Science and Mathematics Education Centre

The Influence of Classroom Environment on Students' Motivation and Self-Regulation

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

June 2012

DECLARATION

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

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Signature: …………………………….

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1 June 2012

ACKNOWLEDGEMENTS

I wish to take this opportunity to express my sincere gratitude to my supervisor, Associate Professor Jill Aldridge. I am greatly indebted to her for all the guidance, constructive comments and intellectual inspirations that made me complete this research within the prescribed time. Her dedication, encouragement and support motivated me to strive and do my best in this academic journey. My sincere thank you also goes to Professor Barry Fraser, my co-supervisor, for all the valuable suggestions, directions and support. My supervisors' active involvement and interest in my work motivated me to publish this research in journals and present it at conferences. The publication and presentation of my research has been an invigorating and rewarding learning experience.

I would like to extend my sincere thanks to numerous other staff in the Science and Mathematics Education Centre, Curtin University especially Professor David Treagust, Dr Tony Rickards and Dr Christine Howitt who have contributed towards my growth as a student and researcher. My appreciation also goes to Ms Petrina Beeton and Mrs. Rosalie Woods for their administrative support throughout my doctoral study.

This piece of work could not have been completed without the unconditional love of my family members especially the support of my beloved children Sarveen and Sharmilla. The final heartfelt thank you goes to my beloved husband, Gunasegaran for his invaluable assistance, encouragement and gift of love and patience in seeing me through this research. You will always be my source of inspiration, love and affection.

ABSTRACT

Students’ motivational beliefs and self-regulatory practices have been identified as instrumental in influencing the engagement of students in the learning process. An important aim of science education is to empower students by nurturing the belief that they can succeed in science learning and to cultivate the adaptive learning strategies required to help to bring about that success. The lack of research on the influence of the learning environment on students’ motivation and self-regulation provided the impetus for this research. The primary aim of this study was to investigate and identify salient psychosocial features of the classroom environment that influence students’ motivation and self-regulation in science learning.

The first imperative was the development and validation of an instrument to measure salient factors related to the motivation and self-regulation of students in lower secondary science classrooms. The development of the instrument involved identifying key determinants of students’ motivation and self-regulation based on sound theoretical and research underpinnings. Once the instrument was developed, a pilot study involving 52 students from two grade 8 science classes was undertaken in addition to in-depth qualitative information gathered from 10 experienced science teachers and 12 grade 8 students. Quantitative data were collected from 1,360 students across grades 8, 9 and 10 in five public schools in Perth, Western Australia. Analyses of the data suggest that the survey has strong content, face, convergent, discriminant, concurrent and predictive validity when used with lower secondary students. Quantitative data, gathered from the same sample, established the convergent, discriminant, concurrent and predictive validity of the What Is Happening In this Class? (WIHIC) learning enviromnment instrument when used in lower secondary science classes.

Partial Least Square (PLS) based Structural Equation Modeling (SEM) analysis of the data found that students’ perceptions of investigation, task orientation and student cohesiveness were key determinants of students’ motivation and self-regulation in science learning. The extent to which students' perceive the teacher to be supportive was strongly associated with their learning goal orientation and task value, whilst student involvement was a strong predictor of self-efficacy in science learning. The findings indicated that all three motivational constructs (learning goal orientation, task value and self-efficacy) were strong predictors of students' self-regulation in science learning. The most influential motivational belief on boys' and girls' self-regulation is self-efficacy followed by learning goal orientation. Although for boys the influence of task value was significant, for girls this construct appeared to have a limited impact on their self-regulation in science learning.

The present study made distinctive contributions to the field of learning environment as well as to science education as it was the first study in within the field of learning environment research to examine the influence of psychosocial learning environment on both student motivation and self-regulation in the area of science learning. The methodological contribution is the use of a comprehensive and rigorous construct validity framework to develop and validate an instrument to measure students' motivation and self-regulation in science learning. The use of the PLS based SEM data analyses in the examination of the research model provided renewed rigor and depth to the interpretation of results. The practical implications presented possible opportunities for educators to plan, and to put into practice, effective pedagogical strategies aimed at increasing students' motivation and self-regulation in science learning. The results from the moderating role of gender could be utilised to design targeted intervention programmes that may differ in terms of orientation for girls and boys. The newly-developed survey could be practically valuable as an expedient tool for gathering information that may guide classroom teachers in refocusing their teaching practices and help to evaluate the effectiveness of intervention programmes. Although the focus of this research is on science learning, the findings probably could help educators to understand and improve student motivation and self-regulation in other subject areas.

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INTRODUCTION

> "…*we see that there is clear evidence that the curriculum and classroom practice is failing to excite the interest of many if not most young people at a time when science is a driving force behind so many developments and issues in contemporary society*."
>
> *(Tytler, 2007, p.15).*

1.1 Background to the Study

Reviews of contemporary science education around the world highlight the current crisis of disappointingly low student achievement and enrolments in science courses and call for major reforms focused on engaging all young people in science learning (Osborne & Dillon, 2008; Sjøberg & Schreiner, 2010; Tytler, 2007). According to these reviews, the failure of school science is mainly attributed to the inability of science curricula and classroom practices to ignite the interest of students to learn science. Whilst important, these reviews provide minimal insights into the factors that contribute towards the decline in student interest. In view of this, the present study endeavours to provide important understanding of factors that determine students' engagement in science learning.

The consensus amongst theorists is that students' successful learning engagement in science is primarily determined by their level of motivation and self-regulation in science learning (Boekaerts & Cascallar, 2006; Hanrahan, 2002; Kaplan, Lichtinger & Gorodetsky, 2009; Zimmerman, 2000). Indeed, one of the foremost aims of science education is to motivate and empower students by nurturing the belief that they can succeed in science learning and to cultivate the self-regulatory strategies that are required to help to bring about that success. Students' self-regulation in academic settings has been identified as a pivotal construct that influences students' engagement in learning and their achievement in school (Boekaerts & Cascallar, 2006). Zimmerman (2000) argues, however, that self-regulatory skills are of little value to students if they cannot motivate themselves to use them. Kaplan et al. (2009) proposed that, in order to facilitate self-regulated learning in a subject matter, educators should first focus on understanding students' motivational beliefs. Hanrahan (2002) reiterates that an essential key to successful science learning is a positive motivational belief that mobilises otherwise inert knowledge.

The term 'adaptive' is widely used in educational psychology to describe characteristics that promote students' engagement in learning (Ames, 1992; Dweck, 1986; Kaplan & Maehr, 2007; Martin, 2007; Midgley, 2002; Pintrich, 2000). Students with adaptive characteristics are more likely to be focused on mastering academic tasks and more willing to provide sustained effort to engage in the process of learning (Ames, 1992). According to Dweck (1986, p. 1040), students' adaptive motivational beliefs "promote the establishment, maintenance, and attainment of personally challenging and personally valued achievement goals". Pintrich (2000) argued that both adaptive motivational beliefs and adaptive self-regulated learning are integral to students' engagement in classroom tasks.

Based on the above discussions, one of the primary aims of this research was to analyse and identify factors that contribute towards students' adaptive motivated and self-regulated learning engagement in science and to develop a questionnaire that could be used to assess these salient factors economically. Practically, this instrument will provide instructors with a reliable, valid and convenient tool for gathering from science students, information on student motivation and self-regulation to guide classroom teachers in directing and focusing their teaching practices. It also could be used as an instrument for evaluating the effectiveness of instructional strategies and materials designed to increase students' interest, confidence and competence in science as they progress through school.

While contemporary research in psychology draws attention to the importance of developing self-belief and self-regulatory capabilities in students (Zimmerman, 2008), the field of leaning environment research focuses on classroom life, usually from the students' perspective (Fraser, 2007). Research conducted over the past 40 years has consistently shown that the quality of the classroom environment in schools as an important determinant of students' learning engagement (Fraser, 2007, in press). That is, students are likely to learn better when they perceive their classroom environment positively. According to Hanrahan (2002), research on science pedagogy suggests that the dynamics of science classrooms can be influential in alienating students before they have a chance even to begin to engage with science concepts.

Bandura's (1986) social cognitive theory, construes human functioning as a series of reciprocal interactions between personal influences, environmental features and behaviours. The notion of reciprocal interactions illustrates how the environment can affect thoughts, beliefs, and behaviour. Urdan and Schoenfelder (2006) argue that it is important to embrace the social-cognitive view of student motivation and to understand that altering controllable factors in the classroom environment could considerably enhance students' motivation towards learning. Schunk and Zimmerman (2007) emphasised that teachers ultimately have the responsibility for increasing their students' positive self-beliefs and capacity towards learning as they progress through school.

Zimmerman (2008) contends that the effect of classroom stimulators and constraints on changes in students' self-regulated learning is important and should be studied further. Urdan and Schoenfelder (2006) propose that enhancing student motivation requires attention to the key features of the classroom learning environment that are likely to influence student motivation. The present study took up these suggestions by specifically investigating psychosocial aspects of learning environment and their influence on students' development of motivational beliefs and self-regulation in science learning. Hence, the foremost aim of this research is to inform practitioners and policy makers about which factors within the psychosocial learning environment are likely to enhance students' motivation and self-regulation in science learning. This information could guide teachers in directing and focusing the science classroom environment in an attempt to cultivate students' motivational beliefs and self-regulatory strategies required to succeed in science learning.

The transition to lower secondary school (ages 12-15) is a distinct and critical developmental period for students whereby they are expected to develop a sense of identity, institute and sustain a positive social network that supports them, and efficiently balance social, academic and personal demands (Cleary & Chen, 2009). For most students, this transition represents an overwhelming experience because of the transfer in emphasis from the supportive, mastery-based setting distinctive of elementary schools to a performance-based orientation exemplified by a greater demand on academic achievements, an increased focus on normative comparisons and intensive teacher directed instructions (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Midgley & Edelin, 1998; Schunk & Miller, 2002; Zimmerman, 2002).

The change in teacher-student relationships is further complicated by the growing prominence of peer relationships in early adolescence (Urdan & Schoenfelder, 2006). In addition, these students are expected, by teachers, to manoeuvre and direct their cognitive and motivation processes to become self-regulated learners (Zimmerman, 2002). According to Cleary and Chen (2009, p. 292), examining students' motivation and self-regulation at this transition stage is an essential undertaking "because these processes have consistently been shown to predict adaptive classroom and academic outcomes". Hence, to add to the literature on lower secondary students, this study took up the imperative to investigate the psychosocial classroom environment elements that could influence lower secondary students' motivation and self-regulation in science learning.

According to the Programme for International Student Assessment (2009), the imperative for gender studies can be seen from these three angles: i) to understand the source of any inequalities; ii) to improve average performance; and iii) to improve our understanding of how students learn. Gender gaps point to domains where student characteristics could significantly affect student learning and performance. Hence, gender differences studies provide perceptions on what drives differential student performance to facilitate the design of effective educational policies to address equity concerns. Britner (2008, p. 968) states:

> The full inclusion of girls and women alongside boys and men in science endeavours is not only an issue of equity, but also important for the full inclusion of talents and perspectives on science and its place in society.

The gender gap issues in science education have been well documented over many years and are still persistent and pervasive today (Baker, 2002; Britner, 2008; Ivie, Czujko & Stowe, 2002; Meece, Glienke & Burg, 2006; Watt, 2008a, 2010). Contemporary science education reviews suggest that gender differences continue to exist for student achievement, selection of science courses and careers in science. Due to these distinct gender variations, coupled with the differences in the way that students' learn science, it is vital that science educators both know of and respond to them (Osborne & Dillon, 2008; Programme for International Student Assessment, 2009; Thomson, Wernet, Underwood & Nicholas, 2008). In line with this challenge, the present study explores this subject in relation to the role of gender in students' motivation and self-regulation in science learning.

Distinctively, the present research differs from the familiar method applied by the majority of gender studies which examine mean level differences in key dimensions of motivation (Martin, 2004). The traditional method obtains differences of degree and provides information about whether boys or girls scored higher in particular motivational domains (Martin, 2004). In contrast, the present study focuses on how key facets of motivation influence students' self-regulation and whether these influences differ for boys and girls. Practically, the results provide information to practitioners regarding the most constructive approach towards improving students' self-regulation in science learning. In addition, understanding what drives differential student self-regulation in boys and girls can promote the design of targeted intervention programs to tackle equity issues.

1.2 Research Objectives

Five pertinent research objectives evolved from the discussions on the background of this study. Essentially, the research objectives sought to gather information on the influence of psychosocial learning environment on students' motivation and self-regulation in science learning. The objectives of this research are to:

1. Develop and validate the Students' Adaptive Learning Engagement in Science (SALES) questionnaire to assess lower secondary students' motivation and self-regulation in science learning.

2. Validate the What Is Happening In this Class? (WIHIC) questionnaire when used in lower secondary science classes in Western Australia.

3. Investigate the psychosocial learning environment elements that influence lower secondary students' motivation and self-regulation in science learning.

4. Investigate whether lower secondary students' motivational beliefs influence their self-regulation in science learning.

5. Investigate the moderating role of gender in the relationships between lower secondary students' motivational beliefs and self-regulation in science learning.

1.3 Significance of Research

The present research has the elements of theoretical, methodological and practical significance for science education. As this is the first study within the field of learning environment research to examine the influence of psychosocial learning environment on both student motivation and self-regulation in the area of science learning, the theoretical contribution could benefit both the fields of learning environment and educational psychology. The convergence of these two fields adds to the literature on students' engagement in science learning and may set the precedent for future studies.

This study serves to bridge the research gap in the examination of the influence of the students' motivational beliefs on their self-regulation in science learning. Lower secondary students have been the focal point of past research because these students undergo a distinct and critical developmental period due to transition from primary to secondary school. Since the sample for this study are students in years 8, 9 and 10 (ages 12–15), the findings will add to the literature on lower secondary years. Finally, the gender issues in science education investigated in this study would provide perspectives on how the influences of students' motivational beliefs on self-regulation in science learning differ for boys and girls.

The first methodological contribution of this study is the methods used in the development and validation of an instrument to measure students' motivation and self-regulation in science learning. To establish the validity of the newly developed instrument, a comprehensive construct validity framework, which ascertains content, face, convergent, discriminant, predictive and concurrent validity, was used. This exacting method could be replicated by future researchers who wish to develop and validate new questionnaires. Additionally, for the first time, the widely used WIHIC questionnaire underwent rigorous validity analyses, from the same construct validity framework, to concomitantly determine convergent, discriminant, predictive and concurrent validity.

Another methodological contribution is the use of PLS (Partial Least Squares) a SEM (Structural Equation Modeling) based programme for data analyses. The PLS confirmatory factor analysis conducted on both the SALES and the WIHIC questionnaires, adds credibility to the instruments. In addition, the use of PLS, a powerful statistical tool for prediction-oriented research, enabled the effective examination of the proposed relationships in the complex exploratory research model. Furthermore, the use of PLS based multi-group analysis to examine gender moderation allowed the present study to progress from conventional gender differences studies that in general evaluate mean level differences in key dimensions of motivation and self-regulation. This research method could be used in future studies to derive information related to the moderating role of gender .

One practical contribution of this study is the identification of salient psychosocial elements in the classroom learning environment that influence students' motivation and self-regulation in science learning. The findings provide the opportunity for educators to efficiently plan targeted pedagogical strategies to increase students' motivation and self-regulation in science learning. Additionally, the results on gender moderation provide information to practitioners about the differential ways in which students' motivational beliefs influence their self-regulation in science learning. This information can be utilised to design intervention programs that may differ in terms of orientation and application for girls and boys.

