ablard & Lipschultz, 1998; Ee et al., 2003; Elliot & McGregor, 2001; Elliot et al., 1999; Ford et al., 1998; Greene & Miller, 1996; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Pajares et al., 2000; Patrick et al., 1999; Turner et al., 1998; Wolters, 2004; Wolters et al., 1996). The finding that performance-approach goals had adaptive qualities associated with self-regulated learning is important and contributes significantly to the debate regarding the adaptiveness of the performance-approach goal (Harackiewicz et al., 2002; Midgley et al., 2001). Although a small number of studies have found performance-approach to positively predict self-regulated learning (Ablard & Lipschultz, 1998; Meece et al., 1988; Wolters et al., 1996), the bulk of research has found performance-approach to have null relations with self-regulated learning (Bandalos et al., 2003; Ee et al., 2003; Elliot & McGregor, 2001; Elliot et al., 1999; Ford et al., 1998; Greene & Miller, 1996; Kaplan & Midgley, 1997; Middleton & Midgley, 1997; Neber & Schommer-Aikins, 2002; Niemivirta, 1997; Pajares et al, 2000; Turner et al., 1998; Wolters, 2004). Again, the work cited above has been conducted using trait-level analyses whereas the present research has utilised a micro-learning level of analysis. These results support the contentions of Harackiewicz et al. (2002), who propose that the performance-approach goal may have adaptive qualities associated with it for the areas of achievement, affect, attitudes, effort, and task value. In the present research, students who are oriented towards strong performances are just as capable of utilising adaptive self-regulated learning strategies during classroom learning contexts as are students who have mastery-approach orientations. The present research asked students to report on specific regulatory strategies associated with each learning context thus increasing the validity of students' reporting of self-regulated learning. By utilising more accurate measures of self-regulated learning than pervious research, the present research has significantly contributed to achievement goal research.

The relations between the achievement goals with maladaptive strategy use were also almost as hypothesised. Mastery-approach was found to be a negative predictor of maladaptive strategy use in all learning contexts. Performance-approach was a negative predictor of maladaptive strategy use during group work. All types of avoidance goals were positive predictors of maladaptive strategy use during the learning contexts.

One limitation of using multiple regression is it does not account for the simultaneous interdependent relations between the variables and this may partly explain the lower coefficient of determination (R^2) obtained for the regulatory strategy use and maladaptive strategy use variables in the regressions compared with those acquired for the same variables in the structural equation final models (Table 11.3). In conjunction with Studies 1 (Chapter 6) and 2 (Chapter 7), achievement goals were situated as mediators of task efficacy and perceived ability with respect to the influence of these competence perceptions on regulatory and maladaptive strategy use for the structural equation modelling (SEM) analyses. There is considerable support for situating the perceptions of ability and efficacy as influential antecedents of achievement goals (Bandura, 1997; Dweck & Elliott, 1983; Dweck & Leggett, 1988; Church et al., 2001; Elliot, 1999; Elliot & Church, 1997; Elliot & McGregor, 2001; Greene et al., 2004; Midgley et al., 1998; Midgley & Urdan, 2001; Middleton & Midgley, 1997; Nicholls, 1984; Schunk, 1990; Skaalvik, 1997) and the results of Study 3 support this contention. The SEM analyses found the achievement goals of mastery-approach and performance-approach to be mediators of the impact of task efficacy and perceived ability upon regulatory strategy use. In all contexts, when both task efficacy and perceived ability were positioned as positive predictors of mastery-approach and performance-approach, the direct effects of task efficacy and perceived ability on regulatory strategy use diminished significantly. Rather, the achievement goals of mastery-approach and performance-approach positively predicted the use of regulatory strategies during the contexts (Table 11.4). Hence these findings support the importance of achievement goals as mediators of students' perceptions of their efficacy and ability in specified classroom contexts; a result that may parallel that found at the trait level. Moreover, they also show the role of perceptions of competence in determining adaptive and non-adaptive learning behaviours. Also of relevance was the finding that performance-approach had positive associations with regulatory strategy use. While mastery-approach was hypothesised to have foster adaptive strategies during contexts, there was support for the positive role of performance-approach, something that others have discussed (Harackiewicz et al., 2002; Midgley et al., 2001). The advantage the present research has over previous research with regards to the positive or negative consequences of performance-approach goals is that it related performance-approach goals directly to specified adaptive behaviours in learning contexts rather than report on academic achievement which is so often the case in trait-level studies involving performance-approach goals. The findings of the present research indicate that the performance-approach goal has adaptive qualities that may well be tempered by the amount of mastery-approach the student has although the present research found no significant effects for the impact of a mastery-approach X performance-approach interaction on context strategy use. This result therefore supports an orthogonal outlook for achievement goals. However, as reported for the regression analyses, the SEM results also showed performance-approach to be a positive predictor of both regulatory strategy use and maladaptive strategy use during computer use. As proposed above, this result shows that a learning context that entails computer use, with its highly student-centred learning and least teacher-regulated context, may offer performance-approach students with opportunities to go off task since they cannot demonstrate their prowess to important others and the computer offers avenues of distraction. Mastery-approach students, on the other hand are more involved with their learning. However, there was no avoidance goal used in the SEM analyses in computer use and this may have affected the relations of performance-approach.

One limitation of many studies that investigate self-regulated learning is not measuring students' use of maladaptive strategies. Study 3 addressed this by examining students' reporting of their maladaptive strategy use concurrently with regulatory strategy use in specified learning contexts. The SEM results associated with maladaptive strategy use differed to those found for the regulatory strategy use with competence perceptions having both direct effects upon maladaptive strategy use and some effects mediated by achievement goals. In almost all learning contexts, task efficacy and perceived ability were direct negative predictors of maladaptive strategy use, as hypothesised (Table 11.4). As hypothesised, avoidance goals were also positive predictors of maladaptive strategy use. Of interest was the impact of task efficacy on maladaptive strategy use found for group work. In group work, it is expected that students would have the most peer interaction and thus the main driver of maladaptive strategy use of the competence perceptions would be perceived ability. Finally, mastery-approach and performance-approach were negative predictors of maladaptive strategy use as hypothesised and discussed above.

The final aspect of discussion concerns the relations between the competence perceptions with achievement goals obtained in the SEM analyses. Once again, there were consistent relations obtained throughout the two learning contexts investigated (Table 11.5). Task efficacy was a positive predictor of mastery-approach in each learning context thus highlighting the role efficacy beliefs play in fostering students' adaptive motivational behaviour for tasks in high school science classrooms. Perceived ability was expected to have null relations with the mastery goals since it has externally-based referents. However, perceived ability was found to have positive relations with mastery-approach for the teacher-led discussion context and had null relations for group work. Teacher-led discussion was proposed to be a more teacher-regulated learning context than group work. Thus, perhaps students that adopt a mastery approach in learning contexts that are more teacher-regulated are also confident in their peer-referenced ability.

Table 11.3

Percentage of Variance Accounted for Regulatory Strategy and Maladaptive Strategy Use Variables during Classroom Learning Contexts Statistical Analyses

	% variance explained for Regulatory strategy use		% variance explained for Maladaptive strategy use	
Classroom learning context studied	regression analysis	SEM	regression analysis	SEM
Teacher-Led Discussion (Study 3A)	62.8	87	46.1	58
Group work (Study 3B)	42.6	60	41.3	51

Note. SEM = structural equation modelling.

As hypothesised, task efficacy and perceived ability were positive predictors of performance-approach in all learning contexts (Table 11.5). Hence students that pursued performance-related behaviour in the high school science classroom were both efficacious and had positive perceptions of their ability. Contrary to that hypothesised, task efficacy had null relations with mastery-avoidance. Rather, it was perceived ability that had negative relations to mastery-avoidance in the teacher-led discussion and group work settings (Table 11.5). On the hand, task efficacy had negative relations with performance-avoidance in the teacher-led discussion and group work settings. Perceived ability was a negative predictor of performance-avoidance in the teacher-led discussion learning context. Thus, in these learning contexts both types of competence perceptions were influential on students' avoidance goals although the relations between mastery-avoidance and performance-avoidance with task efficacy and perceived ability were not in accordance with achievement goal theory. It was expected that task efficacy would have negative relations with mastery-avoidance due to their intrapersonal references, and that perceived ability would have negative relations with performance-avoidance due to their external references. These results somewhat complement the measurement properties associated with the avoidance goals in the learning contexts with the avoidance goals having suspect construct validity problems. Perhaps these measurement difficulties contributed towards the results attained for the associations of the competence perceptions with avoidance goals in the learning contexts examined.

In conclusion, the quantitative assessment of the relations between competence perceptions and achievement goals with regulatory strategy use and maladaptive strategy use showed two main results. Firstly, the impact of competence perceptions on regulatory strategy use in the two learning contexts investigated are mediated by students' achievement goals in accordance with achievement goal theory. Secondly, students' use of maladaptive strategies is affected by both competence perceptions and students' achievement goals, again in accordance with theories relating to efficacy beliefs and achievement goal theory. In addition, not only do these results support the evidence gained on the adaptiveness of mastery-approach goals and students' efficacy beliefs, they also lend credence to a context hypothesis for addressing research issues that examine the relations between achievement goals and self-regulated learning.

It should be noted that despite the improvement in the accountability of variance of the two dependent variables (regulatory strategy use and maladaptive strategy use) obtained by using SEM over regression analyses, a considerable amount of variance was still unexplained (Table 11.3) with the explained variance in the models accounting for regulatory strategy use ranging from 60 to 87%, and the explained variance in the models accounting for maladaptive strategy use ranging from 51 to 58%. Future studies at the context level should attempt to improve these values by identifying other variables that affect students' regulatory strategy use and maladaptive strategy use during classroom learning events.

Table 11.4

Synopsis of Significant Predictors of Regulatory Strategy and Maladaptive Strategy Use for High School Science Students during Classroom Learning Contexts using Structural Equation Modelling Analyses

Classroom learning context studied	Number of students	Regulatory strategy use	Maladaptive strategy use
Teacher-Led Discussion (Study 3A)	451	mastery-approach (+)	mastery-approach (-) task efficacy (-) perceived ability (-) mastery-avoidance (+) performance-avoidance (+)
Group work (Study 3B)	476	mastery-approach (+) performance-approach (+)	mastery-approach (-) performance-approach (-) perceived ability (-) mastery-avoidance (+)

Note. (+) = positive relationship; (-) = negative relationship. All relationships are significant at a minimum of $p < .05$.

Table 11.5

Synopsis of Significant Predictors of Achievement Goals for High School Science Students during Classroom Learning Contexts using Structural Equation Modelling Analyses

Classroom learning context studied	Number of students	Mastery-approach	Mastery-avoidance	Performance-approach	Performance-avoidance
Teacher-Led Discussion (Study 3A)	451	task efficacy (+) perceived ability (+)	perceived ability (-)	task efficacy (+) perceived ability (+)	task efficacy (-) perceived ability (-)
Group work (Study 3B)	476	task efficacy (+)	perceived ability (-)	task efficacy (+) perceived ability (+)	task efficacy (-)

Note. (+) = positive relationship; (-) = negative relationship. All relationships are significant at a minimum of $p < .05$.

11.2 LIMITATIONS

Several limitations associated with the Study 3 quantitative analyses need to be acknowledged. The first limitation concerns the type of students and classes that presented for the study. The classrooms that were studied in the context level analyses may have represented a narrow range of ability. In order to coerce involvement from schools for the study and with the intention of obtaining a range of schools and classrooms, one or two junior and senior classes were invited to take part from each school. This procedure may have resulted in schools selecting classes for the study that were well-behaved and containing high calibre students. As such the sample may have consisted of students that were efficacious and well adjusted to studying science. These aspects consequently have implications for the generalisation of the findings.

A second limitation of this study concerned the administration of the questionnaires by the classroom teacher instead of a third party such as a "researcher". As reported in Study 2 (Chapter 7), the administering of the questionnaires by the classroom teacher may have impacted upon students' attitude to the study since students were asked to report their perceptions of a variety of classroom-associated personal features in the questionnaires. Students may have answered the questionnaires in accordance with what they envisaged the teacher expected of them or in retaliation to what they thought the teacher expected of them. These problems were offset by requesting the questionnaires to be filled in anonymously and having the teacher refer to the "researchers" in third party terms when administering the questionnaires.

There were potential limitations associated with the type of data collection protocol employed in Study 3. The majority of classes and students that participated in the study completed a total of five questionnaires – one omnibus questionnaire for the trait-level analyses (presented as Study 2 in Chapter 7) and one for each science learning context investigated - teacher-led discussion and group work. (Students also reported on teacher explanation and computer use contexts; however, space restrictions preclude the reporting of the results for these learning contexts.). Although teachers allocated the questionnaires over the space of approximately one school term (10 weeks), students may have found reporting their perceptions of their personal variables in four different settings in addition to the trait-level questionnaires as tedious especially when considering there was no feedback provided to them. As a result of this procedure some students may have tended towards being recalcitrate with respect to completing the questionnaires in a genuine manner. It should be noted that teachers were able to allocate the context-level questionnaires in any order they deemed appropriate with respect to the teaching procedures used and topics they were teaching. This introduced some randomness into the sequence in which the context-level questionnaires were completed by the students that formed the sample for Study 3. This approach also helped control for students who may have repeated their responses to the questionnaires as a result of the repetitious nature of the protocol.

That the teachers of the classrooms involved in Study 3 were responsible for the administering of the questionnaires in appropriate learning contexts in their classroom may have also been a potential limitation of Study 3. This process was susceptible to teachers having different interpretations of “teacher explanation”, “teacher-led discussion”, “group work” or “computer use” events in their classroom. Hence students’ reporting of constructs in each context may have been influenced by such variation. For example, one teacher may have had the class working as groups in solving a challenging authentic scientific problem whereas another teacher may have groups completing a step-by-step investigation involving practical work. As a result of this there was potential for students reporting their perceptions of their personal variables in slightly different contexts.

One advantage of only measuring personal-based constructs in Study 3 was that it controlled for the effects of certain variables associated with context analyses. For example, collecting data on a one-off group work context is invalid if group membership varies over time along with the type of activity the group attends to. It is important to realise that the unit of analysis in the present research was cognitive in nature and not social. The focus in the Study 3 analyses was on the relations amongst a student’s personal or cognitive-based constructs of self-efficacy, achievement goals and self-regulated learning. Therefore, in the context of the present research it does not matter if a student changes group membership over time since each student will foster a set of orientations with regards to their efficacy beliefs, their achievement goals and self-regulated learning. Study 3 was not concerned with students' perceptions of their peers and the related social-based variables. For example, a student who is highly efficacious when working in one group may foster a certain set of relations between the variables associated with high efficacy beliefs. If that same student worked in a different group and had low efficacy beliefs then they would be expected to foster a set of relations between variables associated with students who are low in self belief. Study 3 presented analyses regarding the relationships between these personal-based variables gathered from a range of students in four different learning contexts of science classrooms thus increasing the generalisibility of these cognitive-based relationships.

11.3 SUMMARY

In summary, the Study 3 quantitative analyses addressed the following research questions.

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?
>
> Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?
>
> Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?
>
> Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Four context-level questionnaires were administered to students after being involved in the specified learning context in their high school science lessons throughout the middle of the school year. The specified learning contexts were classified as: teacher explanation, teacher-led discussion, group work, and computer use. (Only teacher-led discussion and group work are reported here.) Each context-level questionnaire consisted of one task efficacy scale, four achievement goal scales, one regulatory strategy use, one maladaptive strategy use scale, and one perceived ability scale. There was considerable support for the 2 X 2 achievement goals framework and for a context hypothesis. Two statistical forms of analyses were used to ascertain the relations amongst the constructs that were validated from these questionnaires: multilevel multiple regression and structural equation modelling (SEM). The multilevel multiple regression analyses determined the impact of variance attributed to personal-level and classroom-level units upon the constructs. The regression analyses also measured the impact of various subpopulation variables (gender, student type, age) upon the use of regulatory strategies and maladaptive strategies during the specified learning context. Of particular interest was the influence of student type (regular or selective high school students) upon these personal-based variables. This technique found that the bulk of variance for all constructs was attributed to the personal-level with large amounts of intra-class variation for students' perception of their personal-based variables. These results therefore justified a single-level SEM model approach in examining the simultaneous interdependent relations amongst the variables. This study focused on presenting a structural equation model that was applicable to the general high school student and thus controlled for the variance associated with gender, age and student type (regular or selective high school student).

The following statistically significant relationships were found to exist with respect to Research Questions Four and Six.

11.3.1 Research Question Four: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' competence perceptions, students' self-regulated learning and maladaptive strategy use were as follows. Regulatory strategy use was positively predicted by task efficacy (teacher-led discussion, group work) and perceived ability (teacher-led discussion, group work). Maladaptive strategy use was negatively predicted by task efficacy (teacher-led discussion) and perceived ability (teacher-led discussion, group work).

The relations found between students' personal achievement goals, students' self-regulated learning and maladaptive strategy use were as follows. Regulatory strategy use was positively predicted by mastery-approach (teacher-led discussion, group work) and performance-approach (teacher-led discussion, group work). Regulatory strategy use was negatively predicted by mastery-avoidance (teacher-led discussion). Maladaptive strategy use was negatively predicted by mastery-approach (teacher-led discussion, group work) and performance-approach (group work). Maladaptive strategy use was positively predicted by mastery-avoidance (teacher-led discussion, group work), performance-avoidance (teacher-led discussion, group work), and the mastery-avoidance X performance-avoidance interaction (group work).

11.3.2 Research Question Four: Statistically Significant Associations found using Structural Equation Modelling Analyses

The relations found between students' competence perceptions, students' self-regulated learning and maladaptive strategy use were as follows. Maladaptive strategy use was negatively predicted by task efficacy (teacher-led discussion) and perceived ability (teacher-led discussion, group work).

The relations found between students' personal achievement goals, students' self-regulated learning and maladaptive strategy use were as follows. Regulatory strategy use was positively predicted by mastery-approach (teacher-led discussion, group work) and performance-approach (group work). Maladaptive strategy use was negatively predicted by mastery-approach (teacher-led discussion, group work) and performance-approach (group work). Maladaptive strategy use was positively predicted by mastery-avoidance (teacher-led discussion, group work), and performance-avoidance (teacher-led discussion).

The relations found between students' competence perceptions and students' personal achievement goals were as follows. Mastery-approach was positively predicted by task efficacy (teacher-led discussion, group work) and perceived ability (teacher-led discussion). Mastery-avoidance was negatively predicted by perceived ability (teacher-led discussion, group work). Performance-approach was positively predicted by task efficacy (teacher-led discussion, group work) and perceived ability (teacher-led discussion, group work). Performance-avoidance was negatively predicted by task efficacy (teacher-led discussion, group work) and perceived ability (teacher-led discussion). Mastery-approach was positively predicted by performance-approach (teacher-led discussion, group work). Mastery-avoidance was positively predicted by performance-avoidance (teacher-led discussion, group work). Performance-avoidance was positively predicted by mastery-avoidance (teacher-led discussion, group work) and performance-approach (teacher-led discussion, group work).