Another practical contribution of the present study is the newly developed and validated SALES instrument which measures students' motivation and self-regulation in science learning. This survey provides researchers and teachers an expedient tool for gathering information on imperative aspects of students' learning engagement in science. Teachers could use the information to refocus their pedagogical approaches for example, by implementing and evaluating instructional strategies that has the potential of increasing students' motivational beliefs and self-regulation in science learning. This survey could also be used to assess the effectiveness of intervention programs that aim to enhance students learning engagement in science learning. Although the survey measures students' motivation and self-regulation in science learning, it could be modified for use in other domains of learning.

1.4 Thesis Overview

The thesis is organised into six chapters. Chapter 1 communicates the context and background of the thesis by highlighting the current crisis in students' engagement in science learning. Students' motivation and self-regulation were identified as pivotal constructs that influence students' engagement in learning and their achievement in school. The imperative to identify factors that contribute towards students' adaptive motivational and self-regulated learning engagement in science as well as the need to develop a questionnaire that could be used to assess these salient factors were clarified. This chapter details the importance of investigating psychosocial elements of the learning environment that may influence students' motivation and self-regulation. In addition, the chapter argues the necessity to focus on lower secondary students who are undergoing a critical transition and developmental period. The chapter then provides an explanation of the need for gender difference studies to address equity issues. These discussions, related to the background of the research, led to the formation of five pertinent research objectives. These research objectives centred on investigating the influence of psychosocial learning environment on students' motivation and self-regulation in science learning. Finally, the chapter provides the theoretical, methodological and practical implications of the present research.

Chapter 2 reviews the relevant literature for the present study. The chapter begins with reviews of literature related to the social cognitive theory and explains how this theory underpins the development of the research model postulated in this study. This is followed by the elucidation of literature related to students' key motivational beliefs namely, learning goal orientation, task value and self-efficacy. The importance of self-regulation in science learning and the specific construct of self-regulation of effort, examined in the present study, are detailed. Importantly, the research gap in terms of the influence of psychosocial learning environment on students' motivation and self-regulation, is clarified. Additionally, the review of past questionnaires emphasises the need for the development and validation of an instrument to assess students' motivation and self-regulation in science learning. The review then examines gender differences in student motivation and self-regulation and justifies the focus of the present study on the moderating role of gender on the relationships between students' motivation and self-regulation. Finally, literature related to the field of learning environment research is reviewed with respect to the history of the field, extant learning environment instruments and areas of past research.

Chapter 3 describes the research methods used in the present study. The research model, which hypothesises that each of seven psychosocial aspects of the learning environment individually influences each of the three motivational constructs and the self-regulation construct, is presented. The research model also predicts that students' motivational beliefs would influence their self-regulation and that these influences would differ for boys and girls. Details of the instruments, sample selections and data collection procedures for the pilot study as well as for the main study are provided. Since this study involved two types of data analysis, the explanation of the data analysis procedures is divided into two sections. First, the procedures for the validation of the questionnaires, which utilises a construct validity framework is explained. This is followed by descriptions of the Structural Equation Modeling (SEM) data analysis procedures for the evaluation of the research model.

Chapter 4 presents the results of data analyses for the validation of the questionnaires used in this study. First, the sample demographics for the main study are presented. The data analyses for the validation of the Students' Adaptive Learning Engagement in Science (SALES) questionnaire (developed for this study to measure students' motivation and self-regulation in science learning) are then detailed. Findings from qualitative data analyses are presented to establish the content and face validity of the questionnaire. The results of the quantitative data analyses conducted to ascertain the convergent, discriminant, concurrent and predictive validity of the SALES questionnaire are then detailed. Finally, the results of quantitative data analyses of the What Is Happening In this Class (WIHIC) learning environment instrument to examine convergent, discriminant, concurrent and predictive validity are provided.

In Chapter 5, the results of SEM analyses utilised in the evaluation of the research model are presented. The Partial Least Square (PLS) based SEM analyses involved assessment of the measurement properties through confirmatory factor analysis followed by assessment of the research model. The confirmatory factor analyses examined both the convergent and the discriminant validity of the SALES and WIHIC questionnaires. The second stage of the data analysis, the assessment of the research model, included the assessment of the explanatory power of the proposed model and the testing of the hypothetical relationships in the model. For the moderating effects of gender, the multi-group analysis method was used to determine whether the differences between the hypothesised relationships were statistically significant.

Chapter 6 provides a discussion of the results and implications of data analyses. The implications for each of the accepted hypotheses are complemented with practical propositions for both policy makers and science educators. The significant theoretical, methodological and practical contributions of the research are highlighted. The thesis concludes with discussions of the limitations of the study and suggestions for possible future research directions.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This review of literature begins by examining the social cognitive theory, particularly with respect to its relevance to the present study. Section 2.2 explains how this theory has provided the foundation for the development of the research model postulated in this study. Section 2.3 reviews literature related to students' motivational beliefs, specifically, those of learning goal orientation, task value and self-efficacy as key determinants of students' successful science learning. In addition, this section reviews past questionnaires developed to assess students' motivation. Section 2.4 clarifies the importance of self-regulation in science learning and specifies the component of self-regulation that is examined in the present study. This section also reviews past questionnaires that have been used to evaluate students' self-regulation. Sections 2.3 and 2.4 highlight research gaps in terms of the influence of psychosocial learning environment on students' motivation and self-regulation and the need for the development of an economical and theoretically inclusive instrument to assess students' motivation and self-regulation in science learning. Section 2.5 discusses gender differences in student motivation and self-regulation to elucidate the focus of the present study (the moderating role of gender on the relationships between students' motivational beliefs and self-regulation). Finally, Section 2.6 reviews literature related to the field of learning environment research including details of the history of this field, extant learning environment instruments and areas of past research. In particular, discussions related to the history, instruments and past research in this field are focused in explicating their relevance to the current study.

2.2 Social Cognitive Theory

The present study draws on Bandura's (1986) social cognitive theory, which construes human functioning as a series of reciprocal interactions between personal influences (e.g., thoughts, beliefs), environmental features (e.g., classrooms) and behaviours (e.g., self-regulation). Hence, this theory describes human learning in terms of the interrelationships between personal, environmental and behavioural determinants as illustrated in Figure 2.1. The underpinning of the social cognitive theory is the view of human agency, which posits that individuals are agents who are proactively engaged in their own development and have the ability to make things happen by their actions. Central to this sense of agency is the fact that, among other personal factors, individuals possess self-beliefs that enable them to exercise a measure of control over their thoughts, feelings and actions, that "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25).

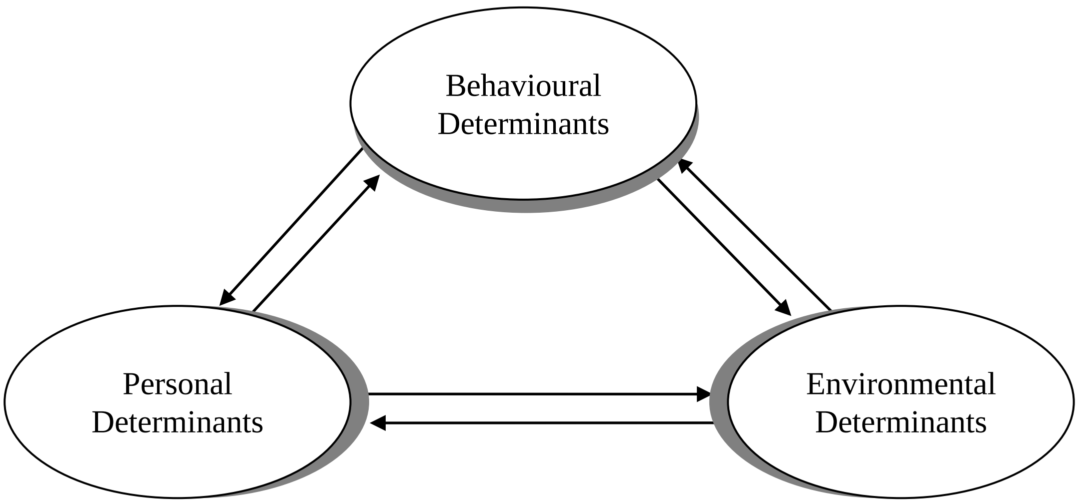


Figure 2.1: Social cognitive theory

This integral theory has provided the groundwork for the development of both constructivism and cooperative learning, both of which are considered to be strong tenets of contemporary science education. Furthermore, because the underlying concept of social cognitive theory is focused on understanding an individual’s reality, it is especially useful when applied to interventions aimed at personality development and behavioural change. Hence, by using the social cognitive theory as a framework, teachers are able to alter school and classroom structures that may undermine student success (environmental factors), work to improve their students’ emotional states to improve their beliefs about themselves and their habits of thinking (personal factors) and improve their academic skills and self-regulatory practices (behaviour).

The focus of this research was to examine the influence of classroom environmental features on students' motivational beliefs and self-regulation in science classrooms. In addition, the influence of students' motivational beliefs on their self-regulation in science learning was investigated. The research model for this study, based on the social cognitive theory, is illustrated in Figure 2.2.

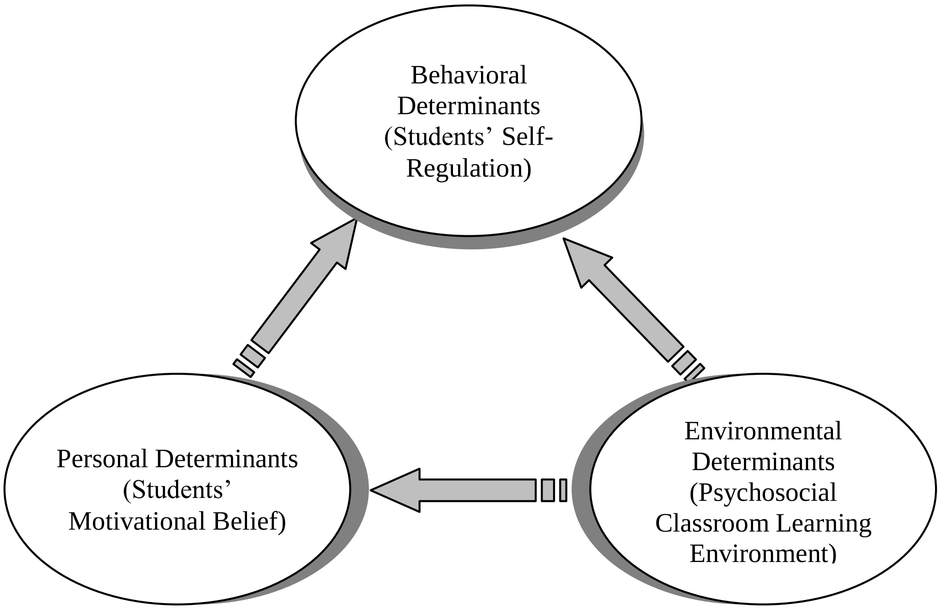


Figure 2.2: Research model based on the social cognitive theory

Figure 2.2 highlights how classroom learning environment can affect both students' beliefs and behaviours. Urdan and Schoenfelder (2006) argue that it is important to embrace the social-cognitive view of student motivation and to understand that altering controllable factors in the classroom environment could enhance students' motivation towards learning. According to Schunk and Zimmerman (2007), students' social environment can influence both their affective domains and behaviours. Additionally, teachers, as an integral component of the classroom environment, can inspire students by creating a favourable classroom environment where students feel more personally efficacious and motivated and, therefore, will work harder to succeed.

Schunk and Zimmerman (2007) argue that, ultimately, teachers have the responsibility to increase their students' competence and confidence towards learning as they progress through school. Hence, this study aimed to inform practitioners and policy makers about which factors within the learning environment are likely to enhance students' motivational beliefs and self-regulation in science learning. In addition, this study endeavoured to identify salient motivational beliefs that influence students' self-regulation in science learning. This information could guide teachers in directing and focusing the science classroom to develop and cultivate students' self-regulation.

2.3 Motivation

Theobald (2006) asserted that one of the greatest challenges for teachers in this century is to provide a learning environment that stimulates students' motivation to learn. Motivation is the internal circumstance that instigates and focuses goal-oriented behaviour (Schunk, 2004). In studying students' motivation to learn science, researchers have examined "why students strive to learn science, how intensively they strive, and what beliefs, feelings, and emotions characterise them in this process" (Glynn, Taasoobshirazi & Brickman, 2009, p. 128). Research has indicated that motivated students are the key to successful learning engagement in classrooms (Pajares, 2001, 2002; Pajares & Schunk, 2001). In order to improve their academic achievement, these students are more likely to increase class attendance, participate in class activities, ask questions and advice, join study groups and increase their study time.

Specifically, in science learning, research indicates that students' motivation plays a pivotal role in their conceptual change processes, critical thinking, learning strategies, and science achievement (Glynn, Taasoobshirazi & Brickman, 2007; Kuyper, van der Werf & Lubbers, 2000; Lee & Brophy, 1996; Napier & Riley, 1985; Pintrich, Marx & Boyle, 1993; Wolters, 1999). Three components of motivation that have been consistently researched are learning goal orientation, task value, and self-efficacy, each of which is integral to self-regulated learning (Zimmerman, 2002). The following discussions provide both theoretical and research evidence that supports the importance of these motivational components in successful science learning.

2.3.1 Learning Goal Orientation

According to Elliot and Murayama (2008, p. 614) “a goal is conceptualised as an aim one is committed to that serves as a guide for future behaviour”. Goal orientation provides important theoretical perspectives that help to explain the reasons for students’ engagement in a task (Pintrich, 2000). In the last twenty years, achievement goal theory has emerged as one of the most prominent theories of student motivation (Kaplan & Maehr, 2007; Midgley, 2002; Wigfield & Cambria, 2010). In addition, this theory provides a constructive framework within which researchers have attempted to understand and enhance students’ adaptive patterns of learning engagement (Kaplan & Maehr, 2007).

According to achievement goal theory, there are two major types of goal orientation, namely, learning goal orientation (which refers to the purpose of developing competence and focuses on learning, understanding, and mastering tasks) and performance goal orientation (which refers to the purpose of demonstrating competence, especially in managing the impressions of others) (Ames, 1992). In learning goal orientation, the learner poses questions such as “How will I do this task?” and “What will I learn?” to reflect this orientation. Conversely, questions such as “Am I doing this task better than my friend?” and “Does completing this task make me look smarter than others?” reflect performance goal orientation (Wigfield & Cambria, 2010).

Performance goal orientation is prevalent in school settings and teachers often believe that it is a necessary tool in motivating performance and achievement in education (Wigfield & Cambria, 2010). However, according to Kaplan and Maehr (2007), in many cases, particularly when students are concerned with failure and believe that they are lacking competence to perform effectively, a performance goal orientation can be detrimental. Several researchers, most notably Elliot (1999), have argued that performance goals orientation should be viewed as two distinct motivational orientations namely, performance-approach orientation and performance-avoidance orientation.

The approach orientation refers to a focus on the possibility of achieving success, whereas an avoidance orientation refers to a focus on the possibility of failure and on an attempt to avoid it. Performance-avoidance goal orientation has been associated with low-efficacy, anxiety, avoidance of help-seeking, self-handicapping strategies and low achievement (Urdan, Ryan, Anderman & Gheen, 2002). Although research on performance-approach goal orientation revealed that this orientation is related to persistence, positive affect and higher grades (Elliot, 1999), it also has been associated to negative outcomes such as disruptive behaviour, anxiety and low retention of knowledge (Midgeley, Kaplan & Middleton, 2001). Midgeley et al. (2001) also suggested that performance approach goal had the potential to turn into performance avoidance goal when students undergo changes in their perceived competence.

Urdan and Schoenfelder (2006), in their review of achievement goal theory, concluded that existing research evidence indicates performance goal orientation has the potential to undermine both student motivation and achievement. Kaplan and Maehr (2007), in their extensive review of research in goal orientation, reiterated that performance goal orientations are problematic. Therefore, because performance goal orientation was not considered as an adaptive motivational belief, it was not included in this study.

Conversely, prevailing evidence from past research has indicated that students' learning goal orientation is likely to influence a range of positive learning outcomes including student achievement (Brookhart, Walsh & Zientarski, 2006; Kaplan & Maehr, 1999, 2007). In addition, students who perceive the teacher as emphasising learning goals are more inclined to use adaptive cognitive, emotional and behavioural regulatory strategies (Ames & Archer, 1988; Kaplan & Midgley, 1999; Newman, 1998; Ryan, Gheen & Midgley, 1998; Urdan & Midgley, 2003). More recently, the distinction between approach and avoidance orientations goal was also applied to learning goal. However, according to Pintrich (2003), the limited research conducted on avoidance-learning goal orientation makes it difficult to evaluate its prevalence among students or to provide generalisations regarding the patterns of engagement that are associated with them. Hence the distinction between approach and avoidance of learning goal orientations was not made in the present study.

The positive influence of learning goal orientation on students' affective and cognitive outcomes has been researched through experimental, correlational and qualitative methods (Kaplan & Maehr, 2007). Examples of experimental studies suggest that learning goal orientation is strongly associated with positive coping, positive emotions and persistence (Elliott & Dweck, 1988), use of problem solving strategies and achievement (Bereby-Meyer & Kaplan, 2005) and positive social attitude towards others (Kaplan, 2004). Longitudinal correlation studies report that students' learning goal orientation is a significant predictor of students' interest, choice of major and the number of courses selected (Cury, Elliot, Da Fonseca & Moller, 2006; Harackiewicz, Barron, Tauer, Carter & Elliot, 2000). The results of correlational studies support the relationship between learning goal orientation and a range of students' positive learning outcomes including effort and persistence (Elliot, McGregor & Gable, 1999), employment of deep learning strategies (Elliot et al., 1999; Kaplan & Midgley, 1997), retention of information learned (Elliot & McGregor, 1999), self-efficacy (Kaplan & Maehr, 1999), positive emotions (Roeser, Midgley & Urdan, 1996) and general well-being (Dykman, 1998). Qualitative studies, using interviews, also have found associations between learning goal orientation and students adaptive outcomes. For example, research by Levy, Kaplan and Patrick (2004) reported the influence of learning goals on students' willingness to cooperate with peers. In the area of science learning, Tuan, Chin and Shieh (2005) reported that achievement goal orientation has a significant influence on students' attitude towards science and science achievement.

Kaplan and Maehr (2007, p. 170), in their recent comprehensive analysis of goal orientation theory, found solid theoretical and research evidence demonstrating that learning goal orientation is "an adaptive motivational orientation". Additionally, Wigfield and Cambria (2010), in their review of goal orientations, concluded that motivational theorists agreed upon the benefits of learning goal orientation to students and strongly recommended that this goal orientation be focused on in school. Based on this theoretical and research evidence, learning goal orientation can be assumed to be a key component of students' motivation in science learning and therefore was included as a motivational construct in this study.

Ames (1992) contends that children's inherent characteristics are not the primary source of their goal orientation but rather a result of classroom learning environment antecedents. Anderman and Young (1994) concluded that both theory and research evidence suggest that teachers' instructional practices and procedures influence the goals that students pursue. In particular, for science education, goal orientation theory implies that changes in classroom goal structures could enhance or inhibit the motivation of all students who participate in that classroom (Anderman & Young, 1994). Kaplan and Maehr (2007) reiterate that goal orientation is dependent on the quality of the student's learning and emotional experiences in school. The implication is that "goal orientations are more a product of context rather than the person" (Wigfield & Cambria, 2010, p. 7). Based on this premise, this study hypothesised that the psychosocial elements of the classroom learning environment would be a significant predictor of students' learning goal orientation. Since the influence of the psychosocial aspects of the science classroom environment on students' learning goal orientation has not been systematically researched, this gap in research was bridged by this study.

2.3.2 Task Value

The expectancy-value theory, regarded as one of the major frameworks for achievement motivation, highlights the pivotal role of students' belief about the value of an academic task in structuring students' motivation to learn (Eccles, 1983, 2005; Wigfield & Cambria, 2010). The definition of the term "task value" was based on the qualities of different tasks and how those qualities influence students' desire to do the tasks (Eccles, 2005; Eccles, Adler, Futterman, Goff, Kaczala, Meece & Midgley, 1983; Wigfield & Eccles, 1992). This definition emphasises the motivational feature of task value (Higgins, 2007; Wigfield & Cambria, 2010). In their version of the modern expectancy-value theory, Eccles and Wigfield (2002) emphasised the integral role that task value played in students' achievement-related choices and performance.

Eccles and Wigfield (2002) suggested that there are four major aspects of task value, these being, attainment value (importance of the task), intrinsic value (enjoyment one gains from doing the task), utility value (usefulness of the task) and cost (what one has to give up to do the task). Wigfield (1994), and Wigfield, Tonks and Klauda (2009) postulate that the first component of task value to emerge in an individual is intrinsic value. Attainment value, which is linked to the individual's sense of self, develops during the elementary school years whilst utility value of different tasks takes shape across the school years. Similar to past studies that had measured students' task value (Wigfield & Cambria, 2010), the present study focused on attainment, intrinsic and utility value, merging these three values into a single task value scale, to enable a wide-ranging yet succinct evaluation of lower secondary students' science task values. In addition, since the focus of this thesis was to develop an economical and theoretically inclusive scale, the separation of task value into four different constructs would not benefit the development of an economical scale

Empirical research supports the theoretical claims of association between the value held by a student for a task and his/her cognitive and affective learning outcomes. Wigfield and Cambria's (2010) recent review on research related to the expectancy-value theory concluded that students' task value predicts both intentions and decisions to persist in learning activities. A variety of longitudinal and cross-sectional studies in different subject areas report that task value influences students' academic choices, persistence, performance and achievement (Bong, 2001; Denissen, Zarrett & Eccles, 2007; Durik, Vida & Eccles, 2006; Eccles, 1993; Marsh, Köller, Trautwein, Lüdtke & Baumert, 2005; Meece, Wigfield & Eccles, 1990; Pekrun, 1993, 2009; Simpkins, Davis-Kean & Eccles, 2006; Xiang, McBride & Bruene, 2004).

Watt (2005) examined Australian adolescents' motivation for selecting mathematics-related careers in a study involving 60 grade 9 students. The open-ended interview data revealed that value perceptions (particularly intrinsic value) were most indicative of students' decision of whether or not they elected to participate in higher level mathematics and their intention to pursue mathematics-related careers. In the field of science learning, Tuan et al. (2005) reported that task value influences students' attitudes towards science and science achievement. In sum, both theoretical and research findings indicate that, when students value the tasks given to them, they are more likely to engage and persist in learning which will, in turn, improve their achievement. Based on this theoretical and research support, task value can be distinguished as an integral motivational component in science learning.

Eccles and her colleagues proposed that task value is influenced by a variety of psychological, social, contextual and cultural influences (Eccles, 1987, 1993, 2005; Eccles & Wigfield, 1995; Meece et al., 1990; Wigfield, 1994; Wigfield & Eccles, 1992, 2000, 2002). Wigfield, Eccles and Rodriguez (1998) suggested that the contextual organisation of classrooms and schools (in particular, the reward structures, type of achievement tasks, nature of emphasised outcomes and opportunities for collaboration and decision making) can influence the development of students' task value. However, Wigfield and Cambria (2010), in their review of task value, acknowledged that there is a lack of research on how these and other classroom environment factors influence the development of task values. This study took up their challenge and investigated the influence of students' psychosocial learning environment on students' task value. There has not been previous research on the influence of psychosocial classroom environment on students' science task value and this study has filled this research gap.

2.3.3 Self-Efficacy

More than three decades ago, Bandura (1977) theorised that a potent influence on student behaviour is the beliefs that they hold about their capabilities. Self efficacy is defined as the belief in one's capabilities to achieve a goal or an outcome. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave (Bandura, 1997). Bandura's (1986) social cognitive theory asserts that students are more likely to have an incentive to learn if they believe that they can produce the desired outcomes.

According to Pajares (1996), students with high self-efficacy regard difficult tasks as challenges that need to be mastered. Once these students have ascertained the challenging goals, they endeavour to accomplish these goals by utilising a variety of strategies. In the area of science learning, Britner and Pajares (2006, p. 486) proposed that those students with high levels of science self-efficacy (related to science tasks) were more likely to “select challenging tasks, work hard to complete them successfully, persevere in the face of difficulty, and be guided by physiological indexes that promote confidence as they meet obstacles”. Students with low self-efficacy, on the other hand, are inclined to give up more easily when faced with difficult tasks and were more likely to avoid the tasks compared to their counterparts. Hence, self-efficacy beliefs are considered to be powerful predictors of the choices that students make, the effort that they expend and their persistence in facing difficulties (Bandura, 1997; Britner & Pajares, 2001; Zeldin & Pajares, 2000).

Consistently, past research has supported the theoretical claims and provided convincing evidence that students’ self-efficacy beliefs are significantly related to positive cognitive and affective outcomes. For example, self-efficacy is positively related to persistence (Lyman, Prentice-Dunn, Wilson & Bonfilio, 1984), academic performance (Schunk, 1989) and meaningful cognitive engagement (Walker, Greene & Mansell, 2006). Multon, Brown and Lent (1991), in their meta-analysis of self-efficacy studies, concluded that students’ academic efficacy is a consistent positive predictor of academic achievement. Self-efficacy beliefs are also positively related to students’ motivational beliefs such as academic motivation (Schunk & Hanson, 1985), learning goal orientation (Urdan, 1997), adaptive causal attributions (Stajkovic & Sommer, 2000) and self-concept (Bong & Skaalvik, 2003).

Past studies have recognised that the role of students’ self-efficacy beliefs in a specific subject area is positively related to their academic motivation and performance outcomes in that particular domain (Britner & Pajares, 2001; Lent, Brown & Gore, 1997; Pajares, 1997; Pajares & Valiante, 1997; Shell, Colvin & Bruning, 1995). In the field of science learning, previous research has established that science self-efficacy is associated with science achievement and science-related choices across grade levels (Britner & Pajares, 2006). At the college level, research has indicated that science self-efficacy is a predictor of achievement (Andrew, 1988), persistence in science-related majors, and career choices (Gwilliam & Betz, 2001; Lent, Brown, & Larkin, 1984; Luzzo, Hasper, Albert, Bibby & Martinelli, 1999). At the high school level, research has indicated that self-efficacy is a stronger predictor of achievement and engagement in science-related activities than are gender, ethnicity or parental background (Kupermintz, 2002; Lau & Roeser, 2002). Among middle school students, science self-efficacy is a predictor of science achievement, with girls having higher science grades and stronger self-efficacy than do boys (Britner & Pajares, 2001; Pajares, Britner & Valiante, 2000). In summary, because self-efficacy is considered to be a pivotal construct that could influence students' engagement in science learning, it was included in this study as a motivational construct.

Shaughnessy (2004) asserted that teachers who seek to help students to increase their self-efficacy should first attend to the sources underlying these beliefs. Bandura (1997) suggested that students formed their self-efficacy beliefs by interpreting information from four sources, these being, mastery experiences (students' interpretation of their own previous attainments), vicarious experiences (students' interpretation of their own capabilities in relation to the performance of others), verbal persuasion (encouragement or discouragement from parents, teachers, and peers whom students trust which could boost or lower students' confidence in their academic capabilities) and physiological and affective states (strong emotional reactions to school-related tasks). Although not recognised by self-efficacy theorists, Dorman (2001) argued that invariably these sources can be related directly to the psychosocial elements in students' learning environment. Dorman (2001, p. 246) elaborates "indeed it is striking that academic efficacy theory has not recognised the potential of psychosocial environment in explaining academic efficacy."

Initially, the lack of research on the influence of classroom environment on academic efficacy was brought to the attention of learning environment researchers by Lorsbach and Jinks (1999) who called for the convergence of these two fields. When Dorman (2001) and Dorman and Adams (2004) took up this challenge, multiple regression analyses of data from mathematics classes indicated that classroom environment related positively with academic efficacy.

The current study differed in that it utilised Structural Equation Modeling (SEM), a second-generation regression analysis to evaluate the influence of classroom learning environment on students' self-efficacy. In addition, this study focused on science classrooms, using science self-efficacy measures. Because self-efficacy beliefs constitute the key factor of human agency, this study considers it to be important to investigate classroom environment as the genesis of these beliefs and to draw out factors that could possibly nurture students' self-efficacy.

2.3.4 Past Questionnaires Developed to Assess Student Motivation

The importance of investigating students' motivation when studying specific subject content areas had been stressed in past research (Britner & Pajares, 2001; Lent et al., 1997; Pajares, 1997; Pajares & Valiante, 1997; Shell et al., 1995). Although students might express different motivational traits in different subject areas (Blumenfeld, 1992; Blumenfeld & Meece, 1988; Lee & Anderson, 1993; Lee & Brophy, 1996; Weiner, 1990), a review of literature indicates that past surveys that assess students' motivation have predominantly been developed by psychologists interested in understanding students' motivation for general learning rather than for a particular subject. For example, the Multidimensional Motivation Instrument (Uguroglu, Schiller & Walberg, 1981), the Academic Motivation Scale (Vallerand, Pelletier, Blais, Briére, Senècal & Valliéres, 1992), Patterns of Adaptive Learning Survey (Midgley, Maehr, Hicks, Roeser, Urdan, Anderman & Kaplan, 1996) and the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia & McKeachie, 1991) assess students' general motivational orientations. A summary of the above mentioned student motivational surveys is provided in Table 2.1.

Although some of the scales in PALS (mastery goal orientation and academic efficacy) and MSLQ (task value and self-efficacy for learning) were considered to be relevant for this study, these instruments were not specifically designed to measure students' motivation in science learning. Furthermore, the PALS survey lacks the task value scale, which had been discussed in section 2.3.2, as a key component of students' motivational beliefs whilst the MSLQ, which was designed to measure university students' motivational beliefs, comprises of complex sentences and words which could potentially confuse lower secondary students. Bandura (2006) cautioned that there is no all-purpose measure of motivation. In other words, the construction of sound motivational scales relies on a good conceptual analysis of the relevant academic domain. A review of literature found two recent studies that have centred on developing science students' motivation scales (Glynn et al., 2009; Tuan et al., 2005).