11.3.3 Research Question Six: Statistically Significant Associations found using Multilevel Multiple Regression

The relations found between students' subpopulation variables, students' self-regulated learning and maladaptive strategy use were as follows. personal achievement goals were as follows. Juniors reported using more regulatory strategies than seniors during group work.

The Study 3 quantitative analyses were confined to examining the relations between the personal-based constructs of task efficacy, achievement goals, regulatory strategy use, maladaptive strategy use, and perceived ability during specified learning contexts. As such, students reported their perceptions of these hypothesised influences of their behaviour in learning contexts via a priori designed sets of indicator items. Due to the nascent nature of the Study 3 research on learning contexts, the quantitative approach employed may have precluded other important features of learning contexts that may be linked to achievement goals and self-regulated learning. A step towards addressing this limitation was the aim of the qualitative study reported in the next chapter (Chapter 12). Students of the classrooms that took part in the context level study reported above were interviewed with the aim of developing a student's view of the learning environment and the impact it has on their achievement goals.

Chapter 12

STUDY 3: QUALITATIVE ANALYSIS

12.1 INTRODUCTION

Most of the research conducted on achievement goals and self-regulated learning has utilised correlational methods. As such, the bulk of research findings on achievement goals and self-regulated learning are based upon pre-emptive views about the indicators of achievement goals and self-regulated learning, the relations between these constructs with their antecedents and consequences, and an assumption that students are cognisant with their achievement goals and self-regulated learning. For example, many correlational studies on achievement goals have used questionnaires in order to ascertain the relations between achievement goals with constructs such as self-efficacy and self-regulated learning. These questionnaires have indicator items based on a priori perspectives with the researchers' predilections influencing the inclusion of indicator items they expect to be valid measures of achievement goals, items that students are expected to identify and quantify. One limitation of this methodology is that it cannot take into account the emic nature of students' responses to queries about their achievement goals and associated motivational properties. While there are inherent advantages in constraining students to certain indicator items and their representative constructs, questionnaires as restrictive measures do not consider the student's predominate view of the context. Furthermore, it is also assumed that there is commonality in the way students interpret items and in the way that students respond to items, particularly items that use Likert scales. That is, it is impossible to control for the subjective interpretation of items. Finally, survey approaches typically do not take into account the reasons behind students' responses to questionnaire items and do not permit exploration of these reasons (Urdan & Mestas, 2006). Thus, although correlational approaches to studying achievement goals and self-regulated learning address the research from a quantitative "scientific" approach, and in so doing conveniently introduce convergence of students' attention and interpretation of indicator items, they are relatively inflexible with respect to what they find and how they find it.

Studies that focus on ascertaining students' achievement goals and their associations using inductive approaches are scarce (however, see Urdan, Kneisel, & Mason, 1999; Urdan & Mestas, 2006). Typically these involve observations and or interviews with researchers aligning with constructivist or objectivist approaches to the analysis of the data. The purpose of this phase of Study 3 was to examine achievement goals in high school science classrooms from a qualitative stance with students being interviewed about their achievement goals and associated classroom factors. This qualitative analysis served to complement the Study 3 quantitative analyses, by garnering students' views towards achievement goals and classroom learning environment events. It is important to clarify that the position adopted in this study was objectivist in nature with the interview questions prepared on an a priori basis with the intention of focussing students upon the contexts relevant to their achievement goals in high school science classrooms. Hence, an inherent assumption in this approach was that students could identify their achievement goals and the relations therein.

12.1.1 Research Questions

Of prime interest in this qualitative research was students' identification and frequency of the four types of achievement goals, mastery-approach, mastery-avoidance, performance-approach and performance-avoidance, they may foster in learning high school science. Therefore this study was conducted in a limited structured framework associated with achievement goal theory thereby confining students to articulate their understanding of what is meant by achievement goals and the events associated with them in the classroom. Gathering students' perspectives about these issues addressed the following research question.

> Research Question Seven: What are students' perspectives with regards to the impact classroom activities have upon the adoption of achievement goals?

Two broad themes dictated the intent of the interviews and the questions pursued by the interviewer. The first theme was concerned with students' reported occurrence of the motivational behaviour associated with the particular achievement goal under focus in the interview: How often did students recognise they adopted the achievement goal? The second theme was concerned with students' reasons for their achievement goal orientations. With regards to this aspect, there was an immanent interviewer bias which anticipated that classroom activities or events influenced students' adoption of achievement goals. This view flowed from the context hypothesis - that classroom activities had a role in influencing students' achievement goals. However, this was a subjective view of the researcher rather than the students' perceptions of their motivational characteristics and their antecedents. Thus, the interviewer also intended to foster students' views on the adoption of achievement goals especially with respect to the influence of classroom learning environment events on the occurrence of achievement goals. One assumption here was that students could identify with behaviour that is cognisant of each of the four achievement goals. These themes predicated the four questions associated with the qualitative analysis:

1. How do students report themselves in terms of the frequency their application of achievement goals in high school science classrooms?

2. What classroom events or activities impact upon are students' explanations for their adoption of achievement goals?

3. What are students' explanations for why classroom events affect their adoption of achievement goals?

4. What are students' reasons for their adoption of their achievement goals?

It is expected that students' answers will vary with each question and it is anticipated that the responses would be of particular interest in light of the nascent quantitative research employed in examining achievement goals in learning contexts (Study 3). No hypothesises are necessary regarding the answers provided by students for these questions; rather the intention was to gather students' views and as such address some of the limitations related with the quantitative research conducted in Study 3 (Chapters 8 to 11).

12.2 METHOD

12.2.1 Participants

A sample of 38 high school science students was assembled from four different New South Wales State education system high schools serving the Sydney metropolitan area. Each of these students had been part of the sample of students that were investigated in the Study 3 quantitative studies (Chapters 8 to 11) and thus had also received written parental permission to participate in the interview study - the parent permission note including the possibility of the student being interviewed as part of the study. The students that comprised the interview sample were not chosen by their classroom teacher nor the interviewer (the researcher), instead students volunteered in pairs on the day of the interview. The participant statistics for the interview sample are displayed in Table 12.1. Students from two regular high schools (n = 16) and two selective high schools (n = 22) served as the interview sample. Females (n = 21) slightly outnumbered males (n = 17) in the interview sample. Students from year 11 (n = 20), year 9 (n = 10) and year 8 (n = 8) were represented in the interviews.

Table 12.1

Participant Statistics for the Study 3 Qualitative Study Interview Sample

	Regular high school[a] students		Selective high school[b] students		
	male	female	male	female	Totals
year 8	2	2	2	2	8 (21%)
year 9	2	2	2	4	10 (26%)
year 11	4	4	5	7	20 (52%)
Totals	8 (21%)	8 (21%)	9 (24%)	13 (34%)	38

Note. [a]Students from two regular high schools participated; [b]Students from two selective high schools participated.

12.2.2 Procedure

Students were interviewed in pairs by the interviewer (researcher) in private in a classroom located conveniently to the students' normal school science classroom. The interviews took place during students' normal science lessons and took approximately 15 minutes per student. All student pairs were interviewed by the same interviewer. For each interview, the interviewer described the function of the audiotape recorder and broadly explained the purpose of the interviews to students without explicating the full intent of the interviews: "We are asking students about their motivation in learning science." Students were also requested to maintain anonymity by being designated as Student 'X' or Student 'Y' (to their amusement) throughout the interview. They were also reassured by the interviewer of the confidentiality of their responses and told that they did not have to answer any questions they were not comfortable with. A semi-structured interview format with open questions was employed with the focus questions written on paper and used as a visual reference for students during the interview. There were four clusters of focus questions, with each cluster focusing on one particular achievement goal and thus confining students' answers and the entailing discussion to the achievement goal under focus (Table 12.2). Where possible, themes that arose throughout an interview that were deemed relevant by the interviewer were pursued with further questioning. Occasionally the interviewer rephrased a question in order to reaffirm a student's answer or comment made in the interview. This process provided a check of the authenticity of the student's responses.

Table 12.2

Achievement Goal Focus Questions used in the Semi-Structured Interviews

Achievement goal category	Focus questions
Mastery-approach	Are there times in your science classroom when you want to try and fully understand what is going on or do you try to fully understand all time? What are the events or activities that make you want to try and fully understand what's going in your science classroom? (Why do you think you try to fully understand what's going on all the time in your science classroom?) Why do these events or activities make you want to try and fully understand what's going on in your science classroom? What do you do if you feel that you do not understand what is going on in your science classroom?
Mastery-avoidance	Are there times in your science classroom when you do not bother trying to get involved because you know you are not going to understand or master the task or does this happen all the time? What are the tasks in your science classroom that you do not bother trying to get involved in because you know you are not going to understand or master the task? (Why do you think that you are not going to understand or master the activities all the time in your science classroom?) Why do these tasks make you not understand or not master the task? What do you do if you have failed to understand or master a task in your science classroom?

Table 12.2 *continued.*

Achievement goal category	Focus questions
Performance-approach	Are there times in your science classroom when you do things so that you will be better than the other students or does this happen all the time? What are the tasks or events that make you want to try and be better than the other students in your science classroom? (Why do you think you try to be better than the other students in your science classroom all the time?) Why do these tasks or events make you want to try and be better than the other students in your science classroom? What do you do if you get a poor result compared to the other students in your science classroom?
Performance-avoidance	Are there times in your science classroom when you don’t bother trying to get involved because you know you are going to be compared to the other students or does this happen all the time? What are the events in your science classroom that you didn’t bother trying to get involved in because you know you are going to be compared to the other students? (Why do you think you are going to be compared to other students all the time in your classroom?) Why do these events make you feel that you are being compared to the other students? What do you do if you are in a situation where results are compared with the other students’ results?

12.2.3 Coding Procedures

All the interviews were audiotaped and transcribed by the researcher. (See the author for complete transcripts of the interviews.) Each interview transcript was labelled and each interview line numbered for ease of reference to students' comments throughout the analysis, the discussion of results, and for location within the transcript. Take the following statement from one student interview as an example.

Stuart: Because I want to be knowledgeable… (St8: L22)

This statement was made by "Stuart" (all names used in the interviews are fictitious and serve only to identify the gender of the student who made the statement) and occurred at line 22 in Stuart's (student 8) interview transcript. Consider another example.

Interviewer So you try to fully understand all the time? (Int1: L52)

This statement was made by the interviewer to student 1 and occurred at line 52 in student 1's transcript.

The method of analysis employed was based on meaning categorisation (Kvale, 1996), with students' responses forming the unit of analysis (Urdan & Mestas, 2006). This indexing data method consisted of several stages. Firstly, all students' responses to a focus question were examined for common and unique responses. Common responses indicated potentiality for the development of categories that could classify all student responses. If categorisation was deemed appropriate the next stage consisted of developing categories that would classify students' responses to a focus question. Thus, the categories developed in this study were developed from students' responses to the interview questions and not from the researcher's subjective view. All the focus questions generated common responses from students thus satisfying the categorisation criteria for code indexing the interview data. The third stage involved applying the response categorisation scheme to the students' responses with respect to each focus question. Finally, the response categories for each focus question were tallied and then tabulated.

Identifying categories appropriate for students' interview responses has several advantages in the context of the present research. Firstly, it has the potential to introduce some form of parsimony to the interview responses of 38 students. Second, it may assist in determining the type of analysis protocol that should be adopted in analysing the interview statements. If students differed vastly in their interpretations of the questions then the process of meaning categorisation would be inappropriate, rather a ground theory or more inductive approach would be applicable. Third, classifying interview statements enables other researchers to identify with and position students' viewpoints with respect to their own research. Fourth, meaning categorisation by independent researchers enables cross checking to occur and thus provide a system that measures coder reliability (Kvale, 1996). Finally, meaning categorisation may help situate the interview findings with respect to relevant theories.

12.3 RESULTS

There was consistency amongst the students' responses to the focus questions thus justifying the use of the categorisation coding method for analysis. Furthermore, these responses indicated that the anticipated impact of classroom learning events upon achievement goals was not vindicated with students speaking in the main of their personal rather than social-based concerns. The results are presented in terms of each of the four focal areas, namely students' responses to the questions associated for each achievement goal. Where appropriate, examples of students' statements are provided to illustrate.

12.3.1 Mastery-Approach

Results of the coding analysis of students' responses to the interview questions regarding the mastery-approach focus questions are displayed in Table 12.3. With respect to students' reporting about the frequency of occurrence of mastery-approach goals, all 38 students interviewed stated they tried to understand all or most of the time. The reasons given for students trying to understand in their science lessons are displayed in Table 12.3. There were a total of 47 statements provided by students regarding the reasons for their pursuit of mastery-approach goals. Some students gave more than one reason. Four categories of reasons were identified from students' responses. The most frequent reason for students adopting a mastery-approach to learning science in the high school science classroom was exam-related, with approximately 43% of students commenting that assessment was uppermost in their minds regarding the purpose of their motivation for understanding in science. Sample statements from students are provided below.

Sally: Because you don't know what is going to be in the test. (St6: L68)

Kate: Well so I know what is going when it gets to the test. (St13: L16)

Mandy: …probably because there is going to be a test on it… (St31: L19)

Referral to assessments such as exams as being the main reason for adopting a mastery-approach to learning science was made by both regular and selective high school students. 45% of regular students' mastery-approach statements and 41% of selective students' mastery-approach statements were attributed to exam-related issues.

23% of the students interviewed gave the pursuit of knowledge or understanding itself as a reason for a mastery-approach. Sample statements associated with this reason are presented below.

Jill: Yeah, I like to learn… (St1: L26)

Sarah: Because I want to be knowledgeable… (St9: L22)

Richard: I guess I am just inquisitive or something. I just want to know like some things I don't understand in class… (St37: L17-18)

Statements related to students' enjoyment and interest in science comprised 19% of the reasons for mastery-approach. Examples of these statements are included below.

Tom: Yeah, that is the kind of stuff I am interested in. (St11: L23)

Rose: I tend to pay more attention with subjects that seem more interesting. (St 23: L8-9)

Jack: I have always like science… (St 26: L172)

The final category of students' reasons for pursuing mastery-approach goals in science related to future goals with career and employment highlighted. Examples of these statements, which accounted for 15% of the reasons for pursuing mastery-approach goals include:

Jim: I know it's going to matter to my future… (St 18: L172)

Don: Well it would probably help towards my future like so if someone asks me about the question then I could explain it to them. (St 34: L128-129)

12.3.2 Mastery-Avoidance

24 (63%) students reported they were always involved during their science lessons and did not consciously pursue mastery-avoidance behaviour. 14 (37%) students did identify with using mastery-avoidance at some time during their science lessons. 7 (50%) of these students were from regular high schools and the other 7 (50%) students being from selective high schools thus demonstrating avoidance behaviour existed in any of these settings. The reasons provided by these 14 students for adopting a mastery-avoidance were classified into four categories (Table 12.3). The most popular reason provided for mastery-avoidance was that the topic was too hard to understand and thus students gave up. This reason accounted for 76% of the mastery-avoidance statements. Typical statements for this category are presented

below.

Jacqui: I admit that I don’t try to understand because I know that it’s too far off and it’s too late for me to get all the information at once. (St 5: L106-107)

Sandra: When…I don’t understand like what the point of it is and I don’t know how to do it. (St 27: L67-68)

Lee-Anne: I might not get involved because I can’t understand it like straight away… (St36: L98)

Statements relating to fatigue also formed one category of reason for mastery-avoidance and these accounted for 12% of the mastery-avoidance reasons. For example:

Nick: …sometimes I am really tired and I just say oh well… (St7: L103)

One student described adopting mastery-avoidance when he perceived the topic as not being useful and one other student said he was focused on other things.

12.3.3 Performance-Approach

The frequency of students reporting the occurrence of performance-approach goals in their high school science classrooms were categorised as mostly competitive, sometimes competitive and not competitive at all. 10 of the 38 students interviewed (26%) were highly competitive, 12 students (32%) classed themselves as sometimes competitive and 16 (42%) of students reported themselves as “not really” competitive.

Table 12.3

Coding Categories Identified in the Semi-Structured Interviews and the Frequency of Related Student Statements

Achievement goal focus question	Categorisation of students' statements reasons	Frequency of statements
Mastery-approach: Why do you think you try to fully understand what's going on all the time in your science classroom?	1: exam preparation	20 (43%)
	2: develop one's knowledge	11 (23%)
	3: interest/enjoyment of science	9 (19%)
	4: career	7 (15%)
Mastery-avoidance: Why do you think that you are not going to understand or master the activities all the time in your science classroom?	1: topic too difficult	13 (76%)
	2: fatigue/tired	2 (12%)
	3: subject matter perceived not useful	1 (6%)
	4: distracted/focused on other things	1 (6%)
Performance-approach: Why do you think you try to be better than the other students in your science classroom all the time?	1: personal satisfaction/improvement	16 (45%)
	2: exam performance	14 (40%)
	3: competent dependency	3 (9%)
	4: friends are competitive	1 (3%)
	5: family expectations	1 (3%)
Performance-avoidance: What are the events in your science classroom that you didn't bother trying to get involved in because you know you are going to be compared to the other students?	1: class character	2 (67%)
	2: topic too hard	1 (33%)

The reasons for performance-approach provided by the students were categorised into 5 types (Table 12.3). The most common reason for performance-approach was associated with personal satisfaction of accomplishment and improvement. 45% of reasons for performance-approach were attributed to personal satisfaction. For example:

Stuart: I don’t necessarily want to be better than the other students, I just want to excel and do the best I can do myself. (St8: L270-271)

Nancy: Well I try to do my best all the time and yeah just see whether I am better or not but I try to do my best all the time. (St21: L37-38)

Roger: Yeah I try and do my best and it is more of a personal best than to beat everyone else just to get where I can get to. (St33: L64-65)

Assessment-related areas accounted for 40% of reasons for performance-approach:

Jill: I am mainly competitive when it is like tests and stuff… (St1: L117)

Alexis: In tests for my report. (St29: L 102)

A small number of students (9%) reported they were only performance-approach orientated when they felt efficacious with respect to the context:

Tom: Well, when I am good at times I try to be better than the others but when I am not so good at it I just try to like just learn it… (St11: L108-109)

Tammy: They will probably be like other subjects like the task or something that I am better at. (St34: L161)

Adrian: …if I think I am really good then I will actually try and compete more… (St38: L193-194)

One student described family expectations as positively influencing her adoption of the performance-approach goal. Another student described being influenced by competitive peers as making her performance-approach orientated.

12.3.4 Performance-Avoidance

35 (92%) of the students interviewed reported themselves as not pursuing any type of performance-avoidance goal during their science lessons. The remaining three students (8%) reported that they sometimes adopted a performance-avoidance goal during their science lessons. Of these respondents, two students reported that it depended on the class:

Interviewer: But you still try to answer the question? You are not really concerned about, you are aware of what they all think but that does not concern you that much? (Int5: L326-327)

Jacqui: Well not in my physics class. In my chemistry class maybe but not my physics class I don't really care what other people say because I know that I'm getting my opinion though, yeah. (St5: L329-330)

Interviewer: So do you think the personality of the class is really important? (Int6: L403)

Sally: Yeah, because if you don't comfortable in the class and if you ask a question and you think they might be judgemental. (St6: L405-406)

One student assigned the difficulty of science topics as being responsible for adopting the performance-avoidance goal.

12.3.5 Other Aspects Related to Influences upon Students' Achievement Goals in the Science Classroom

Students' also made comments regarding the influence of the teacher upon their motivation in the science classroom. Most of these comments related to the emotive relations between the teacher and students. Typical statements included:

Sarah: Well I think it's both parties. I think the teacher has some like thing to do with the motivation of the students like you know being encouraging because if the teacher isn't encouraging to the student and the student's not going to want to try… (St9: L178-180)

Veronica: Basically what student X said like if you don't get along with the teacher you are not going to try because they don't like you and you don't like them so you don't want to please them and you don't want any problems sort of thing. (St10: L183-185)

Interviewer: So if you think the teacher genuinely trying to help you and is interested in you, the student will respond to that? (Int10: L187-188)

Veronica: Yeah, definitely more motivation for sure. (St10: L190)

Ray: Oh yeah, different teachers approach the ways of learning in different ways basically and some teachers would suit me more or some teachers won't… (St 12: L290-291)

Mandy: I reckon it also depends on the teacher because and the way they deliver the information cause when I am with um a discussion teacher like we enjoy a lot more than a lecturer. (St31: L396-397)

Another theme pursued in the interviews related to the influence of student interaction in the science classroom upon students' motivation. Most students described the interaction with their peers in the science classroom as being a motivating experience:

Tom: I much prefer group work …it is better in a group I suppose because it gets a bit boring just listening to the teacher all the time. (St11: L65-67)

Interviewer: Right, so these tasks, you think are a bit more interactive? (Int11: L69)

Tom: Yeah, the thing about working in a group you've got more people to work off and if you can't find out the answer you just ask somebody else for help yeah just sources of. (St11: L72-73)

Kate: Yeah, lots of people prefer practical work because its hands on and you can interact with one another. (St 13: L294-295)

Interviewer: What about the activities and tasks that the teacher sets in the classroom; do they influence the motivation of students? (Int16: L197-198)

Christopher: Group work we all sort of our minds are all together and… (St16: L202)

Jacob: Everyone takes part basically which is good for the students. (St 15: L204)

However, some students mentioned that activities such as group work may be counterproductive:

Alexis: …when we are doing group work and we are doing it with other students and if they are not really doing the work then we just talk about something else. (St29: L193-194)

Roger: Yeah, um what I find is sort of different to er Student Y. um I don't like being in a group as much…because you've got to rely a bit on them…that people don't pull their weight… (St33: L254-258)

Another social dimension that impacted upon some students' motivation was their perception of the character of the class. Typical statements included:

Gillian: Yes, like I said…one of the motivation things is to challenge people and if you are in a class of really smart people you tend to keep up with them… (St17: L326-327)

Jim: I think the class, yeah I kind agree ah that yes the people around you tend to influence what you do … (St18: L333-334)

Kate: We are open for class discussion right cause we are all pretty good close friends we not as worried of asking the question. (St13: L308-309)

12.4 DISCUSSION

Gathering students' perspectives about achievement goals in the context of high school science classrooms complimented the quantitative approaches adopted for Studies 2 (Chapter 7) and 3 (Chapters 8 to 11). The interviews provided a focal point for students to share their views with respect to the influences upon their achievement goals in their science classroom. There were three areas investigated in the qualitative analysis. The first was concerned with students' identification and perceived frequency of the occurrence of achievement goals. The second related to students' reasons for pursuing achievement goals. The third area investigated students' comments about adjunct issues that influenced their motivation in the science classroom. These areas are discussed with reference to achievement goal theory and the empirical-based quantitative findings involving the parent sample of students at the trait and state levels obtained in Studies 2 and 3.

With regards to the frequency of achievement goals in the science classroom, students identified more with both approach goals (mastery-approach and performance-approach) and had difficulty identifying with the avoidance goals (mastery-avoidance and performance-avoidance). While all 38 students interviewed had affinity with mastery-approach and performance-approach goals, the latter in varying degrees, just 14 (37%) of students identified with mastery-avoidance and 3 (8%) could identify with behaviour appropriate to performance-avoidance. There could be several reasons for this. The first matter concerns the validity of the interview questions posed to students. In regards to this, the interview questions used in prompting students to discuss their avoidance achievement goals may have not been representative of the range of behaviours appropriate for avoidance goals and students may have been unable to relate to the intent of the questions affiliated with avoidance goals. Unlike questionnaires, which have 4 to 6 indicator items that reflect the behaviour associated with a particular avoidance construct, the interview questions were confined to single statements such as "Are there times in your science classroom when you do not bother trying to get involved because you know you are not going to understand or master the task or does this happen all the time?" (mastery-avoidance) and "Are there times in your science classroom when you don't bother trying to get involved because you know you are going to be compared to the other students or does this happen all the time?" (performance-avoidance). This could partly explain why many of the students interviewed could not provide any answers to questions about the avoidance goals they adopt in the science classroom. The avoidance goals were also the least reliable of the constructs identified in Studies 2 and 3 thus lending some support for this hypothesis. Second, students may find it difficult relating to avoidance behaviour at a trait-level of analysis, which was the context of the interview questions and ensuing discussion. Perhaps approach goals are more readily identifiable at trait levels than the avoidance goals. In addition, approach goals may have perpetual-like properties whereas avoidance goals are reactive in nature, occurring much less frequently in contrast to the omnipresent approach goals, at least for the students interviewed. As such mastery-avoidance and performance-avoidance goals are not consciously pursued by students; they are not drivers of students' behaviour in or out of the classroom unlike approach goals which may be construed as fundamental motives of students' behaviour in the classroom. A third possibility could be attributed to the nature of the students interviewed. The interviews were conducted with students that had volunteered from their class and these students may have been more adaptive and efficacious than the normal student of the classrooms examined and therefore did not readily identify with avoidance goals. This view has relevance with regards to the generisibility of the interview findings. One way to investigate this aspect is to ask questions that are directly related to the indicator items of the construct investigated (e.g., Urdan & Mestas, 2006) and to interview a range of class members with respect to ability levels. However, one limitation of the present interview research is that the researcher was confined to interviewing students from classes that had taken part in the quantitative studies (Studies 2 and 3). A possible fourth reason is that students did not want to share their avoidance behaviour in the context of a researcher-student interview format. Students were interviewed in pairs due to child protection legislation and talking about their motivation in front of a fellow peer could have dissuaded them from sharing their avoidance behaviour. Finally, the students' interpretation of the language used by the interviewer could have been inappropriate in regards to fostering a valid discussion about their achievement goals.

It is interesting that only three of the students interviewed acknowledged they employed performance-avoidance goals whereas considerably more students identified with mastery-avoidance. That students relate more with avoidance goals that are intrinsically situated and affiliated with cognitive achievement as against those that are externally focused and related to normative-based achievement may well be attributed to the type of valence valued by students. That is, the result demonstrates the manifestation of an intrinsic type of valence with students' classroom motivation and its consequences underpinned by an innate cognitive need to understand in contrast to the intermittent need to out perform peers and thus students find it easier to identify with mastery-avoidance behaviour in comparison with performance-avoidance behaviour. After all, the students interviewed purported to have adopted mastery-approach goals constantly during their learning of science. It therefore seems plausible that these students would more likely relate to their mastery-avoidance goals such as giving up when learning is difficult rather than performance-avoidance goals such as giving up due to concerns about what others may think about their lack of ability. Alternatively, the language used throughout the interview may have been more appropriate for prompting students to report about mastery-avoidance than performance-avoidance. For example, the question, "…when you know you are going to be compared to the other students" may have been interpreted by students as meaning that the teacher or another adult will be judging students' ability or competence in preference to meaning students comparing their own ability with that of other students. In other words, the intent of the interview questions for avoidance goals may have been misinterpreted by students.

The second focus of discussion concerns students' reasons for their achievement goal orientations. The rationale that evolved from the interview data in regards to students' adoption of achievement goals supported the hierarchical theory of achievement goals (Elliot & Church, 1997; Elliot & Harackiewicz, 1996). From the interviews it was clear that the need to achieve was of paramount importance for the attainment of both mastery-approach and performance-approach goals. According to the hierarchical theory of achievement goals, mastery-approach is predicated on the need to achieve relevant to internal standards of cognitive accomplishment (Elliot, 1999). In the interviews, all four categories of reasons for mastery-approach related to this need to achieve albeit in differing forms: the need to accomplish in exams, the need to gain knowledge, and a need to understand for career or future purposes. The fourth category of interest and enjoyment also relates to hierarchical theory by representing an intrinsic type of valence in that the individual seeks satisfaction and or enjoyment with learning. This interview result substantiated the positive relations found for mastery-approach and intrinsic value throughout the present research (Studies 1 and 2).

The interview results also lay claim to the positive relations between mastery-approach and performance-approach achievement goals thus supplementing the quantitative findings of Studies 2 and 3 for the relationships between these two achievement goals. When asked about what motivates them to try and understand in their science classrooms, many of the students interviewed voiced the need to understand for assessment purposes as the reason for adopting a mastery-approach goal. However, this result could be interpreted in two ways, depending upon the type of valence that has primacy for the student. First, students may use assessments as the impetus for the development of their understanding if the valence associated with this motivational goal is intrinsic. In this case, a student is personally satisfied if they have attained a personally set standard such as improvement over the previous exam result or the attainment of an “A” grade result. Alternatively, students may develop their understanding so as to use the achievement in assessments to gain recognition and demonstrate their ability over others; such motivation has an extrinsic-based valence and may be associated with a performance-approach goal. Despite which ever valence is associated with the motivation to understand, these results lend some credence to the adaptiveness of students when faced with performance-based issues such as assessments. Although there have been suggestions that students who focus on performing in exams may adopt superficial approaches to learning (Harackiewicz et al., 2002; Midgley et al., 2001), the evidence from the interviews presented here and the quantitative results of Studies 2 and 3 refutes this. Rather, it seems that assessment is treated by students as a salient motivating force for the development of their understanding in the science classroom. This assumes that students' interpretation of “…try and fully understand…” in the context of the interview question is a valid one, with students employing self-regulated learning (cognitive and metacognitive processes) when trying to “fully understand”. Students' perceptions about what they mean by “try and fully understand” is important, for the type of cognitive and metacognitive strategies they employ to understand is the basis for differentiating mastery-approach from performance-approach achievement goals. A performance-approach goal supposedly fosters “effort-minimizing strategies” (Meece & Holt, 1993), the use of shallow processing and simple cognitive strategies since it is associated with the need to perform and is not concerned with understanding deeply (Dweck, 1996; Elliot, 1999; Elliott & Dweck, 1988; Graham & Golan, 1991). However, in the present research there were positive relations between performance-approach goals and regulatory strategy use at the context level. Hence these results support the contentions that the performance-approach goal may have some adaptive qualities with it (Harackiewicz et al., 2002; McGregor & Elliot, 2002).

Further proof of the positive relations between mastery-approach and performance-approach goals was found in students' responses to questions about pursuing performance-approach goals in the science classroom. The most common reason given was aligned with mastery-approach orientations, reasons that are intrinsically-based such as for personal satisfaction and personal achievement. It seems that students take pride in their assessment accomplishments with some students explicitly pointing out that they were not focussed on demonstrating their ability to others or outperforming fellow students but rather they were concerned with achievements that had an intrinsic type of valence. The other reasons given for performance-approach goals also supported the hierarchical theory view of performance-approach in that this achievement goal is underpinned by both the need to achieve and the fear of failure (Elliot, 1999). However, the results from this study show that students are heavily weighted towards reporting the need to achieve with an intrinsic type of valence. For example, the two most popular categories of reasons for performance-approach in science classrooms were personal satisfaction and exam performance, accounting for 85% of the relevant interview statements. A small number of other reasons for pursuing performance-approach goals were provided by students that complement those found by Urdan and Mestas (2006), who found that students offer a variety of reasons for pursuing performance-approach goals when interviewed about this type of achievement goal.

There is no known research on students' views about mastery-avoidance goals thus the mastery-avoidance interview results were of high interest. Although only 37% of students interviewed acknowledged this form of goal, the interview results supported the theory that this type of achievement goal is associated with a fear of underachieving personally-based standards of accomplishment (Elliot & McGregor, 2001; Pintrich, 2000a). The main reason given in the interviews for mastery-avoidance was concern that the topic was too difficult to understand. There was no distinction between selective students and regular students in regards to adopting a mastery-avoidance orientation thus not supporting the theory that high-achieving students would exhibit this form of avoidance goal (Elliot, 1999; Elliot & McGregor, 2001). One potential problem with interviewing students about mastery-avoidance was the validity issue of students confusing mastery-avoidance with work avoidance and performance-avoidance.

Surprisingly, only three students reported they felt they used performance-avoidance goals in their science lessons. The reasons for performance-avoidance, according to two of these students, were in concordance with performance-avoidance theory (Church et al., 2001; Elliot & Church, 1997; Middleton & Midgley, 1997; Wolters, 2004). These students avoided asking questions or getting involved in some activities since they felt the class was judgemental with respect to their ability level. That the questions asked about performance-avoidance occurred towards the end of the interview may have contributed towards the lack of response from students about this goal. At this stage, students could have been mentally lost after being quizzed about the other three achievement goals. Perhaps future studies involving interviews on achievement goals should focus on students' views about only one or two achievement goals.

The interviews also highlighted the importance of fostering a classroom in which students can discuss their science learning. In the interviews students raised the importance of student interaction as beneficial towards their involvement in science lessons and were negative about teachers that "lecture" or make the topic "uninteresting". This compliments the quantitative findings from Studies 1 and 2 in which the constructivist pedagogical dimension of student negotiation was found to have positive associations with mastery-approaches to learning science. The concept of student negotiation has ties with classroom properties such as class cohesiveness and teacher pedagogical beliefs and deserves more focus in studies on classroom learning environments. Finally, students also mentioned the importance of empathy from the teacher as having a role in motivating students to learn, a result that other qualitative research on achievement goals in classrooms has observed (Turner et al., 2003).

12.5 LIMITATIONS

The interviews associated with the present research had several limitations that need to be highlighted. The semi-structured interview format used in the present research has several advantages over informal and situational-based interviews. By having students answer the same type of focus questions on achievement goals reduces the impact of interviewer bias. It also enables each interview to cover all areas of interest thus generating a multitude of responses (Patton, 1990). However, there is an inherent limitation with this format in that the interview focus questions and the follow up questions during the interview were anticipated by the researcher as being able to incite students to talk about their achievement goals and thus provide valid comments. Furthermore, it was assumed that students were congruent with the language used by the interviewer when discussing the factors relating to achievement goals. These limitations may have been evident with regards to students' interpretation of the questions about the performance-avoidance goal, for which only three students acknowledged. Yet the performance-avoidance goal was construct-validated in the quantitative studies associated with the parent sample and viable relations were obtained for performance-avoidance with other constructs. Thus, future interviews with students about the performance-avoidance goal should attempt to ascertain the identification and utilisation properties of this achievement goal. That is, is this goal cognisant with students so that they can discuss its relations with other constructs? Is the use of performance-avoidance reactive or perpetual-like in the science classroom?

Another limitation of the interviews conducted here concerns the type of students and classes that were used in the interviews. Firstly, the classrooms that were studied in the context level analyses (Studies 2 and 3) may have represented a narrow range of ability. In order to coerce involvement from schools for the study and with the intention of obtaining a range of schools and classrooms, one or two junior and senior classes were invited to take part from each school. This procedure may have resulted in schools selecting classes for the study that were well-behaved and containing high calibre students. As such the interview sample may have consisted of students that were efficacious and well adjusted to studying science. Hence the interview data may have been biased towards high calibre science students. This may have been exacerbated when considering that students presented to the interviews on a voluntarily basis; these students may have been more efficacious than those that did not volunteer. These aspects consequently have implications for the generalisation of the findings.

Interviewing students in pairs may have affected the students' interpretation of the interview context and therefore the responses to the questions. For example, students may have been reluctant to talk about avoidance goals in front of the other student. Finally, the categorisation of the interview data resulted from one researcher's interpretation of the students' responses. This procedure may have introduced some researcher bias into the analysis.

12.6 SUMMARY

The Study 3 qualitative analyses complimented the quantitative trait-based (Study 2, Chapter 7) and context-level analyses (Study 3, Chapters 8 to 11) that were applied to the sample of high school science students. The students interviewed readily identified with the achievement goals of mastery-approach, performance-approach but had difficulty in identifying and describing the factors that were associated with the mastery-avoidance and performance-avoidance goals. Support was found in the interviews for Elliot's (1999) hierarchical theory of achievement goals with students describing the need to achieve in terms of an intrinsic form of valence as being the major inducer of their mastery-approach and performance-approach goals. As hypothesised by the 2 x 2 theory of achievement goals (Elliot & McGregor, 2001; Pintrich, 2000a) students' reasons for mastery-avoidance were attributed to circumstances that were perceived by the students as being too difficult for them to understand or failing to keep abreast of the work. Finally, the roles of environmental factors such as the facilitation of classroom student negotiation and teacher empathy with students were also salient for the students with regards to influencing their achievement goal orientations.

Chapter 13

CONCLUSIONS AND IMPLICATIONS

13.1 OVERVIEW OF THE RESEARCH

The present research generated an array of perspectives in investigating the interaction of achievement goals, self-regulated learning and learning environments in high school science classrooms. Three studies comprised the present research and each of these studies found evidence for the proposal that the constructs from each of these fields interact with each other in an interdisciplinary manner to influence the learning of science in high school classrooms. A variety of social- and personal-based constructs served as the foci in this research which made a distinction between trait-level and context-level approaches to analysing the relations of important constructs associated with the fields of achievement goals, self-regulated learning and learning environments. At the trait-level, the social constructs under focus were associated with constructivist-based learning environments (personal relevance, student negotiation, critical voice, uncertainty, shared control), classroom achievement goal structures (mastery, performance-approach, performance-avoidance) and self-regulated learning (classroom metacognitive structure). The personal-based constructs of interest at the trait-level were associated with motivational beliefs (intrinsic value, self-efficacy, test anxiety), achievement goals (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance), and self-regulated learning (cognitive strategy use, regulatory strategy use). Except for mastery-avoidance, each of these constructs was derived from questionnaires that had been used and validated in many studies from the fields of educational psychology (Achievement Goals Questionnaire, Motivated Strategies for Learning Questionnaire) and science education (Constructivist Learning Environment Survey). Studies 1 (Chapter 6) and 2 (Chapter 7) of the present research used a combination of statistical procedures in order to establish the construct validity of these instruments. Exploratory factor analysis was used to generate the factorial structure of these questionnaires which was then tested using confirmatory factor analysis. The results from these analyses in general supported the a priori factorial structure of each questionnaire thus vindicating the relations between most of the relevant indicator items and their latent constructs. These findings demonstrated the existence of the foci constructs in high school science classrooms at a trait-level.