Table 2.1: Overview of student motivation scales contained in four instruments (MMI, AMQ, PALS and MSLQ)

Instrument	Items per scale	Scales	Reference
Multidimensional Motivation Instrument (MMI)	1 – 7	Academic self-concept Achievement motivation Social self-concept Locus of control Emotional self-concept Physical self-concept	Uguroglu, Schiller & Walberg (1981)
Academic Motivation Scale (AMQ)	4	Amotivation External regulation Introjected regulation Identified regulation Intrinsic motivation–to know Intrinsic motivation–accomplishment Intrinsic motivation-stimulation	Vallerand, Pelletier, Blais, Briére, Senècal & Valliéres (1992)
Patterns of Adaptive Learning Survey (PALS)	4 – 5	Mastery goal orientation Performance approach goal orientation Performance avoid goal orientation, Academic efficacy	Midgley, Maehr, Hicks, Roeser, Urdan, Anderman & Kaplan (1996)
Motivated Strategies for Learning Questionnaire (MSLQ)	4 – 8	Intrinsic goal orientation Extrinsic goal orientation Task value Control of learning beliefs Self-efficacy for learning Performance Text anxiety	Pintrich, Smith, Garcia & McKeachie (1991)

Glynn et al. (2009) incorporated six motivational components that can be linked to learning science, including, intrinsic motivation, extrinsic motivation, personal relevance, assessment anxiety, self-determination and self-efficacy. However, after exploratory factor analysis, the resulting questionnaire, called the Science Motivation

Questionnaire (SMQ), comprised of five scales these being, intrinsic motivation and personal development, self-efficacy and assessment anxiety, self-determination, career motivation and grade motivation. The instrument was developed specifically to evaluate students' science motivation at the university level. Although there are merits to this questionnaire, Glynn et al. (2009) reported that some of the items required revision to represent the constructs more effectively. In particular, items in the career motivation scale, which had only two items, and the grade motivation scale, which had a relatively low reliability of 0.55. The scales in the SMQ and the Cronbach alpha coefficient for each scale are shown in Table 2.2.

Table 2.2: Scales in the Student Motivation Questionnaire (SMQ) and Cronbach alpha coefficient for each scale

Scale	Number of item	Cronbach's alpha
Intrinsic motivation and personal relevance	10	0.91
Self-efficacy and assessment anxiety	9	0.88
Self-determination	4	0.74
Career motivation	2	0.88
Grade motivation	5	0.55

In Tuan et al.'s (2005), Students' Motivation Towards Science Learning (SMTSL) survey, six motivational constructs were identified, namely, self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation (Table 2.3). Close scrutiny of this survey indicates that some of the constructs (for example the active learning strategies and learning environment stimulation scales) theoretically might not be directly related to students' motivational beliefs in science learning.

Table 2.3: Scales in the Student Motivation Towards Science Learning (SMTSL) and Cronbach alpha coefficient for each scale

Scale	Number of item	Cronbach's alpha
Self-efficacy	7	0.91
Active learning strategies	8	0.82
Science learning value	5	0.70
Performance goal	4	0.81
Achievement goal	5	0.80
Learning environment stimulation	6	0.75

In addition, the questionnaire included a number of negatively worded items as well as long sentences and words that could potentially be confusing for secondary school students. For example, the self-efficacy scale included seven items, five of which are negatively worded. A sample item "when new science concepts that I have learned conflict with my previous understanding, I try to understand why" portrays the long sentence structure and the use of complex words. As such, the face validity of the instrument could be compromised. Furthermore, the conceptualisation and measurement of some of the constructs (for example the achievement goal scale) were considered to be ambiguous and theoretically unsound. The achievement goal theory categorises students' goal orientation as either learning goal orientation or performance goal orientation. According to the achievement goal theory, learning goal orientation refers to students' purpose of developing competence and focuses on learning, understanding, and mastering tasks.

The achievement goal scale of the SMTSL is defined as students feeling more satisfied as they increase their competence and achievement in learning science (Tuan et al., 2005). This scale has five items that assess a range of students' perceptions, these being, their fulfilment when getting a good score, their ability to solve difficult problems, teachers and other students accepting their ideas and their confidence about the science content that is being taught. These items reflect the somewhat ambiguous definition provided by the authors and, in some cases, more closely reflect other motivational constructs such as self-efficacy beliefs. Furthermore, the SMTSL has included a four-item scale, all of which are reverse scored, to represent performance goal. Based on these findings, which cast doubt on the content validity of the SMTSL, this survey was precluded in this study.

The unavailability of an economical and theoretically inclusive instrument that could measure lower secondary students' motivational beliefs in science learning led to the development of a new survey. Therefore, the present study involved the development and validation of an improved instrument to surmount the above-discussed issues of extant instruments.

2.4 Self-Regulation

Self-regulation is the ability of an individual to control his or her conduct to achieve a set goal (Schunk & Zimmerman, 2008). Pintrich, (2000, p. 453) describes self-regulated learning as the "active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment". The key feature of self-regulated learning is that the learner steers and directs his or her cognitive and motivation processes to achieve learning goals (Boekaerts & Cascallar, 2006).

Research has identified both general and domain-specific components of self-regulation, including cognitive, meta-cognitive, motivational and behavioural strategies, by which students actively and strategically control and modify their learning to achieve their desired academic outcomes (Butler & Winne, 1995; Zimmerman, 1989). Pintrich and De Groot (1990) identified three components of self-regulated learning that were relevant for classroom performance: students' meta-cognitive strategies in planning, monitoring, and modifying their cognition; use of cognitive strategies; and management and control of effort in academic tasks. Zimmerman (2008) emphasised that self-regulated learning involves the degree to which students meta-cognitively, motivationally and behaviourally participate in the learning process.

Behaviourally, self-regulation refers to a student's choice to engage in a particular learning activity and the degree of intensity of effort and persistence in the activity (Pintrich & Schrauben, 1992). Invariably, motivation theorists have argued that research related to self-regulated learning has focused on a restricted view of cognitive and meta-cognitive strategies that students use (Boekaerts, 1993; Boekaerts & Cascallar, 2006; Corno, 1994; Pintrich, 2000), leaving out the most important aspect of self-regulation, which is related to motivation for learning and effort investment (Boekaerts & Cascallar, 2006).

Self-regulation of effort is the "tendency to maintain focus and effort towards goals despite potential distraction" (Corno, 1994, p. 229). Zimmerman (2008) reiterates that the core requirements of the self-regulated learner are personal initiative, perseverance, and adaptive skills. Therefore, students must not only be motivated through assigning goals and values to the learning activity, but also sustain effort until the completion of the task (Boekaerts & Cascallar, 2006). Alderman (1999) contends that effort regulation is the key element required for building students' learning skills as well as helping them stay focused and handle the numerous distractions that they face in and out of the classroom.

The past two decades have established self-regulation in learning as both an important outcome of the schooling process and as a key determinant of students' academic success (Wolters, 2010). Research evidence consistently indicates that students who are self-regulated gain greater academic achievement (Baker, Chard, Kettlerlin-Geller, Apichatabutra & Doabler, 2009; Dignath, Buettner & Langfeldt, 2008; Guthrie, McRae & Klauda, 2007). Wolters and Pintrich (1998) revealed that self-regulatory strategies utilised by junior high school students predicted their semester grades in mathematics, social studies and English. Pintrich and DeGroot's (1990) research evidenced that motivational, cognitive and meta-cognitive aspects of self-regulated learning predicted students' performance on homework, seatwork, quizzes and overall grades in a sample of seventh graders. In sum, higher achieving students show greater engagement in different components of self-regulated learning when compared to lower achieving students (VanderStoep, Pintrich & Fagerlin, 1996; Zimmerman & Martinez-Pons, 1990).

In addition, studies of interventions aimed at improving students' self-regulated learning have shown promising results, including the transfer of skills beyond the context of training such as improving students' self-efficacy beliefs and scores in standardised measures of reading comprehension (Perels, Gurtler & Schmitz, 2005; Schunk, 2005; Schunk & Ertmer, 2000; Taboada, Tonks, Wigfield & Guthrie, 2009; Wigfield, Guthrie, Perencevich, Taboada, Klauda, McRae & Barbosa, 2008). Perels et al. (2005) researched the effects of self-regulation and problem solving strategies training on 249 eighth-grade students. The findings confirmed that it is possible to improve and sustain students' self-regulation and mathematical problem-solving competence through even relatively short interventions. Cleary, Platten and Nelson (2008), in a mixed-method study on nine ninth-grade students, reported that the students who have been given instructions in self-regulated learning showed increased improvement in biology achievement than those who did not get the instruction. Based on this theoretical and research evidence, self-regulation can be considered to be key component of students' learning engagement in science.

2.4.1 Self-Regulation and Classroom Environment

Boekaerts, De Koning and Vedder (2006), in an analysis of past research that examined classroom practices that either facilitates or impedes the quality of students' engagement in the classroom summarised the components of instruction and teacher behaviour that are likely to influence students' self-regulation. These components include clarity and pace of instruction, the amount of structure provided, autonomy granted, teacher enthusiasm, humour, fairness and teacher expectations of students' capacity. Boekaerts and Cascallar (2006) purport that students' perception of the classroom learning environment affect their conscious and unconscious choices in completing learning activities in the classroom.

Boekaerts and Corno (2005) argued that it would be valuable if research related to self-regulation examined relationships between students' self-regulation in the classroom and their perceptions and interpretations of constructive and adverse cues present in the learning environment. Boekaerts and Cascallar (2006, p. 202) further recommend that "researchers and teachers focus simultaneously on the students' self-regulation of the learning and motivation process as well as on the environmental triggers that affect these processes”. Additionally, Zimmerman (2008) asserts that the effects of learning environment on students’ self-regulated learning should be studied further. There has not been previous research that has examined the influence of classroom learning environment on students’ self-regulation. This study took up this imperative and filled the research gap in terms of investigating the influence of psychosocial learning environment on students’ self-regulation in science learning.

2.4.2 Motivation and Self-Regulation

Theorists agree that a precursor of self-regulation is students’ motivational beliefs (Schunk & Zimmerman, 2008; Wolters, 2010). Boekaerts and Cascallar (2006), in their review of self-regulation theory, reiterate that the key conjecture in most models of self-regulation is that students’ motivational beliefs play a vital function in ensuring students’ successful engagement in self-regulated learning. Zimmerman (2000) emphasises that self-regulatory skills are of little value to students if they cannot motivate themselves to use them. In addition, Pintrich (2003), in a review of past research, concluded that research evidence indicates that students who are more academically motivated show higher self-regulation in learning.

In their comprehensive analysis of goal orientation theory, Kaplan and Maehr (2007) found firm theoretical and research evidence that learning goal orientation is a key predictor of students’ motivated behaviour such as persistence and effort. Results from past research indicates that students who perceive the teacher as emphasizing learning goals are more inclined to use self-regulatory strategies in their learning (Ames & Archer, 1988; Kaplan & Midgley, 1999; Newman, 1998; Ryan et al., 1998; Urdan & Midgley, 2003). Based on the above discussions, this study predicted that learning goal orientation would have a positive influence on students’ self-regulation in science learning.

Wolters and Rosenthal (2000) suggest that, theoretically, students who are convinced that their learning activity is important, interesting and useful are more inclined to expend greater effort and persist longer towards completing an activity. Consistently, empirical research has supported theoretical claims about the association between students’ perception of task value and their choice to participate and sustain effort in academic tasks (Schunk, Pintrich & Meece, 2008; Simpkins et al., 2006). Studies by Pintrich and De Groot (1990) and Wolters, Yu and Pintrich (1996) reported that task value is strongly associated with students' self-regulatory strategies. In particular, the studies concluded that students who believed that their learning activity was interesting and important were more likely to be cognitively engaged in trying to learn and comprehend the materials presented to them. Based on these theoretical and research supports, this study hypothesised that task value would be an important determinant of students' self-regulation in science learning.

The consensus among theorists is that there is a positive relationship between students' self-efficacy beliefs and their self-regulation in learning (Pajares, 2002; Zimmerman, 2000; Zimmerman & Bandura, 1994). According to Schunk & Pajares (2005), students with high efficacy are more likely to expend effort towards completing tasks, evaluate their progress and apply cognitive and meta-cognitive self-regulatory strategies. Research evidence by Sungur (2007) revealed that self-efficacy beliefs significantly predicted students' meta-cognitive strategy use. Additionally, a study by Greene, Miller, Crowson, Duke and Akey (2004) reported that self-efficacy had a significant positive influence on students' self-regulatory strategy use. Based on these findings, this study hypothesised that self-efficacy in science learning would have a positive influence on students' self-regulation in science learning.

There has been no previous study that has specifically examined the influence of the motivational beliefs of learning goal orientation, task value and self-efficacy on students' self-regulation in science learning. Hence, this study filled this research gap by investigating the influential role of these motivational beliefs as predictors of students' self-regulation in science learning.

2.4.3 Past Questionnaires Developed to Assess Student Self-Regulation

Currently two survey instruments are regularly used to assess students' self-regulated learning these being the 80-item self-report Learning And Study Strategies Inventory (LASSI, Weinstein, Schulte & Palmer, 2002) and the 81-item Motivated Strategies for Learning Questionnaire (MSLQ, Pintrich et al., 1991). These extensive general surveys, designed for college students, measure numerous constructs and utilise words and concepts with which lower secondary students may not be familiar.

The LASSI (Weinstein, Schulte & Palmer, 2002) was designed to assess university students' use of learning and study strategies. The ten scale, 80-item survey measures attitude, motivation, time management, information processing, test taking strategies, anxiety management, concentration, ability to select main ideas, use of study aids, and implementation of self-testing strategies. Despite its applicability to assessing self-regulation, due to its complex scales and length, this survey is not usable at the lower secondary level.

Alternatively, the MSLQ is a popular instrument that had been used by numerous researchers to measure high school students' self-regulation (Duncan & McKeachie, 2005). This instrument comprises two parts, a motivation section and a learning strategies section (Table 2.4). The motivation section consists of six scales that assess intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance and text anxiety, most of which were discussed earlier in Section 2.3.4.

The learning strategies section is comprised of three general types of scales, these being, cognitive strategies, metacognitive strategies and resource management (Duncan & McKeachie, 2005). Altogether, four scales, namely, rehearsal, elaboration, organisation and critical thinking assess students' use of different cognitive strategies. Students' use of metacognitive strategies is measured by one scale comprising of 12 items. The final four scales in the learning strategies section, namely, time and study environment management, effort regulation, peer learning and help seeking measure student's management of different resources.

Table 2.4: Scales in the Motivated Strategies for Learning Questionnaire (MSLQ) and Cronbach alpha coefficient for each scale

Section	Scale	Number of item	Cronbach's alpha
Motivation	Intrinsic goal orientation	4	0.74
	Extrinsic goal orientation	4	0.62
	Task value	6	0.90
	Control of learning beliefs	4	0.68
	Self-efficacy for learning	8	0.93
	Text anxiety	5	0.80
Learning strategies	Rehearsal	4	0.69
	Elaboration	6	0.75
	Organisation	4	0.64
	Critical thinking	5	0.81
	Meta-cognitive	12	0.79
	Time and study	8	0.76
	Effort regulation	4	0.69
	Peer learning	3	0.76
	Help seeking	4	0.52

Source: Duncan & McKeachie (2005)

The MSLQ was originally designed for use with university students and as such some of the words were considered to be beyond the comprehension of lower secondary students. Close scrutiny of the MSLQ also indicated that many of the items were negatively worded and, moreover, some of the items were long and complex, increasing the possibility of confusing lower secondary students. In addition, as indicated in Table 2.4, the reliability of some of the scales were relatively low. Furthermore, the cognitive and meta-cognitive strategy scales (rehearsal, elaboration, organisation, critical thinking and meta-cognitive) each assess complex self-regulatory strategies that may be beyond the comprehension of lower secondary students (Duncan & McKeachie, 2005). Based on this premise, the MSLQ was not considered to be a suitable instrument for this study.