The context-level analyses investigated the relations for personal-based constructs associated with motivational beliefs (task efficacy, perceived ability), achievement goals (mastery-approach, mastery-avoidance, performance-approach, performance-avoidance) and self-regulated learning (regulatory strategy use, maladaptive strategy use). Two questionnaires were developed and used to measure the relations between these constructs, which were hypothesised to reflect the cognitive attributes of students in the specific micro-learning environments of teacher-led discussion (Study 3A, Chapter 9) and group work (Study 3B, Chapter 10); these learning environment contexts typifying the type of micro-learning environments in science classrooms, especially those associated with constructivist-based pedagogy. As for the trait-level analyses, the construct validity of these measures was determined by the use of exploratory factor analysis and confirmatory factor analysis; these analyses supported the hypothesised existence of the constructs for the contexts of teacher-led discussion and group work. A sample of 38 students from the Study 3 sample were interviewed about their achievement goals and associated classroom factors, the purpose of these interviews was to examine achievement goals in high school science classrooms from a qualitative stance. This qualitative analysis (Chapter 12) served to complement the Study 3 quantitative analyses, by garnering students' views towards achievement goals and classroom learning environment events.

The specific limitations of the studies conducted for the present research are presented in the chapters associated with each study.

13.2 MAJOR FINDINGS OF THE RESEARCH

The focus now turns to the major findings for each of the research questions that underpinned the present research.

13.2.1 Construct Validity of the 2 X 2 Achievement Goals Framework

One research question was associated with testing the empirical stature of a 2 X 2 achievement goals framework by which achievement goals research may be conducted:

> Research Question One: Is there empirical support for a 2 X 2 achievement goal framework in high school science settings?

The results of the construct validity measures generated across the Studies 1, 2 and 3 found support for the existence of the hypothesised 2 X 2 achievement goals framework (Elliot, 1999; Elliot & McGregor, 2001; Pintrich, 2000a) although the performance-avoidance goal construct measured in the trait-level studies (Studies 1 and 2) may have reflected concern tendencies rather than avoidance behaviour. That is, there was evidence from the present research for the existence of mastery-avoidance in addition to the other three traditional achievement goals of mastery-approach, performance-approach and performance-avoidance for high school science students. Thus, the hypothesised existence of internal and external valences for both approach and avoidance goals in the classroom was upheld. However, the avoidance goals of mastery-avoidance and performance-avoidance attained the lowest reliability estimates thereby indicating that students found it difficult to identify with the indicator items for these achievement goals. Future research should address improving the validity of indicator items and the reliability of the composite scales associated with each of these constructs. Interviewing students about their achievement goals in the science classroom also found support for the mastery-avoidance goal and revealed the avoidance goals to be more difficult for students to characterise in comparison with the approach goals. In addition, while the performance-avoidance goal has been verified in prior research (Elliot, 1999; Elliot & Church, 1997; Elliot & Harackiewicz, 1996), students when interviewed identified more with mastery-avoidance than performance-avoidance. This may have resulted from the dispositional tendencies of the students that volunteered to be interviewed in Study 3 being biased towards mastery approaches in their science classrooms. It would be of great benefit with respect to achievement goal research to obtain students' voices on avoidance goals from a range of student abilities. Overall the results of the quantitative and qualitative investigations suggest that for high school science students approach goals are more manifest than avoidance goals and that the approach goals have perpetual-like properties whereas avoidance goals are reactive in nature, depending upon localised, spasmodic classroom situations that involve fluctuating perceptions of efficacy and ability on behalf of a student. The results from the studies that form the present research were gathered from students that had been members of their classroom for over two school terms and it was expected by that time the students' normative status in the class would have been established. Consequently, students' would have developed the character of their approach goals with respect to their science classroom by this time. However, students' avoidance goals perhaps are more volatile, depending upon perceptions of competence in certain circumstances. Developmental research that uses longitudinal methods in tracking students and their approach and avoidance goals over several years could confirm these suggestions.

13.2.2 Construct Validity of a Context Hypothesis

One research question was associated with testing the empirical stature of a context hypothesis by which achievement goals and self-regulated learning research may be conducted:

> Research Question Two: Is there empirical support for a "context" hypothesis in high school science settings?

The research findings also endorsed the tenets of a "context" hypothesis in several ways. First, constructs pertaining to achievement goals, competence perceptions and self-regulated learning were validated in a variety of micro-learning events or contexts. Second, the interdependent relations between these constructs were found to corroborate with extant theories of achievement goals, self-efficacy and self-regulated learning. The proposal that the calibration-associated issues with students' reporting of constructs in contexts will be improved as compared with trait-level reports was not able to be examined in the current research. The results from the Study 3 analyses, however, when juxtaposed with the trait-level analyses provided a more complete picture of the relations between achievement goals, competence perceptions and self-regulated learning in high school science classrooms. The findings of the trait-level and context-level analyses are integrated in the following discussions concerning the relations between these cognitive constructs. In so doing, the present research offers substantial support for adopting context approaches to studying achievement goals and their relations. (Barron & Harackiewicz, 2001; Harackiewicz & Sansone, 1991; Linnenbrink, 2002; Pintrich & De Groot, 1990; Senko, 2002).

13.2.3 Associations between Environmental/Social and Personal Constructs

The focus of the discussion now centres on the findings for the research questions that underpinned the study of the relations between the social and personal constructs under consideration in the present research. Two research questions addressed these relations:

> Research Question Three: What associations exist between high school science students' perceptions of their learning environment characteristics, students' personal achievement goals, motivational beliefs, and their self-regulated learning at the trait-level?

> Research Question Four: What associations exist between high school science students' competence perceptions, achievement goals, self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Two statistical forms of analyses were used to ascertain the relations amongst the constructs that were validated from the questionnaires used in the trait-level and context-level studies: multilevel multiple regression and structural equation modelling (SEM). The multilevel multiple regression analyses determined the impact of variance attributed to personal-level and classroom-level units upon the classroom learning environment variables, and those associated with motivational beliefs, achievement goals and self-regulated learning (SRL). They also accommodated an evaluation of multiple goal models (mastery-approach X mastery-avoidance, performance-approach X performance-avoidance, mastery-approach X performance-approach, mastery-avoidance X performance-avoidance) and measured the impact of various subpopulation variables (gender, student type, age) upon achievement goals and SRL. Of particular interest was the influence of student type (regular or selective high school students) upon the environmental and personal variables. This technique found for all the large-scale quantitative studies conducted by the present research that the bulk of variance for all constructs was attributed to the personal-level with large amounts of intra-class variation for students' perception of their classroom learning environment variables and, as expected, their personal-based variables. These results therefore justified a single-level SEM model approach in examining the simultaneous interdependent relations amongst the variables. All the large-scale quantitative studies presented a structural equation model that was applicable to the general high school student, controlling for the variance associated with gender, age and student type (regular or selective high school student). The discussion presented below, therefore, focuses in the main on the results obtained from the SEM analyses since these provided a more realistic picture of the relations between the variable and was the more rigorous statistical procedure in comparison with the multilevel multiple regression analyses.

13.2.3.a Social/Environmental Influences of Motivational Beliefs, Achievement Goals and Self-Regulated Learning

One of the contentions of the present research is that social constructivist pedagogy has the potential to foster adaptive learning environments that resonate with those recommended by achievement goals and self-regulated learning research (e.g., Blumenfeld, 1992). This view is complemented by the suggestions of intentional conceptual change scholars that intentional conceptual change can be facilitated or assisted via a pedagogy based upon social constructivist principles (Andre & Windschitl, 2003; Hatano & Inagaki, 2003; Vosniadou, 2003). Consequently, the constructivist-based pedagogical features of high school science classrooms served as the primary focus in relation to the learning environment characteristics examined in the present research. The constructivist pedagogical dimensions assessed were based on the elements associated with critical constructivism as measured by the Constructivist Learning Environment Survey (Aldridge et al., 2000; Taylor & Fraser, 1991; Taylor et al., 1997): personal relevance, student negotiation, uncertainty, critical voice, and shared control. It was proposed that there is a degree of convergence between the aspirations of research associated with these classroom-level dimensions and those espoused by the TARGET research paradigm of achievement goals (Ames, 1992; Church et al., 2001; Greene et al., 2004; Maehr & Anderman, 1993; Midgley, 1993). The other learning environment features of interest were affiliated with the social dimensions of achievement goals research – the classroom achievement goal structures (mastery-approach, performance-approach, performance-avoidance) - and self-regulated learning (classroom metacognitive structure). By examining constructivist pedagogical dimensions, achievement goals and self-regulated learning from an interdisciplinary perspective, the present research contributed to the respective fields of these constructs.

Of particular interest was the seminal research conducted by Studies 1 and 2 that investigated the relations between the constructivist pedagogical dimensions with achievement goals and motivational beliefs. There was support for the hypothesis that constructivist-based pedagogy has associations with adaptive student motivational profiles. The results of the two large-scale trait-level studies, Studies 1 and 2, consistently showed the constructivist pedagogical dimensions of personal relevance and student negotiation to be positive predictors of mastery-approach and intrinsic value although in Study 2 personal relevance did not have direct statistically significant relations with mastery-approach. Synopses of the significant relations attained for these constructs in the structural equation model analyses conducted throughout the studies are presented in Table 13.1. These results imply that teachers who foster a science classroom learning environment that has an emphasis on relating science to what students experience in their day-to-day experiences in conjunction with providing opportunities for students to discuss their ideas about what they learn will facilitate mastery-approach and intrinsic value in students. However, treating the constructivist pedagogical dimensions of personal relevance and student negotiation as predictors implies causality which is invalid when considering that Studies 1 and 2 were correlational in nature. For example, we do not know if these findings are a result of the dispositional character of students. After all, there was no significant variance amongst the constructivist pedagogical dimensions attributed to the classroom level, with most of the variance of these constructs occurring within the classes. Students that were inclined to value science and have high mastery-approach goal orientations may perceive their classroom as being personally relevant and may induce their negotiation of understanding rather than depending upon the implementation of certain pedagogical structures by the teacher.

These issues could be addressed by experimental or intervention studies that examine the impact of constructivist-based science teaching upon students' achievement goals and use of self-regulated learning. Although one such study was conducted by the author as part of his doctoral research, space restrictions preclude the reporting of this small scale study in this thesis.

One aspect of students' approaches to learning science that should also be considered is students' epistemological inclinations towards constructivist approaches to the learning of science (in contrast to empiricist views). There is evidence that the epistemological features of students influence their views of the science classroom with students' scientific epistemological views proposed as influential cognitive constructs towards students' learning of science (Tsai, 1998, 1999, 2003; Wallace et al., 2003; Windschitl, & Andre, 1998). Perhaps these epistemological views were responsible for some of the unaccounted variance found in the large-scale quantitative research (Studies 1 and 2), particularly with achievement goals. One limitation of the present research was it did not address the scientific epistemological inclinations of students.

Prior research involving constructivist pedagogical dimensions has found students prefer learning environments that foster student social negotiations (Hand et al., 1997; Kim et al., 1999; Kinchin, 2004; Tsai, 2000, 2003). With respect to the limitations of the present research outlined above, the findings from the present research support this work. The present research, however, extended these findings by demonstrating the links between constructivist pedagogical dimensions with achievement goals. Despite the correlational nature of the present research, the findings obtained in the present research show the importance of the two constructivist pedagogical dimensions of personal relevance and student negotiation for the adoption of mastery-approach goals and facilitating intrinsic value in science students. The reciprocality of the relations between these constructs implies that

Table 13.1

Synopsis of Significant Environmental Predictors of Personal Constructs for High School Science Students obtained in the Trait-Level Analyses of Study 1 and Study 2 using Structural Equation Modelling Analyses

	mastery-approach	mastery-avoidance	performance-approach	performance-avoidance	intrinsic value	self-efficacy	test anxiety	cognitive strategy use	regulatory strategy use
Study 1	perrel (+) studneg (+)	-	clmast (-)	uncert (+)	perrel (+) clmast (+)	-	-	-	studneg (+) clmast (-) clmeta (+)
Study 2	studneg (+)	-	-	-	perrel (+) studneg (+)	-	-	sharec (+)	studneg (+)

Note. (+) = positive relationship; (-) = negative relationship. The predictor variables are symbolised as: personal relevance (perrel); uncertainty (uncert); student negotiation (studneg); shared control (sharec); mastery goal structure (clmast); metacognitive structure (clmeta). All relationships are significant at a minimum of $p < .05$.

science teachers will take a step towards procuring mastery-approach goals and intrinsic value in their students if they place an emphasis on personal relevance and the student negotiation of learning in their science classroom. However, more research is warranted with regards to the impact a teacher may have in fostering personal relevance and student negotiation in high school science classrooms. The approach adopted in the present research towards investigating the role of the constructivist pedagogical dimensions on the personal constructs of interest was of an informal curriculum type in contrast to formal curriculum types in which teachers purposely set out to emphasise certain pedagogical dimensions of their classroom (Dorman et al., 2002). How teachers can effectively increase the personal relevance their students perceive of science and generate positive student negotiation in the classroom is a question still to be answered. Some research has found teachers to perceive the constructs of personal relevance and student negotiation to be "core beliefs" as against "peripheral beliefs" in the implementation of constructivist-based teaching practice (Haney & McArthur, 2002) thus vindicating the findings presented here. Others suggest that the role of a teacher's affective domain (Brophy, 1999) and the type and quantity of supportive discourse provided by the teacher (Turner et al., 2003) to be influential in fostering classrooms that facilitate greater intrinsic meaning and value to students.

It is pertinent to note that the results obtained in Study 1 controlled for the presence of classroom achievement goal structures. Contrary to that hypothesised these social constructs had no influence upon achievement goals except the mastery goal structure, which had negative relations with performance-approach, as hypothesised. It was puzzling as to why the constructivist pedagogical dimension of uncertainty was a positive predictor of performance-avoidance in Study 1. The uncertainty dimension related to philosophical-type statements about the nature of science and had no basis for any form of relationship with the performance-associated achievement goals. This result did not occur in Study 2.

The importance of the adaptive features of personal relevance and student negotiation was further demonstrated in Studies 1 and 2 by way of their relations with intrinsic value and regulatory strategy use. Intrinsic value was positively predicted by personal relevance in Studies 1 and 2, positively predicted by student negotiation in Study 2, and positively predicted by the mastery goal structure in Study 1. These findings support the contention that students who perceive their teacher as stressing understanding in the classroom, promoting an atmosphere of discussion in the classroom and making the topics important and of relevance to students will foster students' value for the subject. There was no evidence that teachers who stress normative-based, performance-related aspects of the classroom had negative or positive impacts upon students' motivation, whether it is mastery or performance in nature. What these results indicate is that superficial approaches to teaching will not promote students' value for the subject.

As hypothesised, student negotiation was found to have direct positive relations to regulatory strategy use in Studies 1 and 2. Study 1 also obtained positive associations for regulatory strategy use by the classroom metacognitive structure and negative associations by the mastery goal structure. Although the classroom metacognitive structure was expected to have positive associations with regulatory strategy use, the mastery goal structure was also expected to promote regulatory strategy use. These relations for regulatory strategy use may not have necessarily be due to the impact of the classroom learning environment constructs since most of the regulatory strategy use indicator items referred to students' behaviour outside the classroom ("I ask myself questions to make sure I know the material I have been studying") and therefore having external referents rather than internal classroom referents. It may have been invalid to measure environmental constructs with personal constructs that represent behaviour occurring in a different environmental situation. This limitation of the Motivated Strategies for Learning Questionnaire was addressed in Study 3; in which students' self-regulated learning was studied at the context level using indicator items that specifically reflected students' regulatory strategy use and maladaptive strategy use in certain learning contexts within the science classroom. The reciprocal nature of these studies suggests, therefore, that students who report themselves as using a large amount of regulatory strategies outside the classroom perceive their classroom having more opportunities for student negotiation and a greater emphasis from the teacher on the use of metacognitive strategies than students who report their self as using smaller amounts of regulatory strategy use.

However, the use of regulatory strategies outside the classroom may have also been an indirect measure of the amount of regulatory strategy use within the classroom, with positive correlations between the two. This view makes the results obtained more tangible.

13.2.3.b Motivational Beliefs as Predictors of Achievement Goals and Self-Regulated Learning

The next focus of discussion concerns the results found for the interactions of the personal variables with each other. There was support for positioning the motivational beliefs as predictors of achievement goals and SRL. Synopses of the significant relations attained for these constructs in the structural equation model analyses conducted throughout the studies are presented in Table 13.2. As hypothesised, intrinsic value positively predicted mastery-approach in Studies 1 and 2. Although the relations between intrinsic value and mastery-approach were highly significant (Study 1: $\beta = 0.578$, $p < .001$; Study 2: $\beta = 0.501$, $p < .001$) the multiple regressions found no multicollinearity evident. Such relations imply that students who value the subject will tend to adopt mastery-approaches to learning it. The only significant relations between intrinsic value with SRL was found in Study 2 for which intrinsic value positively predict regulatory strategy use. This is to be expected since students who value what they are learning would invest in the application of higher deep order thinking strategies inside and outside their classroom (Meece et al., 1988; Pintrich & De Groot, 1990; Wolters et al., 1996). Interestingly, in Study 2 intrinsic value was a negative predictor of cognitive strategies, the lower order SRL strategy although this result may have been offset by the large amount of covariance between the two self-regulated learning variables, cognitive strategy use and regulatory strategy use. The positioning of regulatory strategy use as a positive predictor of cognitive strategy use ($\beta = 0.861$, $p < .001$) may have affected the amount of variance available for cognitive strategy use with variables such as intrinsic value which also had significant covariance with regulatory strategy use. In light of these statistical limitations, intrinsic value was found to be an important indicator of adaptive motivational and self-regulated learning in high school science students.

Of the motivational belief antecedents of achievement goals used in the present research the one having the most extensive impact was self-efficacy. Studies 1, 2 and 3 were replete with relations between self-efficacy and the achievement goals although in Study 3, the context analyses, self-efficacy was specifically referred to as task efficacy. Countering that hypothesised, students did not distinguish between the competence perceptions of self-efficacy and perceived ability in Studies 1 and 2; the associated MSLQ indicator items of these proposed constructs combining to represent an overall trait-based perception of self-efficacy. However, students were able to distinguish these competence perceptions when they were contextualised into task efficacy and perceived ability in Study 3. Self-efficacy was a positive predictor of all achievement goals in Studies 1 and 2 except for mastery-approach in Study 1.