Zimmerman (1998) pointed out that self-regulation should not be viewed as a fixed characteristic of students, but rather as context-specific processes that are selectively used to help students to succeed in a particular subject. In other words, self-regulation is maximally predictive when it is measured in a manner that is specific to the academic task at hand. At present, an economical and theoretically inclusive scale that specifically measures students' self-regulation in science learning is not available. Therefore, the present study developed a domain-specific, concise and valid scale to assess students' self-regulation of effort in science learning.

2.5 Gender Differences in Student Motivation and Self-Regulation

Ivie et al. (2002), and Haworth, Dale and Plomin (2010) contend that girls begin to consider the possibility of a career in science during their high school years and that this period plays an essential role in the development of students' competence and confidence in their science abilities. In a theoretical review of the role of motivation in explaining gender differences in academic attainment and achievement, Meece et al. (2006) concluded that, across four major achievement motivation theories (expectancy-value, attribution, self-efficacy and achievement goal theories), girls and boys continue to differ in line with traditional gender role stereotypes (with boys indicating higher ability and interest in science and mathematics). Pintrich and Zusho (2007) reviewed research related to gender differences in students' motivation and self-regulated learning. They summarised that one of the major perceptible differences is that girls inherently have lower self-perceptions of their academic ability in science even when they actually perform better when compared to boys (Eccles, 1983; Meece & Eccles, 1993).

It has been acknowledged that gender differences in students' academic motivation and self-regulation in learning are not due to gender per se but a function of gender stereotype beliefs and gender socialisation (Pajares & Valiante, 2001). In general, students view science as being a male domain and success in science as a masculine imperative (Pajares, 2002). In particular, adolescent girls are more inclined to conform to these gender stereotype roles (Wigfield, Eccles & Pintrich, 1996). The following is a summary of research related to gender differences in students' learning goal orientation (Section 2.5.1), task value, (Section 2.5.2), self-efficacy (Section 2.5.3) and self regulation (Section 2.5.4).

2.5.1 Gender Differences in Learning Goal Orientation

Few studies have examined gender differences in student' learning goal orientation but, it is notable that these studies have conflicting results. Anderman and Young (1994), in a study of 678 students in grades six and seven, reported that girls were more learning focused and less ability focused in science than were boys. In contrast, a study involving 213 fifth and sixth grade students by Meece and Jones (1996) reported no gender differences for learning and performance goal orientations in elementary science students. In a study involving 703 sixth grade students, Middleton and Midgley (1997) reported that girls perceived a stronger learning goal orientation than boys. However, Greene and her colleagues (Greene, DeBacker, Ravindran & Krows, 1999), in a study involving 1,801 high school students, documented that there were no gender differences in students' learning and performance goals in mathematics. In sum, although gender differences are indicated, these studies do not reveal a clear pattern of these differences with respect to students' learning goal orientations.

2.5.2 Gender Differences in Task Value

Meece et al. (2006), in their review of research on gender differences in students' task value, summarised that there are perceptible differences in the value that children and adolescents attach to tasks in different academic domains. Unlike learning goal orientation, the patterns in these gender differences are consistent with gender norms and stereotypes. For example, Eccles et al. (1993), in a longitudinal study of students from first grade to fourth grade, found that boys placed a higher value on sports activities than girls, whilst girls placed a higher value on musical and reading activities than boys. The study also revealed that, for elementary students, gender differences were not apparent in the value students attached to mathematics. Wigfield, Eccles, Mac Iver, Rueman and Midgley (1991) reported that, when students were transitioned from primary to junior high school, their perceptions of the value of mathematics, reading, and sports tasks declined. Their study also indicated that girls had a greater value on English than did boys whilst boys placed greater value on sports than did girls.

Jacobs, Lanza, Osgood, Eccles and Wigfield (2002) examined changes in students' value perceptions beginning from the first grade to the twelfth grade in three academic domains. Their findings revealed that students' value perceptions about mathematics, language arts and sports declined over the years, with the value of mathematics declining most rapidly in high school. The study concluded that the gender patterns have mirrored previous studies' that report that boys placed a higher value on sports activities, girls placed higher value on language arts and there were no gender differences for mathematics task value.

However, Watt (2004, 2008b), in a longitudinal study, involving 1,323 students spanning from grades 7 to 11, reported that, even when students' intrinsic value of mathematics declined during adolescence, boys consistently maintained a higher intrinsic value for mathematics than did girls. The same study concluded that gender differences in intrinsic value for English favoured girls, which is consistent with existing gender stereotypes. According to Watt (2004), the contradictory results found by Jacobs et al. and her own study could be a result of Jacob et al.'s use of a composite task value measure as opposed to the desegregated measure of the different values used in her own study.

In a separate study, Watt (2006) investigated the role of motivation in students' mathematics-related occupational intentions using longitudinal data from 442 students spanning from grades 9 to 11 in Australia. The students' data were separated according to gender and their perceptions of mathematics utility value. The results of the study indicated that, although boys with mid to high utility values planned to pursue mathematics-related careers, only those girls with the highest utility value planned to pursue mathematics-related careers. In sum, past studies have revealed that there exists a pattern of gender differences in students' value of tasks, in particular, in mathematics, sports and English domains. However, due to a lack of research, gender differences and the moderating role of gender are not apparent in the area of science learning.

2.5.3 Gender Differences in Self-Efficacy

Research on gender differences in students' self-efficacy beliefs has invariably focused on the domains of mathematics and science which have traditionally been stereotyped as either male or female prerogatives (Meece & Painter, 2008). These studies have consistently documented that boys are inclined to be more positive about their ability in mathematics and science than girls (Anderman & Young, 1994; Pajares, 1996; Pintrich & DeGroot, 1990; Zimmerman & Martinez Pons, 1990). Whitley (1997), in a meta-analysis of gender differences studies in computer-related attitudes and behaviour, revealed that boys exhibited higher computer self-efficacy than girls. In the subject of writing, gender differences were reversed with girls reporting higher writing self-efficacy beliefs than boys, even though there was no gender difference in their performance (Pajares & Valiante, 1997, 2001). However, Britner & Pajares (2001) and Pajares, Britner and Valiante (2000) reported that, among middle school students, girls had higher science grades and stronger self-efficacy than do boys. The studies explained that this may be a function of girls' greater facility with language. In the middle school years, science classes are often taught using more language-related methods than investigative-methods, thus enabling the language-related strengths girls develop in elementary years to carry them to middle school science experiences.

The research evidence also indicates that gender differences in students' self-efficacy beliefs are likely to be linked to their age or grade level (Schunk & Pajares, 2002), with perceptible differences emerging once the students begin high school (Bandura, Barbaranelli, Vittorio Caprara & Pastorelli, 2001; Wigfield et al., 1996). The differences can be attributed to adolescent's increased anxiety to conform to gender stereotype roles (Hill & Lynch, 1983; Pajares, 2006; Wigfield et al., 1996). Generally, students perceive the domain of mathematics, science and technology as male domains (Eisenberg, Martin & Fabes, 1996). Hence, successes in these areas are believed to be a masculine imperative (Eccles, 1987). Conversely, success in language arts is associated with a feminine orientation as writing is typically viewed as a female domain. Taken together, majority of past studies indicate that there exist gender differences among high school students' self-efficacy beliefs, generally favouring boys, in the area of science and mathematics learning.

2.5.4 Gender Differences in Self-Regulation

Gender differences associated with students' self-regulation in learning have been reported across various academic domains and academic tasks (Meece & Painter, 2008). The general consensus is that girls display more self-regulatory strategies than boys. Girls tend to be more disciplined and more often display the ability to delay gratification than boys (Duckworth & Seligman, 2006). Research by Bembenutty (2007) examined gender differences among 364 college students with respect to their use of self-regulation strategies. The findings showed that females report higher effort regulation and use of self-regulatory strategies of rehearsal and organisation when compared to males.

Nevgi (2002) and Niemi, Nevgi and Virtanen (2003) investigated gender differences in higher education students' use of self-regulated learning strategies. Both Nevgi (2002) and Niemi et al. (2003) reported that females used more self-regulated learning strategies. For example, females were able to use keywords, apply advance organisers and connect new knowledge actively to previous knowledge while studying more often than males. In sum, the research evidence indicates that gender differences are evident in students' self regulation with girls reporting higher effort regulation and higher use of cognitive and meta-cognitive strategies.

The analyses of past research related to gender differences revealed that the accustomed research method applied by gender studies is to compare mean level differences in key dimensions of motivation and self-regulation. The traditional method examines differences of degree and provides information about whether boys or girls scored higher in particular motivational or self-regulatory components. However, this study used an alternate and possibly improved research method to derive information on the moderating role of gender in the relationships between students' motivational beliefs and self-regulation. As suggested by Meece et al. (2006), if gender differences are evident in students' motivational beliefs, then these differences are likely to have an impact on the choice of activity, engagement and performance of students. Hence, this study examined how key facets of motivational beliefs influence students' self-regulation and whether these influences differ for boys and girls. Structural Equation Modelling based, multi-group data analysis, was used to add to the depth of insights that can be drawn from the results.

2.6 Learning Environment Research

Sections 2.4 and 2.5 have elucidated that students' motivation and self-regulation could be influenced by their classroom learning environment. There is, however, a lack of research related to examining which dimensions of the learning environment are the determinants of students' motivation and self-regulation. Based on the discussions and to extend extant research in the field of learning environment, the present research examined the influence of psychosocial elements in the classroom environment on students' motivation and self-regulation. Hence, this section of the literature review presents a review of literature related to the field of learning environment. This section begins by providing an overview of the history of learning environment research (Section 2.6.1). This is followed by the description of the various instruments that have been developed for use in this field (Section 2.6.2). The final section reviews the types of research that have been carried out in the field of learning environment (Section 2.6.3).

2.6.1 History of Learning Environment Research

It has been estimated that students spend up to 15,000 hours in classrooms by the time that they complete high school (Fraser, 2001; Rutter, Maughan, Mortimore, Ouston & Smith, 1979). Therefore, what happens within these classrooms, such as the nature of the teaching and learning and the interactions experienced by students, are likely to have a profound impact on a range of student outcomes. Despite the importance of what goes on in the classroom, educators tend to rely heavily on achievement and other outcomes which do not provide a complete picture of the educational process (Fraser, 2001, in press). Although the learning environment is a subtle concept, there has been much progress in the conceptualisation, assessment and examination of its determinants and effects.

The notion that there exists a learning environment which mediates aspects of educational development began as early as the 1930s. Kurt Lewin initiated a shift in the study of psychology from a focus on the individual to a focus on processes between individuals (Crosbie-Brunett & Lewis, 1993). The foundation for modern social learning theories is based on Lewin's (1936) contention that the environment and its interaction with the personal characteristics of individuals are responsible for human behaviour. Fundamentally, Lewin (1936) came up with the formula for human behaviour as described in Equation 1.

Equation 1

$$\mathbf{B = f\ (P,E)}$$

B = human behaviour
P = person
E = environment
f = function

Bandura (1986) acknowledges that the social cognitive theory's concept of reciprocal interactions, which was utilised in this study, stems from Lewin's concepts on human behaviour.

Murray's (1938) Needs Press Model asserts that an individual's need is provoked directly by the occurrence of one or more pressures from within the individual's environment. Murray (1938) referred to the pressure that forces an individual to act as environmental "press". He further argued that there existed a difference between the environmental forces perceived by an outside observer (alpha press), and those that were perceived by the individual in that environment (beta press). Stern, Stein and Bloom (1956) clarified that alpha press is the consensual description of the environment that a particular group develops whilst beta press is the private view of the environment that the individual develops.

An integral element of classroom environment theory was Moos' (1974, 1979) conceptual framework for human environments, which was significantly influenced by the work carried out by Lewin and Murray. Moos extended Lewin's environmental influences by focusing on the psychosocial aspect of a range of environments including the classroom environment. The conceptual framework centred on the descriptions of the classroom through the perspectives of individuals in the classroom environment as argued by Murray's (1938) Needs Press Model.

Herbert Walberg and Rudolf Moos embarked on independent studies related to participants' perceptions of their learning environment across a spectrum of learning situations. Walberg initiated his research with investigations linked to the Harvard Project Physics (Anderson & Walberg, 1968; Walberg, 1968a, 1968b; Walberg & Anderson, 1968; Welch & Walberg, 1972) and developed the Learning Environment Inventory (LEI). Moos' research in various learning environment settings, including classrooms, prisons and hospitals (Moos & Houts, 1968), led to the development of the Classroom Environment Scale (CES) (Moos & Trickett, 1974).

Moos (1974), also delineated three general dimensions, based on the work of Lewin and Murray, that characterise any human environment, these being personal relationships, personal growth and system management. Table 2.5 provides a description of each of these dimensions. The personal relationships dimension focuses on the different types and strengths of relationship in the environment whilst the personal growth dimension is concerned on the availability of opportunities for personal development and self-enhancement. The final dimension, system management, evaluates the degree to which the environment is orderly, maintains control and is responsive to change. Moos' (1974) classification of the human environment has provided a theoretical underpinning for the development of various learning environment instruments.

Table 2.5: Dimensions of human environment

Dimension	Description
Relationship	Assesses the nature and intensity of relationships in the environment
Personal development	Assesses the degree of opportunities for personal growth and self-enhancement
System maintenance and change	Assesses the extent of responsiveness, orderliness, level of expectation and control in the environment

2.6.2 Learning Environment Instruments

The most frequent method of investigating the learning environment has been through the utilisation of perceptual measures. Classroom learning environment research has evolved and flourished over the past 40 years with researchers developing well-validated and robust classroom environment instruments to measure students' perceptions based on the three pertinent dimensions described by Moos (Fraser, 2007). Indeed, a striking feature of this field is the availability of a variety of economical, valid and widely-applicable questionnaires. Table 2.6 provides an overview of the scales of eight historically important learning environment instruments. Each of the instruments in the table is categorised according to the education level of the students that the instrument was intended for, the scales included in each and the number of items in each scale. The scales in each instrument are classified according to Moos' scheme and a reference for each instrument is provided. Each of the questionnaires in the table is described below.

The Learning Environment Inventory (LEI) was desveloped in the 1960's through the work of Walberg as part of the Harvard Project Physics (Fraser, Anderson & Walberg, 1982). After undergoing modifications, the final version of the LEI had fifteen scales and 105 items. The four-point response format ranges from strongly disagree to strongly agree. Two important dimensions of LEI that are of relevance to this study are the cohesiveness and democracy scales. This early instrument has, from the onset, recognised the importance of both the social relationships between students and the perceived fairness of the classroom environment. These two dimensions have developed into important aspects of current learning environment research. The internal consistency reliability and discriminant validity of LEI was reported by Fraser et al. (1982). The survey has been successfully and widely used by past researchers in investigating the associations between students' perceptions of their learning environment and student outcomes (Fraser, 1979; Hirata & Sako, 1998; Hofstein, Gluzman, Ben Zvi & Samuel, 1979; Lawrenz, 1976; Power & Tisher, 1979; Walberg, 1968a, 1968b).