That self-efficacy had positive relations with mastery-approach and performance-approach was expected and supports prior research (Kaplan & Maehr, 1999; Kaplan & Midgley, 1999; Middleton et al., 2004; Middleton, & Midgley, 1997; Patrick et al., 1999; Roeser et al., 1996; Skaalvik, 1997; Turner et al., 1998; Urdan et al., 1997; Valle et al., 2003). The context-level results also demonstrated the importance of efficacy on the approach achievement goals by revealing that in both learning contexts investigated efficacy was a positive predictor of mastery-approach and performance-approach. According to the hierarchical model of achievement goals, competence perceptions are important antecedents of achievement goals, the other main variable being motive dispositions such as fear of failure (Elliot, 1999; Elliot & Church, 1997; Elliot & Harackiewicz, 1996; Elliot & McGregor, 2001). Accordingly, students with high academic self-efficacy perceptions would endeavour to persist with a task since they believe they have the capability to master it, leading to the adoption of a mastery-approach goal orientation. Furthermore, students develop greater efficacy as they achieve mastery of the task thus resulting in the interactions between efficacy and mastery-approach being volitional in nature (Schunk, 1990, 1996; Schunk & Ertmer, 1999). Students with perceptions of high normative ability will tend to pursue performance-approach goals since there is a high chance of demonstrating competence to external referents such as peers and teacher (Diener & Dweck, 1980; Dweck & Leggett, 1988; Elliott & Dweck, 1988).

Table 13.2

Synopsis of Significant Motivational Belief Predictors of Personal Constructs for High School Science Students obtained in the Trait-Level Analyses of Study 1 and Study 2, and the Context-Level Analyses of Study 3 using Structural Equation Modelling Analyses

	mastery-approach	mastery-avoidance	performance-approach	performance-avoidance	cognitive strategy use	regulatory strategy use	maladaptive strategy use
Study 1	intrv (+)	eff (+)	eff (+)	eff (+) testa (+)	testa (+)	eff (+) testa (-)	-
Study 2	intrv (+) eff (+)	eff (+) testa (+)	eff (+)	eff (+) testa (+)	intrv (-) testa (+)	intrv (+) eff (+)	-
Teacher-led discussion	teff (+) abil (+)	abil (-)	teff (+) abil (+)	teff (-) abil (-)	-	-	teff (-) abil (-)
Group work	teff (+)	abil (-)	teff (+) abil (+)	teff (-)	-	-	abil (-)

Note. (+) = positive relationship; (-) = negative relationship. The predictor variables are symbolised as: intrinsic value (intrv); self-efficacy (eff); test anxiety (testa); task efficacy (teff); perceived ability (abil). All relationships are significant at a minimum of $p < .05$.

The finding that self-efficacy also had positive relations with performance-avoidance in the trait-level analyses conducted in Studies 1 and 2 was contrary to that hypothesised and previous research findings (Church et al., 2001; Elliot & Church, 1997; Middleton & Midgley, 1997; Pajares et al., 2000; Skaalvik, 1997). In accounting for this result and other relations associated with performance-avoidance at the trait-level, the present research introduced a "concern" hypothesis. The performance-avoidance construct was derived from six indicator items from the achievement goals questionnaire developed for the trichotomous goal model (Elliot & Church, 1997) and reflected Elliot's (1999) hierarchical theory of achievement goals. According to this theory, the motivational rationale for the mastery-approach goal is the need to achieve, the rationale for the performance-avoidance goal being the fear of failing, and the performance-approach goal has the need for both achieving and not failing. Hence, the items tapping the performance-avoidance latent construct contained an emotive-based motivational rationale related to the "fear of failure" (e.g., "My fear of performing poorly in tests in this class is often what motivates me") rather than representing the goal to avoid situations in which a student's lack of ability may be conspicuous. Thus, the items used to represent performance-avoidance were not valid indicators of this construct. Indeed, these findings support the contentions of Midgley and her colleagues (Midgley et al., 1998; Midgley & Urdan, 2001; Middleton et al., 2004; Middleton & Midgley, 1997), who have espoused the use of items that reflect the symptomatic tendencies of achievement goals with emphasis on comparative ability concerns rather than emotive-based concerns as used by Elliot and his colleagues. In the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1997), for example, one indicator item used for performance-avoidance is stated as: "One reason I would not participate in class is to avoid looking stupid". The present research contends that the "performance-avoidance" measured reflected the tendency to be concerned about performing poorly in a classroom learning environment and that concerns or worries may also be applicable when it comes to learning accomplishments (concern about task mastery) and performance-based issues (concern about the result and ranking obtained in an exam). Concern may also qualify as an emotive-based construct itself and have precursory relations with achievement goals amongst other cognitive constructs. For example, students that are concerned about their learning, concerned about their performance and concerned about failing to perform in exams may report to have high achievement goal orientations in mastery-approach, performance-approach and performance-avoidance respectively; those who are not concerned about these matters will tend to report low achievement goal orientations. This model explains the various associations found in the present research for performance-avoidance, as discussed below.

Support for these assertions was found in the context-level analyses. Most of the items used to represent performance-avoidance in the context-level questionnaires were based upon symptomatic tendencies that were specific to the learning context; these may have been more valid measures of performance-avoidance than those used in the trait-level analyses. Consequently, the results found for the relations between task-efficacy and performance-avoidance in the context-level analyses (Study 3) were as expected with efficacy having negative relations with performance-avoidance in teacher-led discussion and group work contexts. Thus, students who perceived themselves as having low efficacy for the task reported using greater performance-avoidance in the learning context. In both learning contexts examined, task efficacy was a positive predictor of mastery-approach and performance-approach goals, as hypothesised. Students who perceive they have the capability to accomplish a task will tend to adopt mastery-approach and performance-approach goals, goals that have internal- and external-based standards of achievement respectively.

A concern hypothesis may be applied to describe the positive relations between self-efficacy and performance-avoidance at the trait-level. Students that are highly efficacious in the classroom may also have concurrent concern inclinations and this may explain why students that reported themselves as being highly efficacious also reported they had high performance-avoidance goal orientations. According to the concern hypothesis presented above, this result implies that students who are highly efficacious are also greatly concerned about their performance-based issues in the science classroom but whether this concern translates into symptomatic avoidance behaviour may be dependent upon the student’s other achievement goal orientations and their motivational beliefs - test anxiety and intrinsic value.

Self-efficacy also had positive relations with mastery-avoidance in Studies 1 and 2. These results have some credence with respect to the prevailing theory on mastery-avoidance goals which suggests that such goals are related to students that have high expectations towards their learning goals (Elliot, 1999; Elliot & McGregor, 2001; Pintrich, 2000a). According to this theory, students that have high feelings of self-efficacy would have high levels of personal learning expectations and are thus more likely to promote mastery-avoidance when they perceive themselves as not able to achieve to their high standard of internal competence. However, these results were not supported by the context-level analyses. The two learning contexts studied, teacher-led discussion and group work, found null relations between mastery-avoidance and task efficacy. It is important to note that the mastery-avoidance goal had the lowest composite scale reliability coefficient results in the context-level and trait-level analyses. Perhaps measurement difficulties contributed towards the results attained for the associations of the mastery-avoidance goal with task efficacy in the learning contexts examined.

Self-efficacy was found to be a positive predictor of regulatory strategy use in the trait-level studies (Studies 1 and 2). This finding supports previous studies that have investigated the relations between self-efficacy and self-regulated learning (Ames & Archer, 1988; Greene et al., 2004; Joo et al., 2000; Kaplan & Midgley, 1997; Neber & Schommer-Aikins, 2002; Wolters & Pintrich, 1998; Zimmerman et al., 1992; Zimmerman & Martinez-Pons, 1990). Students that believe they have the potential to accomplish a task tend to have greater resilience, believe in effort attributions for success and utilise adaptive self-regulated learning mechanisms (Pajares, 2002). Further proof of the influence of self-efficacy upon SRL came in the context-level analyses. Study 3 found task-efficacy to be a negative predictor of maladaptive strategy use for the teacher-led discussion context. Hence students who believe they are not capable at succeeding in a learning context tend to employ maladaptive strategies such as giving up, copying at the end or distracting others. Study 3 found no direct relations between task-efficacy and regulatory strategy use in the two learning contexts. Rather, it seems that achievement goals mediate the relations between students' task-efficacy and regulatory strategy use. In both contexts, when task-efficacy was positioned as a positive predictor of mastery-approach and performance-approach, the direct effects of task efficacy on regulatory strategy use as found in the multilevel multiple regressions diminished significantly. Rather, the achievement goals of mastery-approach and performance-approach positively predicted the use of regulatory strategies during the contexts. Hence these findings support the importance of achievement goals as mediators of students' perceptions of their efficacy in specified classroom contexts.

The second type of competence perception explored in the present research was perceived ability. This was only discernible in the context-level analyses (Study 3) and its hypothesised relations with achievement goals and self-regulated learning were supported. Students who perceived that they had high ability reported to use greater mastery-approach, performance-approach goals than those who were not as confident with their ability level in the class. These results were complemented with the relations discovered for perceived ability with mastery-avoidance and performance-avoidance, for which perceived ability was a negative predictor. Like task-efficacy, the direct effects of perceived ability on regulatory strategy use obtained in the regressions diminished significantly when positioned as positive predictors of mastery-approach and performance-approach. Rather, the achievement goals of mastery-approach and performance-approach positively predicted the use of regulatory strategies during the contexts of teacher-led discussion and group work, contexts which contained the most peer-referenced interaction. Hence these findings support the importance of achievement goals as mediators of students' perceptions of their efficacy and ability in specified classroom contexts; a result that may parallel that found at the trait level. The results gathered from the context-level studies confirmed the importance of the competence perceptions in determining students' adaptive and non-adaptive learning behaviours in the high school science classroom.

Test anxiety was the third type of motivational belief studied at the trait-level (Studies 1 and 2). As expected, students that reported they had high levels of emotional distress and anxiety when it came to doing exams also had greater orientations with respect to mastery-avoidance and performance-avoidance. Test anxiety was also found to have negative relations with regulatory strategy use in Study 1 and positive relations with cognitive strategy use in Studies 1 and 2. The latter result supports the study of Wolters and Pintrich (1998), who found students who reported higher levels of test anxiety to maintain their use of cognitive strategies but use less metacognitive strategies (regulatory) than students who were less anxious. These findings suggest that students who become overly concerned and emotionally distressed with regards to sitting for exams may panic and consequently invoke avoidance goals in order to relieve this state of being.

13.2.3.c Achievement Goals as Predictors of Achievement Goals

Rarely are achievement goals positioned as having direct relations with each other, however, the present research purposely examined such relations since a significant amount of covariance was found between the achievement goals throughout the trait-level and context-level studies. Synopses of the significant relations attained for these constructs in the structural equation model analyses conducted throughout the studies are presented in Table 13.3. Examining the relations between achievement goals was even more creditable in light of the “concern” hypothesis proposed for the performance-avoidance construct used in the trait-level studies (Studies 1 and 2). Given that the performance-avoidance used in the trait-level studies was aligned with emotive-based concern issues, the positive relations it had with mastery-approach, mastery-avoidance and performance-approach in Studies 1 and 2 were of no surprise. Thus, students who reported they had great concerns about how they fared in the class may have also reported high levels of mastery-approach, mastery-avoidance and performance-approach. Furthermore, performance-avoidance had positive associations with regulatory strategy use in Studies 1 and 2. These results support the concern model described above: students who are concerned about their performance in the classroom will utilise regulatory strategies in order to prevent failing. In the context analyses (Study 3), performance-avoidance had reciprocated positive associations with mastery-avoidance. This result implies that students may have avoidance tendencies irrespective of the competence reference involved (mastery or performance).

The results obtained for the relations of the performance-approach goal in the context-level studies had some important implications for goal theory and normative and multiple goal model perspectives. Significant positive associations were found for performance-approach with mastery-approach while at the same time performance-approach had positive associations with performance-avoidance in the teacher-led discussion and group work contexts. These effects indicate two features of the performance-approach goal. Firstly, the performance-approach goal orientation has the need to achieve with respect to both external-based and internal-based competence expectations. Thus, there is an internal type of valence associated with the performance-approach goal.

Secondly, the performance-approach goal orientation has the need to avoid failure. This feature was evident in the positive associations between performance-approach and performance-avoidance in the teacher-led discussion and group work contexts. The outcomes of the present research thereby indicate that the performance-approach goals of students may be moderated by their mastery-approach and performance-avoidance goals. From a multiple goal perspective, the relations between achievement goals may not simply be interactions, as used in multiple regression analyses. Instead, the present research contends that perhaps multiple goal investigations should examine the relations of achievement goals in terms of mediator or moderator models which can be assessed using structural equation model analyses. Nevertheless, these results support Elliot's (1999) theory with regards to the positive and negative consequences of the performance-approach goal.

Table 13.3

Synopsis of Significant Achievement Goal Predictors of Personal Constructs for High School Science Students obtained in the Trait-Level Analyses of Study 1 and Study 2, and the Context-Level Analyses of Study 3 using Structural Equation Modelling Analyses

	mastery-approach	mastery-avoidance	performance-approach	performance-avoidance	cognitive strategy use	regulatory strategy use	maladaptive strategy use
Study 1	pav (+)	pav (+)	pav (+)	-	reg (+)	map (+) mav (-) pap (-) pav (+)	-
Study 2	pav (+)	pav (+)	map (+) pav (+)	-	reg (+)	map (+) pav (+)	-
Teacher-led discussion	pap (+)	pav (+)	-	mav (+) pap (+)	-	map (+)	map (-) mav (+) pav (+)
Group work	pap (+)	pav (+)	-	mav (+) pap (+)	-	map (+) pap (+)	map (-) mav (+) pap (-)

Note. (+) = positive relationship; (-) = negative relationship. The predictor variables are symbolised as: mastery-approach (map); mastery-avoidance (mav); performance-approach (pap); performance-avoidance (pav); regulatory strategy use (reg). All relationships are significant at a minimum of $p < .05$.

13.2.3.d Achievement Goals as Predictors of Self-Regulated Learning

One of the more prominent findings of the present research was the impact that mastery-approach had upon regulatory strategy use. All of the large-scale quantitative studies, trait-level (Studies 1, 2) and context-level (Study 3), reported the hypothesised positive relations between these two constructs. According to the normative goal model, a mastery goal orientation fosters the use of self-regulatory strategies such as monitoring with respect to one's internal standards and regulating progress in attempting to find effective strategies that bring about learning and understanding (Pintrich, 2000a). There was considerable support throughout the present research for these associations thus complimenting similar findings from prior research (Bandalos et al., 2003; Greene et al., 2004; Kaplan & Midgley, 1997; Meece et al., 1988; Middleton & Midgley, 1997; Niemivirta, 1997; Valle et al., 2003; Wolters, 2004; Wolters et al., 1996).

Of major interest, though, were the results found for the performance-approach goal on self-regulated learning. Negative relations between performance-approach and regulatory strategy use were uncovered in Study 1. These trait-level results reflect prior research that has found performance-approach to positively predict superficial self-regulated learning strategies such as surface processing (Elliot & McGregor, 2001; Elliot et al., 1999; Greene & Miller, 1996; Kaplan & Midgley, 1997; Niemivirta, 1997). In the context of the present research, the regulatory strategy use items used in Study 1 had external classroom referents and thus students who are performance-approach orientated may have tended to use self-regulated learning strategies that were superficial and cognitive-based rather than metacognitive-based when studying outside the classroom although null relations were found between performance-approach and cognitive strategy use. On the other hand, the learning context of group work displayed positive relations between performance-approach and regulatory strategy use thus demonstrating that at least in specific micro-learning environment settings students that are performance-approach orientated employ adaptive self-regulated learning processes. Indeed, performance-approach was a negative predictor of maladaptive strategy use in the group work setting. In sum, the context-level analyses yielded evidence for the adaptiveness of a mastery-approach/performance-approach multiple goal model with both these achievement goals having direct positive associations with regulatory strategy use. Both these achievement goals also had negative relations with maladaptive strategy use in the contexts although these relations were heterogenous in nature. These results support the contentions that the performance-approach goal may have some adaptive qualities with it (Harackiewicz et al., 2002; McGregor & Elliot, 2002). The finding that performance-approach goals had adaptive qualities associated with self-regulated learning is important and contributes significantly to the debate regarding the adaptiveness of the performance-approach goal (Harackiewicz et al., 2002; Midgley et al., 2001).

Both avoidance goals had positive relations with maladaptive strategy use during teacher-led discussion, while mastery-avoidance was the only positive predictor of maladaptive strategy use in group work. These outcomes supported the hypotheses associated with these achievement goals from a normative goal perspective. The multilevel multiple regressions revealed some interesting achievement goal interactions from a multiple goal model perspective. In the context-level studies of teacher-led discussion and group work there were significant mastery-avoidance X performance-avoidance interactions on the use of maladaptive strategies in high school science classrooms. In these learning contexts, an increase in both mastery-avoidance and performance-avoidance goals corresponded to an increase in maladaptive strategy use; students that report themselves as high in performance-avoidance goals have a correspondingly greater increase in maladaptive strategy use than students who report they have low performance-avoidance goals. These results provide support for a multiple goal model. At the trait-level, the positive relations that performance-avoidance had with regulatory strategy use in Studies 1 and 2 was explained by the performance-avoidance equating more with student concerns rather than being an avoidance-associated trait (see above). The Study 1 regression analyses, however, yielded a significant performance-approach X performance-avoidance interaction. According to this multiple goal model, the impact of performance-approach goals on cognitive strategy use depended upon the performance-avoidance goal orientation of the students. For students having high performance-avoidance goals, an increase in performance-approach corresponded to a decrease in cognitive strategy use. For students with low performance-avoidance goals, an increase in performance-approach resulted in an increase in cognitive strategy use. These results show the potential adaptive importance of the performance-approach orientation in cognitive strategy use.

13.2.4 Associations between Subpopulation Variables with Achievement Goals and Self-Regulated Learning

The discussion now concentrates on the impact of the subpopulation variables examined throughout the present research. These variables included age (junior high or senior high), gender and global ability (gifted or regular). Of particular interest are the relations between global ability status with achievement goals and self-regulated learning. Two research questions addressed the relations between subpopulation variables with personal achievement goals and self-regulated learning:

> Research Question Five: What associations exist between high school science students' subpopulation variables, students' personal achievement goals and their self-regulated learning at the trait-level?

> Research Question Six: What associations exist between high school science students' subpopulation variables and their self-regulated learning and maladaptive strategy use on the basis of micro-learning contexts?

Gender, student age and student type, were considered as classifier variables in the present research and the variance attributed to each was removed for the structural modelling equations in order to produce a model applicable to the general high school science student. However, the associations between these three subpopulation variables with achievement goals and self-regulated learning were also of interest and these were ascertained using multiple multilevel regressions in Studies 1, 2 and 3. The same gender effects were obtained across both trait-level studies (Studies 1 and 2). Null relations were found for gender on mastery-approach, a result that supports other research (Cavallo et al., 2004; Church et al., 2001; Meece & Miller, 1999; Middleton et al., 2004; Middleton & Midgley, 1997; Patrick et al., 1999; Urdan, 1997; Young, 1997) although some research has found females to report higher mastery-approach than males (Ablard & Lipschultz, 1998; Anderman & Midgely, 1997; Anderman & Young, 1994; Bråten & Strømsø, 2004; Elliot & McGregor, 2001; Harackiewicz et al., 2002; Kaplan & Maehr, 1996; Meece & Holt, 1993; Nolen, 1988; Pajares et al., 2000; Thorkildsen, & Nicholls, 1998). The context-level analyses also found null relations for gender and mastery-approach. Thus, the effects of gender on mastery-approach appear to be inconclusive.

Mastery-avoidance was hypothesised to have no relations with gender, a result that occurred in the context-level investigations. However, females were found to report lower mastery-avoidance goal orientations than males in both trait-level studies (Studies 1 and 2). The trait-level result demonstrates that high school male students are more susceptible to avoiding situations in which they perceive potential failure with respect to learning. That is, males are not as amenable as females when it comes to making mistakes while learning. Males also reported having greater performance-approach in the trait-level studies, a result commensurate with much prior research (Anderman & Young, 1994; Anderman & Midgley, 1997; Cavallo et al., 2004; Middleton & Midgley, 1997; Midgley & Urdan, 1995; Pajares et al., 2000; Roeser et al., 1996; Thorkildsen, & Nicholls, 1998; Urdan, 1997; Young, 1997). Patrick et al. (1999) describe males as being more concerned about their social status and academic image and the results from the present research provide support for this observation with males perceiving themselves as being more competitive than females in the high school science classroom.

Females were found to report using more cognitive and regulatory strategies in their learning of high school science than males in Studies 1 and 2. Like mastery-approach there are mixed findings for the influence of gender upon SRL with some research showing females to use more SRL than males (Ablard & Lipschultz, 1998; Joo et al., 2000; Pokay & Blumenfeld, 1990; Zimmerman & Martinez-Pons, 1990), while others have found no gender effect (Neber & Schommer-Aikins, 2002; Pintrich & de Groot, 1990; Rao et al., 2000). No relations were detected between gender and adaptive SRL in the context-level analyses of the present research. However, females reported using less maladaptive strategies during the computer-based learning context. These findings suggest that females are more prone to employing adaptive SRL, at the trait-level, than males while learning science. Pajares (2002) suggests that females and males may vary in their reporting of confidence and self-belief related items: females may deflate their responses whilst males may inflate their responses to self-efficacy and self-regulated learning items. If this is indeed the case, then the relations found between gender and SRL in the present research are more convincing.

Hardly any research has considered the global ability dimension of high school students in the context of achievement goals. The present research contributed to research on academically gifted students (students attending academically selective high schools) by comparing regular and selective students in terms of their perceptions of achievement goals and self-regulated learning at the trait-level and context-level. Although the 2 X 2 achievement goal theory suggests that high achievers (gifted) are prone to mastery-avoidance goals (Elliot, 1999, Elliot & McGregor, 2001) it was hypothesised that global ability will not be a significant predictor of goals and that global ability was expected to be a significant predictor of self-regulated learning, with gifted students expected to report using more self-regulated learning than regular students (e.g., Chan, 1996; Zimmerman & Martinez-Pons, 1990). Study 1 revealed that gifted students reported to use more performance-avoidance than regular students. This result makes sense when considering the concern hypothesis the present research proposed (see above) in addressing the type of construct represented by the performance-avoidance goal indicator items used in the trait-level goals questionnaire. That is, given that the performance-avoidance construct used in the trait-level analyses of the present research represented students' concern about their performance in the classroom, it makes substantive sense that gifted students would report being of greater concern than their regular high school peers. On the contrary, regular high school students perceived themselves as having greater mastery-avoidance and performance-avoidance than selective students in Study 2. There were no differences detected between regular and selective students for achievement goals and self-regulated learning in the context-level studies. Thus, the differences between gifted and regular high school students are inconclusive with respect to students' achievement goals.

There was some support shown for the hypothesis that selective students use more self-regulated learning than regular students. In Study 1, selective students perceived themselves as using more cognitive and regulatory strategies than regular students, a result that resonates with previous research in this area (Bouffard et al., 1993; Chan, 1996; Swanson, 1992). However, this result was not supported in Study 2, the other trait-level study involving these constructs, and in the context-level studies. Like achievement goals, there seems to be inconsistent findings regarding the differences between selective and regular high school science students in terms of their self-regulated learning. In their review of metacognition in gifted and regular students, Alexander and Schwanenflugel (1996) cite work that has demonstrated gifted students to maintain their greater declarative metacognitive knowledge over regular students to grade four but then regular students begin to close this gap due to either a ceiling effect or a deceleration of declarative metacognitive knowledge for gifted students. Hence, high school students' achievement goals and self-regulated learning are perhaps more dependent upon the student's personal perceptions of their immediate learning environment and cognitive experiences such as self-efficacy and intrinsic value other than their inherent intelligence.

There were also inconsistent findings for the effects of age upon achievement goals and self-regulated learning. Of the trait-level analyses, only Study 2 found any effects for age upon achievement goals and self-regulated learning: junior students reported more mastery-avoidance than seniors whereas seniors were more performance-approach orientated than juniors. That seniors were more attuned to their performance in the classroom supported the proposal that seniors may have more personal expectations as they encroach upon important achievement milestones in their schooling. Juniors may have less resilience than seniors when it comes to dealing with making mistakes when trying to learn and this may cater for the greater use of mastery-avoidance by juniors. Study 2 also found juniors to report using more regulatory strategies than seniors. It was expected that seniors would report using more self-regulated learning than juniors, a result of developing adaptive learning strategies throughout school (for example, from observing peers and experiencing different teachers). However, like the effects of age upon achievement goals and self-regulated learning were inconclusive due to the differences obtained between Studies 1 and 2.

13.2.5 Students' Views about Achievement Goals and their Classroom Learning Environment

Obtaining students' views about their achievement goals and associated classroom factors formed the basis of the qualitative research presented in Study 3 (Chapter 12). This work addressed the following research question.

> Research Question Seven: What are students' perspectives with regards to the impact classroom activities have upon the adoption of achievement goals?

The purpose of this phase of Study 3 was to examine achievement goals in high school science classrooms from a qualitative stance with students being interviewed about their achievement goals and associated classroom factors. The interview results supported the existence of the four forms of achievement goals although students more readily identified with mastery-avoidance over performance-avoidance. Generally, students talked about personal-based factors as being the instigators of achievement goals rather than identifying any specific classroom contextual events or tasks. Mastery-avoidance was precipitated when students perceived a task as being too difficult for them to understand or they had failed to keep abreast of the work. Support was found in the interviews for Elliot's (1999) hierarchical theory of achievement goals with students describing the need to achieve in terms of an intrinsic form of valence as being the major inducer of their mastery-approach and performance-approach goals. The roles of environmental factors such as the facilitation of classroom student negotiation and teacher empathy with students were also salient for the students with regards to influencing their achievement goal orientations. The interviews also highlighted the beneficial importance of fostering a classroom in which students can discuss their science learning. It was recommended that future studies involving interviews on achievement goals should focus on students' views about only one or two achievement goals. An in-depth discussion of these qualitative findings is presented in Chapter 12 (Study 3).

13.3 IMPLICATIONS

The present research has implications for the teaching practice of science teachers, theory and research associated with science education, achievement goals and self-regulated learning. It also has methodological implications for studying the interactions of the learning environment, achievement goals and self-regulated learning. These implications are presented below.

13.3.1 Implications for the Teaching Practice of Science Teachers

The most adaptive profile generated across the studies that comprised the present research was that of students who reported high mastery-approach orientations. Students that perceived themselves as having high mastery-approach orientations elicited greater use of regulatory strategies at trait-level and context-level situations than students who had lower mastery-approach orientations. Furthermore, students that were mastery-approach orientated tended to use less maladaptive strategies during whole class discussions and in group work discussion settings. In studying the environmental and personal antecedents of the mastery-approach goal, the present research proffers several ways in which teachers may procure an increase in the mastery-approach goal of their science students. These may act at both the environmental and personal contexts for high school science students.

In terms of the environmental aspects of the high school science classroom, teachers should find ways in fostering activities and science learning themes that have personal relevance to students. The constructivist pedagogical dimension of personal relevance had positive associations with intrinsic value, an important positive predictor of mastery-approach, and direct positive associations with mastery-approach. Teachers can focus on making science relevant by utilising authentic social-based themes which involve students' everyday living experiences. These may come through informal and formal curriculum means. Another constructivist pedagogical dimension teachers should emphasise in the science classroom is student negotiation. This entails fostering an environment in which students share and discuss their ideas about science concepts. Student negotiation was found to have direct positive relations with mastery-approach from quantitative and qualitative perspectives. Students who reported their classroom as having an emphasis on the student negotiation of ideas also reported to use more regulatory strategies. The present research also affirmed the adaptiveness of teachers creating a learning environment that emphasises understanding and mastery approaches to learning. This approach tends to encourage greater intrinsic value, which has positive associations with mastery-approach and greater use of regulatory strategies. There was evidence that an emphasis on the metacognitive-related aspects of learning may encourage greater use of regulatory strategies by students. This could be accomplished by adopting constructivist pedagogical procedures that require students to explicitly share their ways of learning science and highlight learning difficulties.

From a pedagogical viewpoint, the research conducted has found much support for the contention that constructivist-based pedagogy has some convergence with the adaptive learning environments proffered by research on achievement goals and self-regulated learning. In recent time, "teaching for understanding" programs have been based upon social constructivist principles (Andre & Windschitl, 2003; Blumenfeld et al., 1997) as has relatively recent advances in the field of intentional conceptual change (Andre & Windschitl, 2003; Hatano & Inagaki, 2003; Vosniadou, 2003) and science education curriculum reforms (Applefield et al., 2001; Bell, 2005; Palincsar, 1998; Singer et al., 2000; Windschitl, 2002). However, there has been no research that has explicated the relations between the pedagogical dimensions affiliated with social constructivist principles and the motivational, affective and self-regulated aspects of students' learning. The findings of the present research endorse the principles and teaching methods of these programs as they have pedagogical elements that resonate with learning environments that promote mastery-approach and the use of regulatory strategies by science students.

Intrinsic value and self-efficacy were found to be important personal-based antecedents of mastery-approach throughout the studies conducted in the present research. Students that were highly efficacious and valued the subject tend to have high mastery-approach goal orientations. Hence teachers should structure learning tasks in class that have an appropriate level of challenge and are perceived by students as accomplishable. If students are continually encountering tasks that are too difficult, then they will tend to adopt avoidance goals and resort to maladaptive strategy use such as giving up. This has implications for the way activities are designed and used in learning environments that are based upon constructivist principles.

The least adaptive profile unveiled in the present research was associated with students who reported to adopt high mastery-avoidance and high performance-avoidance goals. These goals had positive relations with maladaptive strategy use in the context settings studied while mastery-avoidance had negative relations with regulatory strategy use at the trait-level. Avoidance goals were found to have personal-based antecedents rather than being influenced by environmental factors although two senior students interviewed for Study 3 (Chapter 12) acknowledged that the character of the class induced avoidance behaviour in them. Future research should gather more student views about the personal and environmental antecedents of achievement goals, particularly those concerned with avoidance goals (e.g., Urdan & Mestas, 2006). The avoidance goals had negative associations with efficacy and perceived ability during learning contexts. Thus, students that perceive they are not capable of accomplishing a task may resort to avoidance goals. Teachers should attempt to ensure that students working on tasks have appropriate assistance and guidance and that the task is manageable for students. For example, teachers may provide regular constructive and formative feedback to students as they progress through a task. This allows the student to increase their feelings of efficacy towards the task. Teachers can also focus on the individual student mastering a set of learning objectives by using an outcomes approach in which each student is allowed to acquire a skill or learning objective over time with the focus on self-improvement and accomplishment. Although self-efficacy was a positive predictor of all achievement goals at the trait-level, mastery-avoidance and performance-avoidance goals were additionally influenced by test anxiety. Students who thought they had high test anxiety also reported having high mastery-avoidance and performance-avoidance goals. This demonstrates that avoidance goals are influenced by feelings of inadequacy. Teachers should perhaps adopt more caring and empathetic roles in dealing with students who are anxious regarding their performance in high school settings. In addition, teachers could emphasise a mastery learning environment rather than one that is performance-based - understanding should be assessed in terms of mastery and not in reference to normative-based measures. Thus, the call for teachers to consider the affective domain characteristics of learning environments, particularly with respect to motivationally effective classroom practice and the associated socialising mechanisms (Brophy, 1999; Yung & Tao, 2004) are well-founded and endorsed by the results of the present research.

13.3.2 Implications for Achievement Goals, Constructivist Pedagogy and Self-Regulated Learning Research - Theoretical Considerations

The three studies that form the present research found evidence for the proposal that constructs from the fields of achievement goals, self-regulated learning and constructivist learning environments (science education) interact with each other in an interdisciplinary manner to influence the learning of science in high school classrooms. The findings of these studies have ramifications for future research accompanying each of these fields. There are two main implications for the field of science education that stem from the present research. First, future research attending to students' acquisition of science-based knowledge and conceptual understanding should cater for the roles of students' achievement goals, self-regulated learning and competence perceptions. Constructivist research tends to neglect the motivational, affective and self-regulated aspects of students' learning and it is encouraging to see that a step towards addressing these intrapsychological dimensions of students' learning is being attended to in the guise of intentional conceptual change research (e.g., Sinatra & Pintrich, 2003b). However, the work that has examined achievement goals and self-regulated learning in conceptual change contexts has focused mainly on the self-regulated learning dimensions with scant attention applied to the learner's achievement goals and their motivational beliefs. The present research has demonstrated the adaptiveness of students that adopt mastery-approach goals for their learning while also showing the maladaptive characteristics of the avoidance goals. Students' motivational beliefs of self-efficacy, intrinsic value and test anxiety were also shown to be crucial antecedents upon students' achievement goals, self-regulated learning and science achievement. The contributions these personal-based constructs have towards promoting learning need to be attended to when examining students' learning in science.

The second offering for science education research concerns the impact of classroom learning environment dimensions upon personal-based factors. Although constructivism has spawned an associated pedagogy, its main focus has been on the intrapsychological dimensions of students. Similarly, intentional conceptual change theories have also been intrapsychologically situated with not much attention paid to the influence of social factors such as the learning environment fostered by the teacher or learning contexts (Hatano & Inagaki, 2003; Pintrich & Sinatra, 2003) or the interaction of these with personal-based factors. The present research has demonstrated the impact that two constructivist pedagogical dimensions, personal relevance and student negotiation, have had on the attainment of adaptive student learning and motivational profiles in high school science classrooms. It is recommended that future work investigates the influence of personal relevance and student negotiation upon achievement goals and self-regulated learning in experimental and correlational formats in both informal and formal curriculum settings in order to confirm the results presented here.

There are several implications the present research offers for the field of achievement goals. First, achievement goal research should consider constructivist pedagogical dimensions as integral environmental influences upon students' achievement goals. As hypothesised, there was evidence throughout the present research for the positive effects that the constructivist pedagogical dimensions of personal relevance and student negotiation have upon achievement goals and self-regulated learning. Moreover, these effects were beyond the classroom goal structures that have been the focus of contemporary goals research. In addition, it has been observed elsewhere that students express preference for learning environments that foster student social negotiations (Hand et al., 1997; Kim et al., 1999; Kinchin, 2004; Tsai, 2000, 2003).

Research should attempt to examine the potential that constructivist-based pedagogy has for fostering learning environments that are commensurate with mastery-approaches to learning and explore the impact these may have upon students' achievement goals.

Second, it is time that achievement goals research incorporates the full spectrum of valences (internal and external) for both approach and avoidance achievement goals in the classroom and employ a 2 X 2 goals framework for investigating achievement goals and their relations. Throughout the present research there was empirical support for the existence of the four achievement goals espoused by Elliot (1999) and Pintrich (2000b). Furthermore, students tend to identify with mastery-avoidance rather than performance-avoidance when interviewed about their avoidance goals. Research may also investigate the stability aspects of achievement goals. It was suggested here that approach goals have perpetual-like properties whereas avoidance goals are reactive in nature, depending on localised, spasmodic classroom situations that involve fluctuating perceptions of efficacy and ability on behalf of a student. Longitudinal studies would be of use for addressing these issues.

Third, there should be research conducted on comparing the validity and reliability of achievement goal indicator items that are based on emotive motivational rationales (e.g., Church et al., 2001; Elliot & Church, 1997; Elliot & McGregor, 2001) with those that are based on symptomatic tendencies (e.g., Midgley et al., 1997). The avoidance goals in the present research had the lowest reliability coefficient results and it was suggested that students may have had difficulty in identifying with the intentions of the indicator items associated with each avoidance response variable (construct) since they were based upon the emotive rationale features of the goal. Of particular interest were the indicator items for performance-avoidance used in the trait-level investigations. These were more aligned with students' concerns about classroom performance aspects rather than being symptomatic of performance-avoidance. As a consequence, the present research developed a "concern" hypothesis which contends that the concern that students have about learning and performance in the classroom may be an important antecedent of achievement goals and self-regulated learning. For example, students who have large amounts of concern about their mastery of learning and their classroom performance may have better attitudinal dispositions than students who were not concerned about these aspects. The former may implement adaptive measures such as employment of regulatory strategies in order to accommodate their concerns. Concerns may be related to other constructs such as future goals and work avoidance and research that explores students' concerns may be justified.

Fourth, future research is warranted for exploring the relations between achievement goals, motivational beliefs and self-regulated learning at the context-level. The context-level analyses of the present research provided conformation for most tenets of a context hypothesis. The constructs of the four achievement goals, task efficacy, perceived ability, regulatory strategy use and maladaptive strategy use were validated at the context-level and the relations between them were viable. There was also evidence that the salience of these constructs and their sub-constructs depended on the type of context students encountered with respect to the amount of teacher-regulation and individual student-regulation involved.

Fifth, it is recommended that research continue to assess the roles of achievement goals from normative and multiple goal perspectives. Research that has addressed the impact of multiple goal models has traditionally examined the outcomes of goal interactions using multiple regression (Barron & Harackiewicz, 2001; Kaplan & Midgley, 1997; Meece & Holt, 1993; Midgley & Urdan, 2001). While the present research used this approach, it also observed a large amount of covariance for the achievement goals in the structural equation models. Using structural equation modelling enabled the specified relations between goals to be assessed and thus demonstrated the mediating and moderating roles that achievement goals may have upon each other. For example, the SEM approach enabled the relations of performance-approach with mastery-approach and performance-avoidance to be inspected in the context-level analyses. Significantly positive relations were found for each goal thus demonstrating that students who adopt performance-approach goals may have their regulatory strategy use mediated by their mastery-approach and performance-avoidance orientations. It is recommended that more research follow the lead presented here by adopting a covariance approach to analysing multiple goal models. Confining the analysis of multiple goal models to goal interaction variables in regression analyses precludes any examination of the structural relationships that can be examined using structural equation modelling. In addition, it assumes that goals are directly related in simple mathematical ratios instead of goals having other forms of functionality with each other such as mediating or moderating relationships. While the SEM approach depends upon substantive views it does allow a more valid investigation of these models.