Table 2.6: Overview of scales contained in eight learning environment instruments (LEI, CES, ICEQ, CUCEI, QTI, SLEI, CLES and WIHIC)

Instrument	Level	Items per scale	Scales classified according to Moo's scheme			Reference
			Relationship dimensions	Personal development dimensions	System maintenance and change dimensions	
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material environment Goal direction Disorganisation Democracy	Fraser, Anderson & Walberg (1982)
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher support	Task orientation Competition	Order and organisation Rule clarity Teacher control Innovation	Moos & Trickett (1987)
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation	Fraser (1990)
College and University Classroom Environment Inventory(CUCEI)	Higher education	7	Personalisation Involvement Student cohesiveness Satisfaction	Task orientation	Innovation Individualisation	Fraser & Treagust (1986)

Instrument	Level	Items per scale	Scales classified according to Moo's scheme			Reference
			Relationship dimensions	Personal development dimensions	System maintenance and change dimensions	
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8–10	Helpful/friendly Understanding Dissatisfied Admonishing		Leadership Student responsibility and freedom Uncertain Strict	Wubbels & Levy (1993)
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher education	7	Student cohesiveness	Open-Endedness Integration	Rule clarity Material environment	Fraser, Giddings & McRobbie (1995)
Constructivists Learning Environment Survey (CLES)	Secondary	7	Personal relevance Uncertainty	Critical voice Shared control	Student negotiation	Taylor, Fraser & Fisher (1997)
What Is Happening In This Classroom (WIHIC)	Secondary	8	Student cohesiveness Teacher support Involvement	Investigation Task orientation Cooperation	Equity	Aldridge & Fraser (2000)

After identifying aspects of the classroom psychosocial environment that were integral for teachers and students, the Classroom Environment Scale (CES) was developed by Moos and Trickett (1974, 1987). The CES focuses on teacher behaviour, teacher-student interaction and student-student interaction. Altogether, there are eight scales comprising of ten items each that are responded to using a true-false response format. The scales from the CES that are pertinent to this study are the teacher support and involvement scales from the relationship dimension and the task orientation scale from the personal development dimension. These scales are considered to be important elements of the learning environment in contemporary research. The validity and reliability of the CES when used in classroom settings have been reported by numerous researchers (Fisher & Fraser, 1983; Humphrey, 1984; Keyser & Barling, 1981; Moos R. H. & Moos B. S., 1978; Trickett & Moos, 1973).

The Individualised Classroom Environment Questionnaire (ICEQ) was developed by Rentoul and Fraser (1979) to assess the environment related to individualised and inquiry-based education. The final version of the ICEQ (Fraser, 1990) was comprised of five scales which have ten items in each. The five-point frequency response format ranges from almost never to very often. The instrument is significant because it marks the introduction of the investigation scale which is an important element in current inquiry-based science education. Investigation has been established as a fundamental component of contemporary science education and the investigation scale is regularly used by learning environment researchers today. The ICEQ has been utilised and validated in various classroom settings by past researchers (Ashgar & Fraser, 1995; Fraser & Butts, 1982; Fraser, Pearse & Azmi, 1982).

To assess the learning environment at the college and university level, the College and University Classroom Environment Inventory (CUCEI) was developed by Fraser and Treagust (1986). The development of the CUCEI involved the examination of the three previous questionnaires, the LEI, CES and ICEQ, to ensure that the new survey catered to higher educational students and captured salient features of the three surveys. The CUCEI is comprised of seven scales with seven items in each scale. The four-point response format ranges from strongly disagree to strongly agree. The instrument has incorporated task orientation from the personal development scale as well as involvement and student cohesiveness from the relationship dimension. Although the CUCEI was designed for university students, these three scales are consistently considered to be relevant for investigating both lower and upper secondary school classroom environments. The CUCEI has been utilised and validated by past researchers (Fraser, 1991; Joiner, Malone & Haimes, 2002; Nair & Fisher, 2000; Yarrow, Millwater & Fraser, 1997).

The Questionnaire on Teacher Interaction (QTI) was specifically designed to investigate the interaction between students and teachers in the classroom (Creton, Hermans & Wubbels, 1990; Wubbels & Levy, 1993). The instrument originated from Leary's (1957) theoretical model of proximity (cooperation – opposition) and influence (dominance – submission). Altogether, eight dimensions of relationships are examined and each scale comprises of eight items. The five-point response format in the QTI ranges from never to always. The QTI is a widely recognised and extensively utilised learning environment survey that has been validated by numerous past researchers (den Brok, Fisher & Koul, 2005; Fisher, Rickards & Fraser, 1996; Fraser, Aldridge & Soerjaningsih, 2010; Henderson, Fisher & Fraser, 2000; Kokkinos, Charalambous & Davazoglou, 2009; Lee, Fraser & Fisher, 2003; Rickards, den Brok & Fisher, 2005; Treagust, 1991; Waldrip & Fisher, 2003). However, for the present study, the use of QTI would have limited the scope of the research as it focuses only on student-teacher interactions.

Fraser, Giddings and McRobbie (1995) developed the Science Laboratory Environment Inventory (SLEI) to investigate school science laboratory learning environments. The focus of this instrument was to examine the effectiveness of science laboratory activities. The SLEI is comprised of five scales with seven items in each scale. The five response alternatives used in the SLEI range from almost never to very often. The SLEI has incorporated student cohesiveness and open-endedness (similar to investigation) which are also considered to be relevant constructs in examining science classroom environment. The SLEI has been reported to be a valid and reliable instrument by numerous past researchers (Fisher, Harrison, Hofstein & Henderson, 1998; Fraser & Lee, 2009; Henderson & Fisher, 1998; Lightburn & Fraser, 2007; Quek, Wong & Fraser, 2005). However, since the focus of this research is on science classrooms and not science laboratories, this instrument was not used in the present study.

The advent of the constructivist viewpoint in science learning prompted the development of the Constructivist Learning Environment Scale (CLES) (Taylor, Fraser & Fisher, 1997). The constructivist learning theory describes learning as an active process of creating meaning from different experiences. In other words, students are likely to learn better if the learning activity is based on their previous knowledge and involves active negotiation and consensus building within the classroom. The CLES can be used to help teachers and researchers to determine the level of perceived constructivist learning that is happening in the classroom. This is the first instrument to group together, in blocks, items that belong to the same scale rather than arranging them randomly or cyclically. The five response alternatives range from almost never to very often. This instrument has been validated and successfully used in many past studies (Aldridge, Fraser, Taylor & Chen, 2000; Dorman, 2001; Harrington & Enochs, 2009; Kim, Fisher & Fraser, 2000; Nix & Fraser, in press; Nix, Fraser & Ledbetter, 2005; Ozkal, Tekkaya, Cakiroglu & Sungur, 2009; Peiro & Fraser, 2009). Although contructivism is considered to be an important component of science classrooms, to broaden the scope of the psychosocial elements examined in the present study, the CLES was not selected as the learning environment instrument. However, similar constructs to those embodied in the CLES were examined through the use of the questionnaire described in the following section.

The What Is Happening In this Class? (WIHIC) questionnaire (Fraser, McRobbie & Fisher, 1996) is comprised of seven scales with eight items in each. The WIHIC is currently one of the most widely used learning environment instruments because of its strong validity, reliability and robustness across a range of settings (Dorman, 2008). The WIHIC questionnaire incorporates classroom learning environment scales that have been confirmed through past studies as predictors of student outcomes as well as scales of contemporary relevance to classroom learning, such as the promotion of understanding, rather than rote learning, constructivism and equity (Fraser et al., 1996). The seven scales incorporated in the WIHIC are student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. The five-point response format of the instrument are almost never, seldom, sometimes, often and very often.

The development and the extensive use of the What Is Happening In this Class? (WIHIC) questionnaire is considered to be a significant milestone in the field of learning environment. The questionnaire has been used to examine classroom learning environments in numerous countries across the world including recent studies in Australia (Dorman, Fisher & Waldrip, 2006), Canada (Zandvliet & Fraser, 2005), India (den Brok et al., 2005), Indonesia (Fraser, Aldridge & Adolphe, 2010; Wahyudi & Treagust, 2006), New Zealand (Saunders & Fisher, 2006), Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008), Turkey (Telli, Cakiroglu & den Brok, 2006), UAE (Afari, Aldridge, Fraser & Khine, in press; MacLeod & Fraser, 2010) and the US (Allen & Fraser, 2007; Gabler & Fraser, 2007; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008). Given the reliability and validity of the WIHIC and its applicability to science classroom learning environments, this instrument was selected for the present study.

The following section provides the basis for choosing the WIHIC scales to measure students' perception of their psychosocial learning environment. The first of the WIHIC scales, student cohesiveness, assesses the extent to which students know, help and are supportive of one another. Social acceptance by peers and the need to have friends are integral facets of the learning environment that can have an effect on students' learning. In addition, according to Aldridge, Fraser, Bell and Dorman (2012), students are more likely to do well in their learning if they do not experience harassment and prejudice from their peers. A cohesive learning environment also helps students to feel that they are accepted and supported by their peers and allows them to make mistakes without running the risk of being ridiculed.

The second scale, teacher support, assesses the extent to which the teacher helps, relates to, trusts and is interested in students. The teachers' relationship with the students is a critical aspect of any learning environment as this could determine whether the students are inspired to learn the subject or be turned away from learning. When the students consider the teacher to be approachable and interested in them, they are more likely to seek the teacher's help if there is a problem with their work. According to Hijzen, Boekaerts and Vedder (2007), in a collaborative learning environment the teacher's supportive role is a pivotal key in determining the student's learning.

The involvement scale assesses the extent to which the students have attentive interest, participate in discussions, do additional work and enjoy the class. According to the Curriculum Council (1998, p. 34): ''Students should be encouraged to think of learning as an active process on their part, involving a conscious intention to make sense of new ideas or experiences and improve their own knowledge and capabilities, rather than simply to reproduce or remember.'' Taylor and Campbell-Williams (1993) argue that a key factor in students' learning process is participation in classroom discussions and negotiation of ideas and understandings with peers.

The investigation scale measures the extent to which skills and processes of inquiry and their use in problem solving and investigations are emphasised in the learning environment. Students in this learning environment would have more opportunities to engage in investigative tasks and activities that enable them to actively construct their knowledge of science concepts. Britner and Pajares's (2006) recommends that science teachers should implicitly encourage lower-secondary science students' to engage in authentic inquiry-oriented science investigations in their learning process

Task orientation assesses the extent to which students perceive that it is important to complete activities and understand the goals of the subject. This scale is important because, according to Killen (2001) and Spady (1994), students need to have goals, both short-term and long-term. If the goals or learning objectives are clear and meaningful, then the students are more likely to be engaged in their learning. In addition, to ensure students optimise their time-on-task, Aldridge et. al (2012) states that the teacher has to demonstrate clear expectations and provide frequent feedback and reinforcement.

The cooperation scale assesses the extent to which students cooperate rather than compete with one another on learning tasks. According Johnson, Johnson, Smith (2007) and Tan, Sharan and Lee (2007), in a collaborative learning environment, the students work together to find solutions to given problems. A cooperative learning environment would ensure students relate positively to each other and learn from each other.

The equity scale assesses the extent to which students' perceive that the teacher treats them in a way that encourages and includes them as frequently as their peers. This scale gives teachers an indication of whether students perceive that they are being treated fairly by the teacher. Rennie (2004, 2005) contended that this element of the learning environment is important because it would ensure that the teacher provides equal and unbiased opportunities for all the students in the class. Based on the discussions on the important contributions of each scale in the WIHIC towards the conception of the psychosocial learning environment, all seven scales were included in the present study. The provision of more details on the WIHIC including sample items and Moos classification for each WIHIC scale is discussed in Section 3.4.2.

2.6.3 Past Research in Learning Environment

Research in the field of classroom learning environments has spanned more than four decades with significant contributions to the field of education, including, program evaluation (Martin-Dunlop & Fraser, 2008; Nix et al., 2005; Wolf & Fraser, 2008), teacher action research (Aldridge & Fraser, 2008; Aldridge, Fraser, Bell & Dorman, in press; Aldridge, Fraser & Sebela, 2004) and cross-national studies (Aldridge, Fraser & Huang, 1999; Fraser et al., 2010). The extensive range of research in the field of learning environment prompted Fraser (2007) to categorise these researches into six distinct areas. Table 2.7 outlines these lines of research with an explanation of the focal point of each. Each reseach area is then further explicated in the discussions below.

Table 2.7: Area of past research in the field of learning environment and their emphasis

Research area	Main emphasis of research
Association between student outcomes and environments	Investigation of associations between perceptions of psychosocial characteristics of a classroom environment and students' cognitive and effective learning outcomes.
Evaluations of educational innovations	Process criteria used in the evaluation of educational innovations
Differences between student-teacher perceptions and between actual-preferred environment	Investigation of differences between students and teachers in their perceptions of the same classroom situation. Differences could also be between actual or preferred environments.
Determinants of classroom environment	Classroom environment dimensions used as criterion variables in research aimed at identifying how classroom environment varies with different class-level and school-level factors
Use of qualitative research methods	Research involving the use of both quantitative and qualitative methods in the same study in order to identify salient features of the learning environment.
Cross-national studies	Research that crosses national boundaries.

The strongest tradition in past learning environment research has involved the investigation of associations between students' perceptions of psychosocial environmental characteristics and their cognitive and affective outcomes (Aldridge & Fraser, 2008; Fraser, 2007, in press). Fraser (2007), in a review of past learning environment studies, summarised that an extensive range of studies has been conducted in a variety of subjects (mathematics, science, English, geography, computing), at various grade levels (elementary, secondary, higher education), using numerous outcome measures (achievement, attitude, self-efficacy) and different learning environment questionnaires throughout the world. The consensus is that student perceptions of the learning environment account for an appreciable amount of variance in learning outcomes, often beyond that attributable to student background characteristics (Dorman, 2001; Fraser, 2007, in press).

A meta-analysis by G. D. Haertel, Walberg and E. H. Haertel. (1981), involving 17,805 students from four nations, concluded that students in learning environments that are organised, cohesive, goal-directed and had less friction, showed consistently higher achievements. McRobbie and Fraser (1993) in their study, using the SLEI, with 1,594 senior high school chemistry students in Australia, summarised that the science laboratory environment accounted for a substantial proportion of variance in students' inquiry skills and attitude towards science. Dorman and Fraser (2009) examined 4,146 Australian high school students' affective outcomes, namely, attitude to the subject, attitude to computer use and academic efficacy using the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI). The study concluded that improving the classroom environment had the potential to improve student outcomes and that academic efficacy mediated the effect of classroom environment dimensions on attitude to subject and attitude to computer use. Telli, den Brok and Cakiroglu (2010), administered a translated form of the QTI and an attitude survey to 7,484 students in gradse 9 to 11 from 55 public schools in Turkey. The study summarised that scales related to the influence dimension from the QTI were associated with student enjoyment while the scales related to the proximity dimension were related to attitudes to inquiry.