Sixth, the relatively large amounts of unexplained variance attributed to each achievement goal across the studies presented indicates there are other influences of achievement goals that were not examined in the present research. One of these potential influences is students' epistemological views. Studies on the epistemological views of science students have shown students with constructivist-aligned orientations tend to prefer constructivist learning environments and use more meaningful learning strategies whereas those that have empiricist or positivist orientations tend to use less deep approaches to learning such as rote-learning (Edmonson & Novak, 1993; Roth, 1997; Tsai, 1999, 2000; Wallace et al., 2003; Windschitl & Andre, 1998). Furthermore, it has been suggested that epistemology is another form of goal, in addition to achievement goals, that influences students as they learn (Hofer & Pintrich, 1997). Generally, epistemological beliefs have been used as predictors of goals (e.g., Elliot & McGregor, 2001) and self-regulated learning (e.g., Neber & Schommer-Aikins, 2002) although there is scarce research on the relations of epistemological factors with achievement goals and self-regulated learning. Future research could examine the compatibility of science students' constructivist epistemological views with that of the science learning environment they encounter at school. This research would compliment investigations that examine the compatibility of students' achievement goals with those of the classroom teacher. Other explanatory variables of achievement goals that have been studied but not addressed by the present research include students' perceptions of the evaluation practice of the teacher (Church et al., 2001), fear of failure, work mastery and overall need for achievement (Elliot & McGregor, 2001).

The present research also has implications for the field of self-regulated learning. As for achievement goals, it would be useful to explore the impact of the constructivist pedagogical dimension of student negotiation upon students' self-regulated learning in the science classroom. The present research found positive relations between student negotiation and regulatory strategy use. Constructivist pedagogy emphasises students' construction of understanding in an environment that promotes self-regulated learning rather than restrict it as may be the case in teacher-dominated lecture formats. Research that specifically examines the impact that constructivist-based pedagogical environments have upon the self-regulated learning of students in science classrooms is called for.

The present research incorporated the measurement of maladaptive strategy use in studying the interactions of achievement goals and self-regulated learning of high school science students. This proved to be useful in confirming the relations of both approach and avoidance goal forms with SRL in the context of the science classroom. Future research that investigates the relations of SRL with achievement goals should also consider examining adaptive and maladaptive forms of self-regulated learning (e.g., Midgley et al., 1997).

A distinction was made between trait-level and context-level analyses by the present research. As for achievement goals, the application of a context hypothesis provided a valid interpretation of students' application of their self-regulated learning within the classroom as distinct from asking students to report on their trait-level perceptions. Further research is encouraged to verify the specific types of strategies that students use when learning in certain contexts within the science classroom (e.g., teacher explanation and computer use). This approach may be of greater value than relying upon trait-based perceptions of self-regulated learning and associated constructs such as achievement goals.

It is recommended that researchers use indicator items of constructs like cognitive and regulatory strategy use that are compatible with the context of other constructs being investigated. The self-regulated learning items used in the present research were derived from the Motivated Strategies for Learning Questionnaire (MSLQ, Pintrich et al., 1991) and had external classroom referents ("When I study for a test, I try to put together the information from class and from the book") whereas the other constructs of interest had an intra-classroom focus. Potentially, this incompatibility may have invalidated the use of the SRL constructs as consequences of achievement goals and motivational beliefs in the trait-level studies. The present research assumed that the SRL constructs used were indirect measures of the SRL fostered by the student in the science classroom.

Finally, a large amount of covariance was observed between the cognitive and regulatory strategy constructs in the trait-level studies hinting at multicollinearity for these two forms of self-regulated learning. Although the present research vindicated the separation of these constructs via exploratory factor analysis and confirmatory factor analysis, the sizeable relations between them indicate that students found it difficult to distinguish between cognitive-based and metacognitive-based learning strategies. It would be useful for research to develop more valid measures of these two forms of self-regulated learning.

13.3.3 Implications for Achievement Goals, Constructivist Pedagogy and Self-Regulated Learning Research - Methodological Considerations

There were several important implications for further research that evolved from the quantitative methods applied in the present research in studying the interactions of the learning environment, achievement goals and self-regulated learning. First, the present research used a two-step procedure in establishing the construct validity measurement properties of the scales associated with each questionnaire. The factorial structure of all the questionnaires, established or novel, was initially determined using exploratory factor analysis (EFA). Principal axis factoring was used as the factor extraction method with an oblique rotation method. This has several advantages over principal components (Costello & Osborne, 2005; Reise et al., 2000; Rowe, 2006). Next, adjunct confirmatory factor analyses (CFAs) using LISREL 8.72 (Jöreskog & Sörbom, 2005) were used to test any alterations to the relations between indicator items and their factors and justify any scale-indicator item modification to the questionnaire. For example, the use of CFAs enabled an assessment of several first-order models of achievement goal items in order to determine which model accounted for more variance and thus provided the better fit of the achievement goals questionnaire data. Examining such psychometric properties of the questionnaires using EFAs helped minimise the effects of collinearity and multicollinearity with constructs that were used in relational statistical analyses. Another important advantage of using the CFA procedures of LISREL 8.72 is that it caters for items that use ordinal measures such as Likert-type scales. Likert scales do not generate continuous variables and hence when analysing the relations of ordinal with other ordinal variables, polychoric correlations should be computed rather than using traditional Pearson product-moment correlations (Jöreskog, 2002). Most research in the fields associated with the present research does not attend to such measurement properties of indicator items. CFA has several advantages over EFA in determining the construct validity of questionnaire scales (Marsh, 1994; Rowe, 2002; Stevens, 1995) and it is recommended that research use similar procedures to test the construct validity of scales associated with quantitative measures.

It is also recommended that future research consider implementing fitted one-factor congeneric measurement model procedures in forming the composite variables that represent the various social/cognitive constructs being investigated. One-factor congeneric modelling has several important advantages over traditional measurement analyses such as exploratory factor analysis (EFA) and principal components (Holmes-Smith & Rowe, 1994; Rowe, 2002, 2006; Rowe & Hill, 1998). This process maximised the fit of indicator items and the construct they represent and in so doing minimising the impact of measurement error in computing composite scale scores (Fleishman & Benson, 1987; Rowe, 2006). For example, the composite scales for most constructs in the present research accounted for approximately 99% of the variance in the data associated with the construct. In addition, one-factor congeneric modelling facilitated the construction of composite variable scale scores based on the weighted contribution of relevant items. Traditional research composite scale score computation assumes that each indicator item has equal weighting or is “unit-weighted” (Rowe, 2006). Using PRELIS and LISREL to form the one-factor congeneric models deals with psychometric scales that are ordinal such as Likert scales and cater for items that have non-normal distributional properties of their data.

Implementing these processes increases both the reliability and validity of composite scales computed from indicator items as compared to the traditional means of generating composite scale scores using factor analysis and unit-weightings of indicator items from ordinal data.

A third recommendation is that research should normalise composite scale scores. The univariate normality tests of the raw composite scale data associated with the present research showed the composite scale data, even after completion of the one-factor congeneric modelling analyses was not normally distributed with most composites exhibiting significant skewness and kurtosis. Normalised values of the raw composite scale scores were achieved in the present research using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b), which rescores the raw composite scale scores on the basis of normal equivalent deviates in accordance with the original score rankings (Rowe, 2003, 2006). This process yields composite scales having distributional properties close to being normal distributed with insignificant skewness and kurtosis and thus can be used with confidence in relational statistical analyses such as multiple regression and structural equation modelling. It is rare that research reports the distributional properties of composite scales.

The present research used two statistical procedures in addressing the structural properties of the data. First, multilevel multiple regression analyses using *MLwiN* 2.02 (Rasbash et al., 2005a; Rasbash et al., 2005b) were used to assess the hypothesised relationships between classroom environmental and personal factors with personal achievement goals, self-regulated learning (cognitive and regulatory strategy use) using a two-level hierarchy, with students at the first level and their classroom membership forming the second level. Multilevelling modelling enables variance attributed to the student-level and class-level to be controlled and thus improve the validity of analyses. It is also useful in determining if data used in future structural equation modelling analyses should be multilevel. If multilevel modelling reveals significant effects at various levels, then it may be necessary to conduct structural equation modelling at each level rather than being confined to single-level analyses (Rowe, 2003, 2006). Multilevel analyses are rarely conducted in the context of achievement goals (for exceptions see Anderman & Young, 1994; Church et al., 2001; Ee et al., 2003; Wolters, 2004), constructivist learning environment dimensions, motivational beliefs, and self-regulated learning. In the case of the present research, the multilevel multiple regressions revealed that much of the variance associated with the reporting of all constructs was accounted for at the personal level and not to classroom-level differences. All education systems have hierarchical tendencies and research should consider the unit of analysis associated with the constructs examined.

The second statistical procedure employed in the present research was structural equation modelling (SEM). SEM was used to analyse the simultaneous relationships between the explanatory and response variables on the basis of substantive perspectives. Furthermore, the generalisibility of the structural equation modelling analyses were enhanced by removing the variances attributed to the classifier variables, namely gender, student age and student type (selective or regular high school). Therefore, the SEM approach adopted in the present research was able to address the question: What are the interactions between the classroom learning environment and personal-level variables in high school science classrooms when the effects of classifier variables such as gender, student age, and student type are controlled for? It is suggested that researchers consider this type of procedure when examining the relations amongst multiple variables. SEM analyses have an advantage over multiple regression analyses in being able to measure the simultaneous relations between variables. This aspect is particularly useful for situating variables in terms of mediating and moderating relationships.

The present research applied trait-level and context-level analyses with respect to examining the relations between the learning environment, achievement goals and self-regulated learning. This enabled a form of quantitative triangulation with respect to the antecedents and consequences of achievement goals and self-regulated learning. It should be pointed out that throughout the relational analyses of these studies the unit of analysis was at the construct-level rather than the student. Most of the results gathered at the context-level supported the prevailing theories on achievement goals and self-regulated learning. The results of this research therefore demonstrate the potential for more studies to consider the contextualisation of achievement goals, motivational beliefs and self-regulated learning. With this in mind, it is important that future studies take into account the homology of indicator items with respect to the target experiences students are to report upon.

The present research also calls for future research to incorporate some form of qualitative assessment of the issues being addressed. In the present research, students were interviewed in semi-structured formats in order to field their views on factors affecting their achievement goals. The views generated from the students were extremely useful in highlighting issues that are often not captured in questionnaires. Prospective research on pedagogical-based interventions should consider the use of quantitative measures that explicitly requests students to compare the pedagogical experiences of interest ("Compared to your normal classroom…").

Finally, the present research calls for more experimental and longitudinal approaches towards examining the relations between the learning environment, achievement goals and self-regulated learning. The results of the trait-level and context-level analyses were of large-scale correlational studies involving teachers implementing a science curriculum without explicit employment of constructivist pedagogical principles. These studies were correlational in nature and any causal paths discussed are inferred only. To prove causality, experimental-based or longitudinal studies need to be conducted. With respect to the intentions and findings of the present research, it would be most useful to examine the longitudinal experiences of students in terms of the constructivist pedagogical dimensions they encounter and their concomitant motivational beliefs, achievement goals and self- regulated learning.

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Appendix A

Constructivist Learning Environment Survey

School:	
Class:	Year (grade):
Age:	Gender (male or female):
Name:	
Your mother's country of birth:	
Your father's country of birth:	
Language(s) spoken at home:	

Science Classroom Learning Environment Questionnaire

Instructions: The statements below are about the usual type of learning environment you encountered while learning science at school. If you "almost never" feel about or do what the statement says, circle the 1. If you "seldom" feel about or do what the statement says, circle the 2. If you "sometimes" feel about or do what the statement says, circle the 3. If you "often" feel about or do what the statement says, circle the 4. If you "almost always" feel about or do what the statement says, circle the 5.

There are no right or wrong answers for these statements. We are interested only in what you actually think about your science classroom. Your teacher will not see any of the answers given.

In this science class:

	1	2	3	4	5
	almost never	seldom	sometimes	often	almost always
1. I learn about the world outside of school.	1	2	3	4	5
2. My new learning starts with problems about the world outside of school.	1	2	3	4	5
3. I learn how science can be part of my out-of-school life.	1	2	3	4	5

Questions continue over →

In this science class:

	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
4. I get a better understanding of the world outside of school.	1	2	3	4	5
5. I learn interesting things about the world outside of school.	1	2	3	4	5
6. What I learn has nothing to do with my out-of-school life.	1	2	3	4	5

In this science class:

	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
7. I learn that science cannot provide perfect answers to problems.	1	2	3	4	5
8. I learn that science has changed over time.	1	2	3	4	5
9. I learn that science is influenced by people's values and opinions.	1	2	3	4	5
10. I learn about the different sciences used by people in other cultures.	1	2	3	4	5
11. I learn that modern science is different from the science of long ago.	1	2	3	4	5

	1	2	3	4	5
12. I learn that science is about creating theories.	almost never	seldom	sometimes	often	almost always

In this science class:

	1	2	3	4	5
13. It's OK for me to ask the teacher 'why do I have to learn this?'	almost never	seldom	sometimes	often	almost always
14. It's OK for me to question the way I'm being taught.	almost never	seldom	sometimes	often	almost always
15. It's OK for me to complain about the teaching activities that are confusing.	almost never	seldom	sometimes	often	almost always
16. It's OK for me to complain about anything that prevents me from learning.	almost never	seldom	sometimes	often	almost always
17. It's OK for me to express my opinion.	almost never	seldom	sometimes	often	almost always
18. It's OK for me to speak up for my rights.	almost never	seldom	sometimes	often	almost always

In this science class:

	1	2	3	4	5
19. I help the teacher to plan what I'm going to learn.	almost never	seldom	sometimes	often	almost always
20. I help the teacher to decide how well I am learning.	almost never	seldom	sometimes	often	almost always
21. I help the teacher to decide which activities are best for me.	almost never	seldom	sometimes	often	almost always

Questions continue over →

22. I help the teacher to decide how much time I spend on learning activities.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

23. I help the teacher to decide which activities I do.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

24. I help the teacher to assess my learning.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

In this science class:

25. I get the chance to talk to other students.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

26. I talk with other students about how to solve problems.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

27. I explain my understandings to other students.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

28. I ask other students to explain their thoughts.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

29. Other students ask me to explain my ideas.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

30. Other students explain their ideas to me.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

In this science class:

31. My science teacher thinks mistakes are okay as long as we are learning.

1	2	3	4	5
almost never	seldom	sometimes	often	almost always

Questions continue over →

	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
32. My science teacher wants us to understand our work, not just memorise it.	1	2	3	4	5
33. My science teacher really wants us to enjoy learning new things.	1	2	3	4	5
34. My science teacher recognises us for trying hard.	1	2	3	4	5
35. My science teacher gives us time to really explore and understand new ideas.	1	2	3	4	5
36. My science teacher points out those students who get good grades as an example to all of us.	1	2	3	4	5
37. My science teacher lets us know which students get the highest scores on the test.	1	2	3	4	5
38. My science teacher tells us how we compare to other students.	1	2	3	4	5
39. My science teacher tells us that it is important that we don't look stupid in science.	1	2	3	4	5
40. My science teacher says that showing others that we are not bad in science should be our goal.	1	2	3	4	5
41. My science teacher tells us it's important to join in discussions and answer questions so it doesn't look like we can't do the work.	1	2	3	4	5

Questions continue over →

42. My science teacher tells us it's important to answer questions in class, so it doesn't look like we can't do work.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always

In this science class:

43. Students are asked by the teacher to think about how they learn science.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
44. Students are asked by the teacher to explain how they solve science problems.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
45. Students are asked by the teacher to think about their difficulties in learning science.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
46. Students are asked by the teacher to think about how they could become better learners of science.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always
47. Students are asked by the teacher to try new ways of learning science.	1 almost never	2 seldom	3 sometimes	4 often	5 almost always

End of questionnaire: Thank you for your cooperation

Note: items 31 – 35 represent the Mastery Goal Structure Scale; items 36 – 38 represent the Performance-Approach Goal Structure Scale; items 39 – 42 represent the Performance-Avoidance Goal Structure Scale; items 43 – 47 represent the Classroom Metacognitive Structure Scale.

Appendix B

Achievement Goals Questionnaire

What school are you at? . . . .

What year are you in? . . . . . . Female: Male:

Science Classroom Motivation Questionnaire - Macro-Level

Instructions: The statements below are about the type of motivation you have while learning science at school. If you feel the statement is "not at all true" of you, then circle the 1. If you feel the statement is "very true" of you, then circle the 7. If you feel somewhere in between these two then circle the number that best describes how you feel about the statement.

There are no right or wrong answers for these statements; the researchers are interested only in your motivation in your science classroom.

In this science class:

Statement	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
1. It is important for me to do better than the other students.	1	2	3	4	5	6	7
2. My goal in this class is to get a better grade than most of the students.	1	2	3	4	5	6	7
3. I am trying to show that I have better ability than others in this class.	1	2	3	4	5	6	7
4. I am motivated by the thought of outperforming my peers in this class.	1	2	3	4	5	6	7
5. It is not important to me to do well compared to others in this class.	1	2	3	4	5	6	7
6. I eagerly participate in all types of activities in this class.	1	2	3	4	5	6	7
7. I do not want to learn as much as I can in this class.	1	2	3	4	5	6	7
8. It is important for me to understand what is being taught.	1	2	3	4	5	6	7

Questions continue over →

In this science class:

9. I hope to gain new skills and knowledge of science.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

10. I desire to completely master the material presented to me in this class.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

11. The activities provided arouse my curiosity, even if the material is difficult to learn.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

12. I prefer activities and course material that really challenges me so I can learn new things.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

13. I often think to myself, "What if I do badly in this class compared to the others?"

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

14. I do not worry about the possibility of getting a bad grade.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

15. My fear of performing poorly in tests in this class is often what motivates me.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

16. I just want to avoid doing poorly, compared to the others, in this class.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

17. I care what my teacher or others think of me if I ask a "dumb" question or make "dumb" mistakes.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

18. I am very careful about what I do during tasks in this class.

1 2 3 4 5 6 7
not at all true of me | moderately true of me | very true of me

In this science class:

19. I focus on not making any mistakes at all during my learning in this class.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
20. I will only do the things that I feel safe or comfortable with. I will not do things that I think I will make mistakes in.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
21. It doesn't worry me if I make mistakes when learning.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
22. I do not like to know that I am doing something incorrectly when learning.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
23. I try not to make mistakes because that would mean that I am not succeeding at the task.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
24. I avoid things that I make mistakes in since I am only interested in things I can successfully accomplish.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
25. What is your ability level in this science class?	1	2	3	4	5	6	7
	very low			moderate			very high
26. What test mark do you usually get in this science class?	1	2	3	4	5	6	7
	very low			moderate			very high

End of questionnaire: Thank you for your cooperation

Appendix C

Motivated Strategies for Learning Questionnaire

What school are you at? . . . .