Table 2.8 lists studies that have used the WIHIC, the instrument selected for use in the present study, in investigating the associations between classroom learning environment and various student outcomes. For each study, the nature and size of sample is provided along with the country and language involved. The factorial validity and internal consistency of the WIHIC is reported for all the studies. The findings from the studies indicate that the psychosocial classroom learning environment scales from the WIHIC are associated with students' attitude, satisfaction, enjoyment, academic efficacy and achievement.

Table 2.8: Studies that have used the WIHIC in investigating the associations between classroom learning environment and various student outcomes

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial validity & reliability reported	Outcome variable
Aldridge, Fraser & Huang (1999); Aldridge & Fraser (2000)	Australia Taiwan	English Mandarin	1,081 (Australia) & 1,879 (Taiwan) junior high science students in 50 classes	✓	Enjoyment
Fraser, Aldridge & Adolphe (2010)	Australia Indonesia	English Bahasa	567 students (Australia) and 594 students (Indonesia) in 18 secondary science classes	✓	Several attitude scales
Zandvliet & Fraser (2004, 2005)	Australia Canada	English	1,404 students 81 networked classes	✓	Satisfaction
Chionh & Fraser (2009)	Singapore	English	2,310 grade 10 geography & mathematics students	✓	Achievement Attitudes Self-esteem
Khoo & Fisher (2008)	Singapore	English	250 working adults attending computer education courses	✓	Satisfaction
Kim, Fisher & Fraser (2000)	Korea	Korean	543 grade 8 science students in 12 schools	✓	Attitude

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial validity & reliability reported	Outcome variable
Afari, Aldridge, Fraser & Khine (in press)	UAE	Arabic	352 college students in 33 classes	✓	Enjoyment Academic efficacy
Martin-Dunlop & Fraser (2008)	California, USA	English	525 female university science students in 27 classes	✓	Attitude
Ogbuehi & Fraser (2007)	California, USA	English	661 middle-school mathematics students	✓	Attitude Achievement
Wolf & Fraser (2008)	New York, USA	English	1,434 middle school science students in 71 classes	✓	Attitude Achievement
Allen & Fraser (2007)	Florida, USA	English Spanish	120 parents and 520 grade 4 & 5 students	✓	Attitude Achievement
Robinson & Fraser (in press)	Florida, USA	English Spanish	78 parents and 172 kindergarten science students	✓	Attitude Achievement
Helding & Fraser (in press)	Florida, USA	English Spanish	924 students in 38 grade 8 & 10 science classes	✓	Attitude Achievement

Adapted from Fraser (in press)

The second research area, the evaluation of educational innovations, examines the impact of innovations in transforming or changing the classroom learning environment. The use of learning environment scales, as an alternative to other student outcomes, such as achievement, could provide a more complete picture of the impact of the innovation on students' educational process (Fraser, in press). A growing number of studies, some of them described below, have successfully used learning environment instruments to evaluate the effectiveness of educational innovations.

Nix et al. (2005) administered the CLES to 445 students in 25 classess to help to evaluate an innovative science teacher development program. The study utilised an innovative side-by-side response format that enabled students to record their perceptions of the classroom taught by a teacher who had undergone the professional development and other classrooms taught by different teachers. The findings indicated that students responded more favourably to two of the CLES scales, namely, personal relevance and uncertainty, for teachers who had experienced the professional development. In another study, the implementation of outcomes-focused education in an innovative new senior high school in Australia was evaluated. This longitudinal study involved 449 students in 2001, 626 students in 2002, 471 students in 2003 and 372 students in 2004 (Aldridge & Fraser, 2008). The study concluded that, although the effect sizes were moderate, changes in students' perceptions of the classroom environment were statistically significant for seven of the ten TROFLEI scales.

Lightburn and Fraser (2007) used the SLEI with a sample of 761 high-school biology students to assess the use of anthropometric activities in science teaching. The findings indicated that the anthropometry group had significantly higher scores for the material environment scale. In another study involving 525 female students in 27 classes, Martin-Dunlop and Fraser (2008) used selected scales from the WIHIC and the SLEI to evaluate an innovative science course for prospective elementary teachers. The results showed large differences on all scales between students' perceptions of the traditional and innovative courses. Pickett and Fraser (2009) in their evaluation of a two-year mentoring program in science for seven beginning grade 3 to 5 teachers, involved a sample of 573 students in the US. Analysis of the

WIHIC data supported the effectiveness of the mentoring program in improving the classroom learning environment across all scales. An investigation of the efficacy of using inquiry-based laboratory activities was gauged using the WIHIC by Wolf and Fraser (2008) and involved 1,434 middle-school students in the US. The results indicated that inquiry-based activities promoted more student cohesiveness compared to non-inquiry-based activities.

The third area of research highlighted by Fraser (2007) has involved the investigations of differences between students' and teachers' perceptions of the same learning environment in addition to differences between students' actual and preferred learning environment. Fisher and Fraser (1983), using the ICEQ with 2,175 students in 116 classes and 56 teachers of these classes, investigated the students' and teachers' perceptions of the same classroom learning environment. The study reported that teachers consistently perceived a more positive learning environment than their students did. Previous research involving students in different grade levels and different countries has found that that students consistently would prefer a more positive learning environment than the one that they perceive as currently present (Fisher & Fraser, 1983; Fraser & Chionh, 2000; Margianti, Fraser & Aldridge, 2001; Quek et al., 2005).

The fourth area of research has investigated the determinants of the learning environment including factors such as teacher personality, class size, grade level, subject matter, nature of school-level environment and type of school. These studies have examined whether these factors impact on the learning environment (Fraser, 2007). The most investigated determinant is gender and the results of past studies consistently indicate that female students view the learning environment more positively than their male counterparts in the subject area of geography and mathematics (Fraser & Chionh, 2000), science (Khine & Fisher, 2002; Kim et al., 2000), computer studies (Margianti et al., 2001) and chemistry (Quek et al., 2005). Past studies indicate that both teacher and student background can impact students' perceptions of their learning environment. For example, a study by Khine and Fisher (2002) involving 1,188 secondary science students, used the QTI to investigate the associations between the cultural background of science teachers (Western and Asian culture) and students' perceptions of their interactions with the teachers. The results indicated that teachers from different cultural backgrounds created different types of learning environments and that the students perceived a more favourable interpersonal relationship with Western teachers than with Asian teachers. In another study, Koul and Fisher (2005) administered the QTI and WIHIC to a sample of 1,021 Indian students with different cultural backgrounds. The findings indicated that the Kashmiri group of students perceived their teacher interactions and classroom environments more positively than those from other cultural groups identified in the study.

The fifth area of research has involved qualitative research methods or a combination of qualitative and quantitative methods within the same study, both of which have become more prevalent in recent years (Tobin & Fraser, 1998). Fraser (1999), in his review of qualitative learning environment studies, concluded that findings from the quantitative component of the research were in accordance with the observations gathered from the qualitative methods. Tobin and Fraser (1998) in a study involving 13 researchers and over 500 hours of observations of 22 exemplary teachers and a comparison group of non-exemplary teachers, also reported the same consistency. For example, the students' responses to the critical voice scale of the CLES was higher for exemplary teachers which was in accordance with the observations of exemplary teachers encouraging their students to voice their opinions and to provide alternative suggestions.

In the field of learning environments, mixed-method studies have become more prevalent. In many studies, quantitative data have been used to provide a broad overview of trends and generalisations and qualitative information gathered are used to provide explanations and depth to the findings. For example, Aldridge et al. (1999), in their cross-national study analysed WIHIC data collected from 1,081 grade 8 to 9 science students in Western Australia and 1,879 grade 7 to 9 students in Taiwan. The findings of the large-scale quantitative overview provided a starting point from which qualitative methods (such as observations, interviews, and narrative stories) were used to gain a more in-depth understanding of the classroom environments in each country. In sum, mixed-method and qualitative studies have been used to help to provide a richer and better understanding of the learning environment dimensions that would not have been possible through questionnaires alone.

The final area of research highlighted by Fraser (2007), involved studies that cross national boundaries. The findings from these studies offer a greater variation in outcome variables as the sample is drawn from multiple countries (Fraser, 2007). In addition, the taken-for-granted, common educational practices, attitudes and beliefs in one country are more likely to be exposed and questioned when more than one country is involved. Cross-national studies between Australia and Taiwan (Aldridge & Fraser, 2000; Aldridge et al., 2000; She & Fisher, 2000) have provided information about the differences that exist between perceptions of students in the two countries as well as valuable cultural insights that have helped to explain the data. A recent cross-national study of classroom environments in Australia and Indonesia (Fraser et al., 2010), involving 594 students from Indonesia and 567 students from Australia, used the WIHIC to investigate differences between countries in perceptions of classroom environment. The data analysis revealed that, for some scales (task orientation and equity), Australian students had significantly more positive perceptions of their classrooms. However, for other scales, (involvement and investigation), Indonesian students perceived their classroom environment significantly more positively than did Australian students.

The focus of the present research is on student motivation and self-regulation, both of which are considered to be key learning outcomes and essential for the improvement of science classrooms. Based on Table 2.7, which reports on the different areas of research taken in the field of learning environment, this study focuses on the associations between student outcomes and the learning environment. Analyses of previous studies in this area have indicated that there exists a strong association between salient students' perceptions of their learning environment and their cognitive and affective learning outcomes (Fraser, 2007). Therefore, in order to stimulate and optimise students' learning outcomes, knowledge of which elements in the psychosocial learning environment are likely to influence these outcomes is crucial for both teachers and educational researchers. However, the learning outcomes which have been previously researched are mainly confined to either cognitive outcomes or the affective outcome of attitude towards a particular subject

(Fraser, 2007). This study fills the gap in the research by examining the influence of psychosocial learning environment on students' motivation and self-regulation in science learning.

A limited number of researchers (Dorman, 2001; Dorman & Adams, 2004; Dorman & Fraser, 2009) have reported that the classroom learning environment has a strong association with academic efficacy. However, the influence of psychosocial learning environment on students' self-efficacy in science learning has not been investigated. Moreover, the influences of psychosocial learning environment on two other motivational dimensions, learning goal orientation and task value, have not been examined in the past. Additionally, previous studies have not investigated the influence of psychosocial learning environment on students' self-regulation in learning a particular subject.

The interactions elucidated in the social cognitive theory suggest that relevant aspects of the learning environment could influence both students' motivational beliefs and students' self-regulation. This theoretical basis, coupled with the lack of research on the influence of psychosocial learning environment on student motivation and self-regulation, provided the impetus for this research. Hence, this study aimed to investigate which elements in the psychosocial classroom learning environment could influence students' motivation and self-regulation in science learning.

2.7 Chapter Summary

The theoretical foundation of this study, social cognitive theory, contends human functioning is a series of reciprocal interactions between personal influences (e.g. students' motivational beliefs), environmental features (e.g. classroom learning environment) and behaviours (e.g. students' self-regulation). In the field of education, the social cognitive theory has been widely used as a framework for understanding and predicting students' behaviour and identifying methods in which behaviour can be modified or changed. This theory provided the underpinning for the development of constructivism and cooperative learning which are considered as current tenets of science education. The focus of this research was to examine three of the interactions purported in the theory, the influence of learning environment on motivational beliefs and self-regulation as well as the influence of motivational beliefs on self-regulation. The present study aimed to inform researchers and practitioners about the salient features of the psychosocial learning environment that could considerably enhance students' motivational beliefs and self-regulation in science learning.

Motivation is the internal circumstance that initiates and sustains goal-oriented behaviour. In science learning, students' motivation plays a pivotal role in their conceptual change processes, critical thinking, learning strategies, and science achievement. Three components of motivation that have been consistently researched are learning goal orientation, task value, and self-efficacy, each of which is integral to students' self-regulation. Students who have a learning goal orientation participate in the classroom for the purpose of learning, understanding and mastering concepts and skills. Students who value the tasks given to them perceive the learning of the tasks in terms of interest, importance and utility. Finally, students with self-efficacy beliefs are confident in their ability to successfully perform learning tasks. Theoretical and research evidences support the importance of these motivational components towards students' successful science learning. Since there has not been previous research on the influence of learning environment on students' learning goal orientation, task value and self-efficacy in science learning, this study took up this imperative challenge. In addition, due to the unavailability of an economical and theoretically inclusive instrument that could measure lower secondary students' motivational beliefs in science learning, the present study aimed to develop and validate an instrument to surmount this setback.

Self-regulation is the ability of an individual to control his or her conduct to achieve a set goal. The behavioural aspect of self-regulation, effort regulation, refers to a student's choice to engage in a particular learning activity and the degree of intensity of effort and persistence that he/she puts into the activity. Students must not only be motivated through assigning goals and values to the learning activity, but must also sustain effort until the completion of the task. Self-regulation in learning has been established as both an important outcome of the schooling process and as a key determinant of students' academic success. However, there has been no previous research in the field of leaning environment that has examined the psychosocial learning environment as a determinant of student self-regulation. This study took the initiative to fill the research gap in terms of examining psychosocial aspects of learning environment and its influence on students' self-regulation in science learning. In addition, this study investigated the role of students' motivational beliefs as predictors of students' self-regulation in science learning. Currently, there is a dearth of instruments that could specifically measure students' self-regulation in science learning. Therefore, the present study developed an economical, theoretically inclusive, domain-specific and valid scale to assess lower secondary students' self-regulation of effort in science learning.

Theoretically, girls and boys continue to differ in line with traditional gender role stereotypes, with boys indicating higher ability, beliefs and interest in science and mathematics. The research evidence indicated that girls inherently have lower self-perceptions of their academic ability in science, even when they actually perform better when compared to boys. Although past studies did not reveal a clear pattern of gender differences with respect to students' learning goal orientations and task value in science, the findings did indicate that boys have higher self-efficacy beliefs in the area of science learning. The predominant research method in previous research has been to compare mean level differences in key dimensions of motivation and self-regulation. This study evolves from traditional gender differences studies by examining how key facets of motivational beliefs influence students' self-regulation and whether these influences differ for boys and girls. Structural Equation Modeling based, multi-group data analysis, was used to add to the depth of insights that can be drawn from the results.

Lewin (1936) contended that the environment and its interaction with the personal characteristics of individuals are responsible for human behaviour. Moos (1974) extended Lewin's environmental influences by focusing on the psychosocial aspect of the classroom environment. Moos emphasised that there are three general dimensions that characterise any human environment these being personal relationships, personal growth and system management.

Classroom learning environment research has evolved with researchers developing well-validated and robust instruments to measure students perceptions based on the three pertinent dimensions described by Moos. Some of the historically important learning environment instruments include the LEI, CES, ICEQ, CUCEI, QTI, CLES, SLEI and WIHIC. The extensive and successful use of the WIHIC instrument around the world is considered as a significant milestone in the field of learning environment research.

The extensive range of research in the field of learning environment prompted Fraser (2007) to categorise them into six distinct areas, these being, associations between students' outcomes and learning environment, evaluation of educational innovations, differences between students' and teachers' perceptions of the same learning environment, determinants of learning environment, qualitative research and cross-national studies. The present study incorporates the area of associations between student outcomes and the learning environment. An extensive range of studies has indicated that student perceptions of the learning environment account for an appreciable amount of variance in learning outcomes, often beyond that attributable to student background characteristics. Therefore, in order to stimulate and optimise students' learning outcomes, knowledge of which elements in the psychosocial learning environment are likely to influence these outcomes is crucial for both teachers and educational researchers. However, the learning outcomes which have been previously researched are mainly confined to either cognitive outcomes or the affective outcome of attitude towards a particular subject. This study fills the gap in the research by examining the influence of psychosocial learning environment on students' motivation and self-regulation in science learning.