What year are you in? . . . . . . Female: Male:

Motivated Strategies for Learning Questionnaire

Instructions: The statements below are about the type of processes you may employ while learning science. If you feel the statement is “not at all true” of you, then circle the 1. If you feel the statement is “very true” of you, then circle the 7. If you feel somewhere in between these two then circle the number that best describes how you feel about the statement.

There are no right or wrong answers for these statements; the researchers are interested only in the type of thinking processes you use while you learn science.

In this science class:

	1	2	3	4	5	6	7
1. I prefer class work that is challenging so I can learn new things.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
2. Compared to other students in this class I expect to do well.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
3. I am so nervous during a test that I cannot remember the facts that I have learned.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
4. It is important for me to learn what is being taught in this class.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
5. I like what I am learning in this class.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
6. I am certain that I can understand the ideas taught in this class.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me

Questions continue over →

In this science class:

7. I think I will able to use what I learn in this class in other classes.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
8. I expect to do very well in this class.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
9. Compared to others in this class, I think I am a good student.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
10. I often do more than is required of me for homework assignments.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
11. I am sure I can do an excellent job on the class assignments and homework.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
12. I have an uneasy, upset feeling when I take a test or exam.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
13. I think I will receive good grades in my exams.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
14. Even when I do poorly on a test or exam I try to learn from my mistakes.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
15. I think that what I am learning in this class is useful for me to know.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
16. I just want to avoid doing poorly, compared to the others, in this class.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me

Questions continue over →

In this science class:

17. I think that what we are learning in this class is interesting.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
18. Compared to other students in this class I think I know a great deal about the topics I am studying.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
19. I know that I will able to learn the materials for the tests and exams.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
20. I worry a great deal about tests and exams.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
21. Understanding the subject is important to me.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
22. When I take a test I think about how poorly I am doing.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
23. When I study for a test, I try to put together the information from class and from the textbook.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
24. When I do homework, I try to remember what the teacher said in class so I can answer the question correctly.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
25. I ask myself questions to make sure I know the material I have been studying.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
26. It is hard for me to decide what the main ideas are when I study.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me

In this science class:

27. When work is hard I either give up or study the easy parts.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

28. When I study I put important ideas into my own words.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

29. I always try to understand what the teacher is saying even if it doesn't make sense.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

30. When I study for a test I try to remember as many facts as I can.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

31. When studying, I copy my notes over to help me remember materials.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

32. I work on practice exercises and answer end of chapter questions even when I don't have to.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

33. Even when study materials are dull and uninteresting, I keep working until I finish.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

34. When I study for a test I practice saying the important facts over and over to myself.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

35. Before I begin studying I think about the things I will need to do to learn.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

Questions continue over →

In this science class:

Item	1	2	3	4	5	6	7
36. I use what I have learned from old homework assignments and the textbook to do new assignments.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
37. I often find the material I use for studying difficult to understand.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
38. I find that when the teacher is talking I think of other things and don't really listen to what is being said.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
39. When I am studying a topic, I try to make everything fit together.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
40. When I am studying I stop once in a while and go over what I have read.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
41. When I read material for this class, I say the words over and over to myself to help me remember.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
42. I outline the chapters in my book to help me study.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
43. I work hard to get a good grade even when I do not like the class.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
44. When I am studying I try to connect the things I am reading about with what I already know.	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me

End of questionnaire: Thank you for your cooperation

Appendix D

Science Classroom Cognitive Processes and Motivation Questionnaire – Teacher – Led Discussion

What school are you at? . . . .

What year are you in? . . . . . . Female: Male:

Science Classroom Cognitive Processes and Motivation Questionnaire – Teacher – Led Discussion

Instructions: The statements below are about the type of thinking processes you used and the type of motivation you had during a teacher-led discussion today. If you feel the statement is "not at all true" of you, then circle the 1. If you feel the statement is "very true" of you, then circle the 7. If you feel somewhere in between these two then circle the number that best describes how you feel about the statement.

There are no right or wrong answers for these statements; the researchers are interested only in type of thinking processes you used and the motivation you had while your science teacher discussed something with the class in today's lesson. It is important that you report only on what happened during the discussion and nothing else.

Regarding today's discussion in science:

Statement	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
1. I liked this learning activity.	1	2	3	4	5	6	7
2. The things talked about helped me to understand science.	1	2	3	4	5	6	7
3. I prefer this type of learning activity.	1	2	3	4	5	6	7
4. I did not learn from today's classroom discussion.	1	2	3	4	5	6	7
5. Since I have learnt successfully from discussions like this in the past, today I paid attention expecting to learn.	1	2	3	4	5	6	7
6. I like listening to what the other students ask and say in the discussion.	1	2	3	4	5	6	7

Questions continue over →

Regarding today's discussion in science:

7. Since the most important thing to me is to beat the others in the test, I tried to understand what was being discussed.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
8. I often compared my thoughts to comments made by other students to see if I am better than them.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
9. I answered questions to show that I am really good.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
10. It was not important to me to do better than the others in this discussion.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
11. I participated in the discussion in order to learn so that I may do well in the test.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
12. I tried to show that I was better than the others by asking questions.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
13. It didn't worry me what the others thought of what I said or asked if I got involved in the discussion.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
14. I did not answer any questions because I was worried my answers may be thought as being stupid.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
15. I was worried when the other students demonstrated they knew more than me.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
16. I did not ask questions because I was afraid that the others would have thought I was "dumb".	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me

Questions continue over →

Regarding today's discussion in science:

17. My fear of performing badly compared to the others influenced what I did in the discussion.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
18. I listened and learnt from the others mainly to avoid doing poorly in the test.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
19. Understanding is very important to me and this was why I focused on the discussion.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
20. I wasn't afraid to ask questions in order to help me understand more.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
21. I listened to the answers from the teacher and students since they will help me to learn.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
22. I answered questions raised by other students or the teacher in my head, or out loud, in order to check my understanding.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
23. I desire to master the material discussed so I paid attention all the time.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
24. The only thing that motivated me during the discussion was to learn what is in the test and nothing else.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
25. I focused only upon the points I could understand.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me
26. I avoided answering questions that I felt I didn't have the correct answer for.	1	2	3	4	5	6	7
	not at all true of me		moderately true of me				very true of me

Questions continue over →

Regarding today's discussion in science:

27. I enjoy answering the difficult questions even if there is a chance I will get them wrong.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

28. I only answered questions that I knew I had a very good chance of getting correct.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

29. If I was failing to understand I would switch my attention to other things that I knew I was able to be good at.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

30. I felt very bad about myself when I could not understand the discussion.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

31. If I wasn't sure of a point, I would ask a question.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

32. I listened to the questions asked and listened to the answers given in order to help me learn.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

33. I formed questions in order to clarify points I wasn't sure of.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

34. I constantly thought about the topic and the discussion and tried to make sense of it all.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

35. I participated in the discussion since this helped me understand.

1 2 3 4 5 6 7
not at all true of me — moderately true of me — very true of me

Questions continue over →

Regarding today's discussion in science:

36. I tried to predict the answers to the questions asked in order to check my understanding.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
37. When I got confused I would ask other students to help me.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
38. I couldn't be bothered asking questions since I wasn't ready to learn.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
39. I was easily distracted and found it hard to learn what was being discussed.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
40. I didn't try too much to link the ideas being presented.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
41. When I thought I had understood everything I stopped participating in the discussion.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
42. I was constantly confused.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
43. When the discussion was too hard I gave up.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
44. I had no idea of what to do when I realised I couldn't understand what was being talked about.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
45. What is your ability level in this science class?	1 very low	2	3	4 moderate	5	6	7 very high
46. What test mark do you usually get in this science class?	1 very low	2	3	4 moderate	5	6	7 very high

End of questionnaire: Thank you for your cooperation

Appendix E

Science Classroom Cognitive Processes and Motivation Questionnaire – Group Work

What school are you at? . . . .

What year are you in? . . . . . .   Female: Male:

Science Classroom Cognitive Processes and Motivation Questionnaire – Group Work

Instructions: The statements below are about the type of thinking processes you used and the type of motivation you had during group work in science today. If you feel the statement is "not at all true" of you, then circle the 1. If you feel the statement is "very true" of you, then circle the 7. If you feel somewhere in between these two then circle the number that best describes how you feel about the statement.

There are no right or wrong answers for these statements; the researchers are interested only in type of thinking processes you used and the motivation you had while you worked with other students in your group in today's lesson. It is important that you report only on what happened during the group work and nothing else.

Regarding today's group work in science:

Statement	1	2	3	4	5	6	7
	not at all true of me			moderately true of me			very true of me
1. I liked this activity.	1	2	3	4	5	6	7
2. I get a lot out of discussions with other students during group work.	1	2	3	4	5	6	7
3. I prefer this type of learning activity.	1	2	3	4	5	6	7
4. I think I am skilled at working with others.	1	2	3	4	5	6	7
5. I dislike working with other students.	1	2	3	4	5	6	7
6. I don't mind learning with the other students in a group.	1	2	3	4	5	6	7

Questions continue over →

Regarding today's group work in science:

Item	1 (not at all true of me)	2	3	4 (moderately true of me)	5	6	7 (very true of me)
7. I tried to do better than the others at this task.	1	2	3	4	5	6	7
8. I wanted to understand in order to get a high mark in the test.	1	2	3	4	5	6	7
9. I participated since I want to get a high mark in this class.	1	2	3	4	5	6	7
10. I wasn't concerned about being better than the others.	1	2	3	4	5	6	7
11. I asked and answered questions in order to show that I knew more than the others.	1	2	3	4	5	6	7
12. I tried to learn all the things since that would help me to do very well in the test.	1	2	3	4	5	6	7
13. I was worried that the others were better than me at the activity.	1	2	3	4	5	6	7
14. It didn't concern me if I asked a "dumb" question.	1	2	3	4	5	6	7
15. I tried to understand in order to avoid being beaten by the other students in the test.	1	2	3	4	5	6	7
16. I didn't want to do anything in front of others that may result in a mistake.	1	2	3	4	5	6	7

Questions continue over →

Regarding today's group work in science:

17. I was worried that my group would do the wrong thing and I would be disadvantaged for the test.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
18. I thought this activity was good because the teacher and the whole class couldn't see me make mistakes.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
19. Getting other points of view is helpful for my understanding.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
20. I was able to ask questions that helped me to check my understanding.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
21. The group discussions were useful in helping me to try to understand.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
22. I liked learning with others because they asked and answered questions and that process helped me to understand.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
23. Working with other students helped me to improve my knowledge and skills.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
24. It was OK if the group messed around because I don't like learning.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
25. I focused on not making any mistakes in my learning.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me
26. This activity was OK because I could do only the things that I am good at – the other students would do the other things.	1 not at all true of me	2	3	4 moderately true of me	5	6	7 very true of me

Questions continue over →

Regarding today's group work in science:

27. I do not worry if I make errors.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

28. I only took part when I was comfortable with the discussion topic.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

29. I liked this activity since I had control over what I could be successfully involved in.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

30. I avoided the tasks or situations that I thought I would make mistakes in.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

31. I got involved in the group discussion.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

32. I listened to the others and linked their comments to my understanding.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

33. I asked questions if I didn't understand.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

34. I challenged what the others were saying in order to check if we were on the right track.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

35. Often I thought about the purpose of this activity.

1 2 3 4 5 6 7

not at all true of me — moderately true of me — very true of me

Questions continue over →

Regarding today's group work in science:

36. I checked what the others were thinking by asking for their views.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
37. I discussed my understanding with the others in order to see how their understanding connected with mine.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
38. I didn't pay attention at all during this activity.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
39. I let the others do the thinking.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
40. I waited and copied off the smartest people in the group at the end.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
41. When I got stuck I gave up.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
42. I was easily distracted.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
43. When I was unsure of what to do, I didn't bother finding out what I should have done.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
44. I thought or talked about things that were not part of the science work.	1	2	3	4	5	6	7		
	not at all true of me			moderately true of me			very true of me		
45. What is your ability level in this science class?	1	2	3	4	5	6	7		
	very low			moderate			very high		
46. What test mark do you usually get in this science class?	1	2	3	4	5	6	7		
	very low			moderate			very high		

End of questionnaire: Thank you for your cooperation

Appendix F

CODE OF ETHICS AND INFORMED CONSENT FORM

F.1 Code of Ethics

I have based my code of ethics on that developed by The Australian Association for Research in Education (Bibby, 1997). The four basic principles of this code include:

1. The consequences of a piece of research, including the effects on the participants and the social consequences of its publication and application, must enhance the general welfare.

2. Researchers should be aware of the variety of human goods and the variety of views on the good life, and the complex relation of education with these. They should recognise that educational research is an ethical matter, and that its purpose should be the development of human good.

3. No risk of significant harm to an individual is permissible unless either that harm is remedied or the person is of age and has given informed consent to the risk. Public benefit, however great, is insufficient justification.

4. Respect for the dignity and worth of persons and the welfare of students, research participants, and the public generally shall take precedence over self-interest of researchers, or the interests of employers, clients, colleagues or groups (p.116).

Consent

Informed consent must be given to all students. This information should include the risks involved to participants, the methods to be used, the aims of the research and "…any other factors which might reasonably be expected to influence their willingness to participate" (p. 117, Bibby, 1997). Informed consent will be prepared using the following guidelines adapted by the Institutional Guide to DHEW (1971, cited in Cohen and Manion, 1994):

1. A fair explanation of the procedures to be followed and their purposes.
2. A description of the attendant discomforts and risks reasonably to be expected.
3. A description of the benefits reasonably to be expected.
4. A disclosure of appropriate alternative procedures that might be advantageous to the participants.
5. An offer to answer any inquiries concerning the procedures.
6. An instruction that the person is free to withdraw consent and to discontinue participation in the project at any time without prejudice to the participant (p.351).

Confidentiality

I will report the results of the study such that anonymity is maintained. If my study is published then I will see that the publishers give written assurance that anonymity is maintained.

Harm

My study is designed to minimise harm to all concerned with it. In so doing, I have considered the following:

- potential physical situations;
- missing part of the curriculum;
- losing any learning time; and
- losing self-esteem as a result of, completing questionnaires.

Deception

I will provide to all concerned the particulars of the study including research methods.

Outcomes

The students and school will be informed of the results.

Reports of the research

I will pursue my study with the utmost integrity and honesty. I will not fabricate any results or findings. All data will be used in the final report. I will report on any problems that arise during my study thereby allowing future researchers to learn from my work. The report, if published, will maintain confidentiality and be available to the widest possible audience so that personal benefit is not maximised.

Signed: . . . . Date: . . . .

References

Bibby, M. (Ed.). (1997). *Ethics and education research.* Victoria: Australian Association for Research in Education Inc. [AARE].

Cohen, L., & Manion, L. (1994). *Research methods in education* (4th ed.). London: Routledge.

F.2 Informed Consent Form 1

Classroom research study title:

The Interaction of Achievement Goal Orientations, Self-Regulated Learning and Learning Environment in High School Science Classrooms.

Intent of this form

This form is one of informed consent pertaining to a study that investigates the effects of constructivist-based pedagogical factors on the achievement goal orientations (personal and classroom) and self-regulated learning of high school science students.

Procedure

1. Administration of three questionnaires to the students of classes involved in the study: year 9 high school science students and year 11 science students. The three questionnaires, the *Constructivist Learning Environment Survey*, the *Motivated Strategies for Learning Questionnaire* and *Science Classroom Motivation Questionnaire* (macro-level), are administered in order to ascertain the type of classroom learning environment, with respect to a constructivist approach to learning, motivational beliefs, the self-regulated learning employed (personal and classroom) and the achievement goal orientations (personal and classroom) of the students in their normal learning of science. This is measuring the students' aptitude with respect to these parameters and hence forms a macro-level of analysis.

2. Upon completion of their courses, the classroom teacher will be asked to submit a final course mark for the students who completed the questionnaires to the researcher. This mark will form a measure of the academic achievement of each student.

3. The questionnaires' data will be statistically analysed by the researcher.

Risks involved

Since this study is based on existing teaching practice of the classrooms concerned, there are no physical or emotional concerns involved.

Benefits of this study

This study will focus on what aspects of teaching practice in science education influence the achievement goal orientations and self-regulated learning of high school science students. This will be of use to teachers of science and educational researchers.

Inquiries

All questions relating to this study are welcomed.

Withdrawal of consent

Any participant is free to withdraw from this study without prejudice to the participant.

Signed: . . . . Date: . . . .

Status: Teacher and researcher

C.3 Informed Consent Form 2

Classroom research study title:

The Interaction of Achievement Goal Orientations, Self-Regulated Learning and Learning Environment in High School Science Classrooms

Intent if this form

This form is one of informed consent pertaining to a study that investigates the effects of various teaching and learning episodes (teacher lecture or presentation, teacher-led discussion, group work and computer-use) on the achievement goal orientations and self-regulated learning of high school science students.

Procedure

1. Administration of three questionnaires to the students of classes involved in the study: Year 8/9 high school science students, and Year 11 science students; both classes are taught by the same teacher. The three questionnaires, the *Constructivist Learning Environment Survey*, the *Motivated Strategies for Learning Questionnaire* and *Science Classroom Motivation Questionnaire* (macro-level), are administered in order to ascertain the type of classroom learning environment, with respect to a constructivist approach to learning, the self-regulated learning employed and the achievement goal orientations of the students in their normal learning of science. This is measuring the students' aptitude with respect to these parameters and hence forms a macro-level of analysis. The students' answers will be anonymous – no name is needed on the questionnaires.

2. After a period of normal teaching, students will be required to complete a series of four micro-level questionnaires in order to determine the effect of certain learning episodes learning episodes (teacher lecture or presentation, teacher-led discussion, group work and computer-use) on their achievement goal orientations and self-regulated learning. For example, after the teacher has explained something, a task that may take 5 or 15 minutes, the students will be given the micro-level questionnaire *Science Classroom Cognitive Processes and Motivation Questionnaire - Teacher Explanation* to complete.

3. Several students from each class involved in the study will be interviewed by the researcher. Again, the students' answers will be anonymous and confidentiality will be maintained during and after the study in question.

4. For the classes involved in the constructivist-based lessons, the same process described above is conducted.

5. The questionnaires' data will be statistically analysed by the researcher. This analysis will be complemented by the qualitative data gleaned from the interviews.

Risks involved

Since this study is based on existing teaching practice of the classrooms concerned, there are no physical or emotional concerns involved.

Benefits of this study

This study will focus on what aspects of teaching practice in science education influence the achievement goal orientations and self-regulated learning of high school science students. This will be of use to teachers of science and educational researchers.

Inquiries

All questions relating to this study are welcomed.

Withdrawal of consent

Any participant is free to withdraw from this study without prejudice to the participant.

Signed: . . . . Date: . . . .

Status: Teacher and researcher