In conclusion, this literature review highlighted existing gaps in extant research and established the significance of the present study in bridging these gaps. This chapter provided the foundation for the development of the research model postulated for this study. The next chapter presents the research model and describes the methodology utilised to evaluate the research model. In addition, the methodology used to develop and validate the newly developed SALES questionnaire is presented.

CHAPTER 3
RESEARCH METHODS

3.1 Introduction

This chapter describes, in detail, the research methods used in the present study. The literature review discussed in Chapter 2 led to the formulation of the research model presented in Section 3.2. The research questions and objectives, outlined in chapter 1, determined the positivist paradigm of this research and the selection of the research methodology. The merits of the positivist paradigm for this exploratory study are clarified in Section 3.3. The next part, Section 3.4, provides details of the instruments, sample selection and data collection procedures for the pilot study as well as for the main study. Since this study involved two different types of data analysis, explanation of the data analysis procedures are divided into two sections. Section 3.5 details the procedures for the validation of the questionnaires, which utilised a construct validity framework, to establish content, face, convergent, discriminant, concurrent and predictive validity. Section 3.6 then elucidates the data analysis procedures for the evaluation of the research model, which utilised Structural Equation Modeling, to ascertain the explanatory power of the model.

3.2 Research Model

The theoretical framework for this study was based on both theory and past research, as discussed in the literature review. The framework, presented in Figure 3.1 as the research model, hypothesises that each of the seven psychosocial aspects of the learning environment (student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity) individually influences each of the three motivation constructs (learning goal orientation, task value and self-efficacy) and self-regulation in science learning. Additionally, each of the three motivation constructs (learning goal orientation, task value and self-efficacy) is predicted to influence self-regulation in science learning. In addition, based on the gender differences discussion in the literature review, the research model envisages that gender would moderate the hypothesised relationships between each of the three students' motivational beliefs construct and students' self-regulation in science learning. The research model also speculates that the hypothesised relationships between motivational beliefs and students' self-regulation in science learning would be more significant for boys.

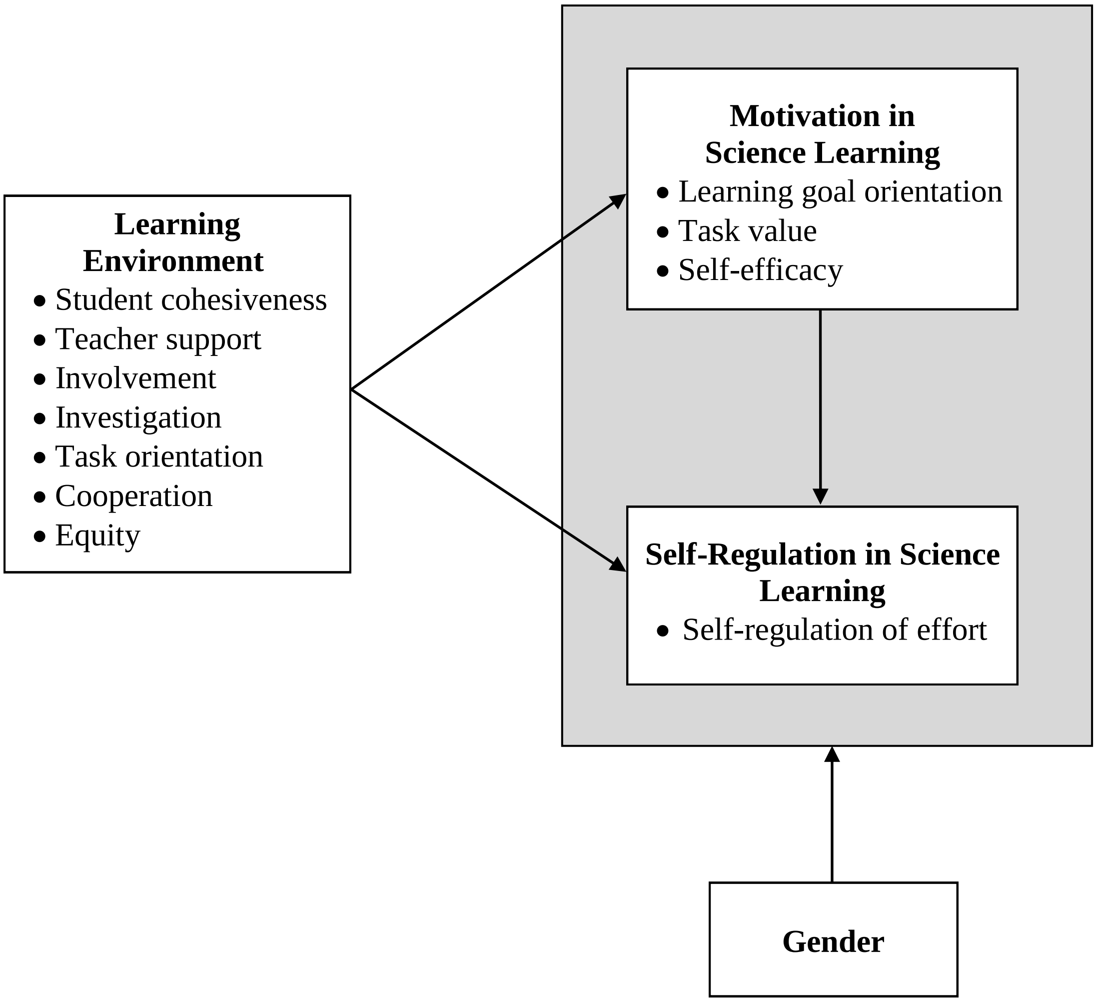


Figure 3.1: Research model

3.3 Research Paradigm

According to Willis (2007, p. 8) a paradigm is "a comprehensive belief system, world view or frame work that guides research and practice in a field". Although there are numerous paradigms that guide research, the widely accepted list always includes positivism (Guba, 1990). In addition, the basic tenets of behavioural science are founded on positivism (Willis, 2007). Hessler (1992) articulated that the positivist's fundamental belief is that any scientific concept or idea can be measured or observed. Therefore, positivists are interested in the discovery of a universal truth that can be applied to all (Guba, 1990).

The focus of this research is to create an understanding of the measurable and observable aspects of classroom learning environment that influence students' motivation and self-regulation in science learning. This exploratory study adopted the positivist assumption that all meaningful problems can be framed in clear-cut frameworks, characterised by precise hypotheses and well-defined methods. The ontological position of this study is that reality is objective and can be found. Therefore, this research takes the positivist approach to build a conceptual model grounded on theory and subsequently tests the effectiveness of the research model.

3.4 Instruments

The quantitative data were collected using two questionnaires, these being, the Students' Adaptive learning Engagement in Science (SALES) questionnaire (developed for the purpose of this study) and the What Is Happening In this Class (WIHIC) questionnaire. Section 3.4.1 describes the sequential stages in the development and validation of the SALES questionnaire whilst a description of the WIHIC, a well established learning environment survey, is provided in Section 3.4.2.

3.4.1 Students' Adaptive Learning Engagement in Science (SALES) Questionnaire

To assess students' motivation and self-regulation in science learning, the SALES instrument was developed and validated. The development of the new questionnaire followed a three-stage approach. Stage 1 involved identifying and defining salient student motivation and self-regulation scales and consisted of two steps. First, an extensive review of theories and research related to student motivation and self-regulation was carried out. This crucial step aided in the identification of key components that theorists, researchers and practitioners consider to be essential in elucidating students’ learning engagement in science. The second step was to define concisely the scales identified in step one based on the analysis of literature. These steps in Stage 1 were undertaken to maximise content validity of the instrument by ensuring that the scales were based on a sound theoretical framework.

Stage 2 involved writing individual items within the scales. First, items from previously validated questionnaires were examined and, if appropriate, adapted. Secondly, suitable items were written for each scale. Once the items for each scale had been adapted or written, ten experienced science teachers were asked to assess the comprehensibility, clarity, and accuracy of items for each scale. The teachers evaluated each item and indicated whether the item was representative of its corresponding scales. The teachers were also asked to remark upon whether they felt that the items were suitable or not and, if appropriate, to propose additional items. The teacher evaluation form is included as Appendix 1. Based on the teachers’ reviews, the items underwent revision.

Stage 3 commenced with a pilot study conducted with 52 students in two grade 8 science classes. Twelve students, six from each of these two classes, based on their willingness to participate, were selected for semi-structured interviews. The main purpose of the interviews was to confirm whether students were responding to the items on the basis intended by the questionnaire. The semi-structured interview schedule, used with these students, is provided in Appendix 2. Finally, validation of the questionnaire involved the large-scale administration of the survey to students from years 8, 9 and 10 in Perth public schools. The data analyses and results for each stage of the development and validation process are detailed in the next chapter in Section 4.3.

3.4.2 What Is Happening In this Class? (WIHIC) Questionnaire

Whilst the newly developed SALES instrument was used to assess students’ motivation and self-regulation in science learning, students’ perceptions of the classroom learning environment were assessed using the What Is Happening In this Class? (WIHIC) questionnaire. The WIHIC was specifically designed for high school science classrooms (Aldridge et al., 1999). It incorporated the best features of existing instruments, by adapting salient scales and included others to assess aspects of constructivism and other relevant factors operating in contemporary classrooms (Aldridge et al., 1999; Dorman, 2008). The reliability and validity of the WIHIC have been supported for samples in Australia and Taiwan (Aldridge et al., 1999), the US (Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008), Indonesia (Fraser et al., 2010), Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008), Korea (Kim et al., 2000), United Arab Emirates (Afari et al., in press; MacLeod & Fraser, 2010) and India (den Brok et al., 2005).

Of all of the questionnaires developed in the field of learning environments, the WIHIC is the most widely used and its impressive validity in a range of contexts and countries has, according to Dorman (2008), contributed to what has been termed its ‘band-wagon status’. The final version of the WIHIC consists of seven eight-item scales, namely, student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. The WIHIC is worded to elicit the student’s perception of his/her individual role within the classroom. Dorman (2008), in a review of research with the WIHIC, stated that the robust nature of the instrument’s reliability and validity has been widely reported in numerous studies in different subject areas, at different age levels and in twelve different countries. Table 3.1 provides, for each WIHIC scale, a description, a sample item and its classification according to Moos’ scheme.

The WIHIC is comprised of seven scales with eight items in each scale, bringing the total to 56 items (Appendix 3). In terms of Moos’ (1974) scheme for classifying the individual dimensions of any human environment (described previously in Section 2.2), the WIHIC is comprised of three scales that measure personal relationships (namely, student cohesiveness, teacher support and involvement), three scales that measure personal development (namely, investigation, task orientation and cooperation) and one scale that measures system maintenance and change (namely, equity).

Table 3.1: Scale description, sample item and Moos classification for each WIHIC scale

Scale name	Scale description	Sample item	Moos' scheme
Student cohesiveness	The extent to which students know, help and are supportive of one another.	I make friendships among students in this class.	R
Teacher support	The extent to which the teacher helps, befriends, trusts and is interested in students.	The teacher takes a personal interest in me.	R
Involvement	The extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class.	I give my opinions during class discussions.	R
Investigation	The extent to which skills and processes of inquiry and their use in problem solving and investigations are emphasised.	I solve problems by using information obtained from my own investigations.	P
Task orientation	The extent to which it is important to complete planned activities and to stay on the subject matter.	Getting a certain amount of work done is important to me.	P
Cooperation	The extent to which students cooperate rather than compete with one another on learning tasks.	I cooperate with other students on class activities.	P
Equity	The extent to which students are treated equally by the teacher.	I am treated the same as other students in this class.	S

Note. R = Relationship, P = Personal Development, S = System Maintenance and System Change.
Response alternatives: Almost Never, Seldom, Sometimes, Often and Almost Always
Source: Aldridge, Fraser & Huang (1999)

3.5 Sample Selection and Data Collection

The data collection procedures for this study can be divided into two main parts, namely the pilot study and the main study. Section 3.5.1 describes that prior to the pilot study, ten experienced science teachers reviewed the newly developed questionnaire. Once the initial questionnaire was modified, based on the teachers' reviews, a pilot study was conducted with 52 students from two year 8 science classes. The main study, explained in Section 3.5.2, involved students in years 8, 9 and 10 from five public schools in Perth.

3.5.1 Pilot Study

As described in Section 3.4.1, in the second stage of the development of the SALES questionnaire, experienced science teachers were asked to assess the comprehensibility, clarity and accuracy of items for each scale. Ten teachers, from one of the schools which participated in the study, volunteered to complete the expert review form. This school, in particular the science department, had previously participated in numerous research studies. Each of the ten teachers had more than fifteen years experience teaching science in lower secondary classes. Two of the teachers were the Heads of the Science Department at their school. One other senior teacher, an active researcher who completed his doctoral studies a few years ago also volunteered to complete the expert review form. To gain further clarification from the teacher's review, two of the teachers were interviewed by the researcher.

Students from the same school participated in the pilot study. 52 students from two year 8 classes, taught by different science teachers, completed both questionnaires. The teachers, assisted by the researcher, distributed the survey during two morning science class periods. The students comprised of 23 boys and 29 girls. Data related to the students' science grades indicated that the sample had a wide range of science achievement. Twelve students, who expressed their willingness to participate in the semi-structured interview, were interviewed by the researcher after they completed the questionnaires. Students whose achievement ranged from low to high were selected to ensure that the interview sample was representative of the population.

3.5.2 Main Study

Ten public schools from the Perth metropolitan area, all with similar socio-economic background, were approached and five schools volunteered to participate. The schools were selected to encompass students with differing abilities and gender to provide a representative sample of lower-secondary students in Perth public schools in terms of achievement and socio-economic background. Hence, the students involved included a wide range of science literacy levels and were from grades 8, 9 and 10.

Both the newly developed SALES and the WIHIC were administered to the students during one morning class period in the last quarter of the academic year. The questionnaires were administered at the same time by the science teachers with guidance from the researcher. Students' participation was voluntary and the confidentiality of students' data was ensured. The total number of useable responses came from 1,360 students, in 78 lower secondary science classes (719 of whom were boys and 641 of whom were girls). Data pertaining to student achievement in science were collected from five of these classes comprising of 129 students. The teachers from these classes provided the students' most recent science achievement grade.

3.6 Data Analysis

The data analysis process can be divided into two parts. The first part is the analysis for the validation of the two questionnaires used in this study. The construct validity framework suggested by Trochim and Donnelly (2006) (see Section 3.6.1) guided the validation of both of the questionnaires. Section 3.6.1 explains the SPSS 17 quantitative data analyses process for the validation. The evaluation of the research model utilised Partial Least Squares (PLS) based Structural Equation Modelling (SEM). The data analyses procedures in PLS, which include assessment of the measurement properties and assessment of the research model, are detailed in Section 3.6.2.

3.6.1 Validation of Questionnaires

This study utilised Trochim and Donnelly's (2006) framework for construct validity (see Figure 3.2) to guide the validation of the newly developed Students' Adaptive Learning Engagement in Science (SALES) questionnaire. Hence, as suggested by Trochim and Donnelly (2006), both quantitative and qualitative research methods were applied to maximise the validity of the questionnaire. According to this framework, a construct must fulfil both translation and criterion-related validity requirements.

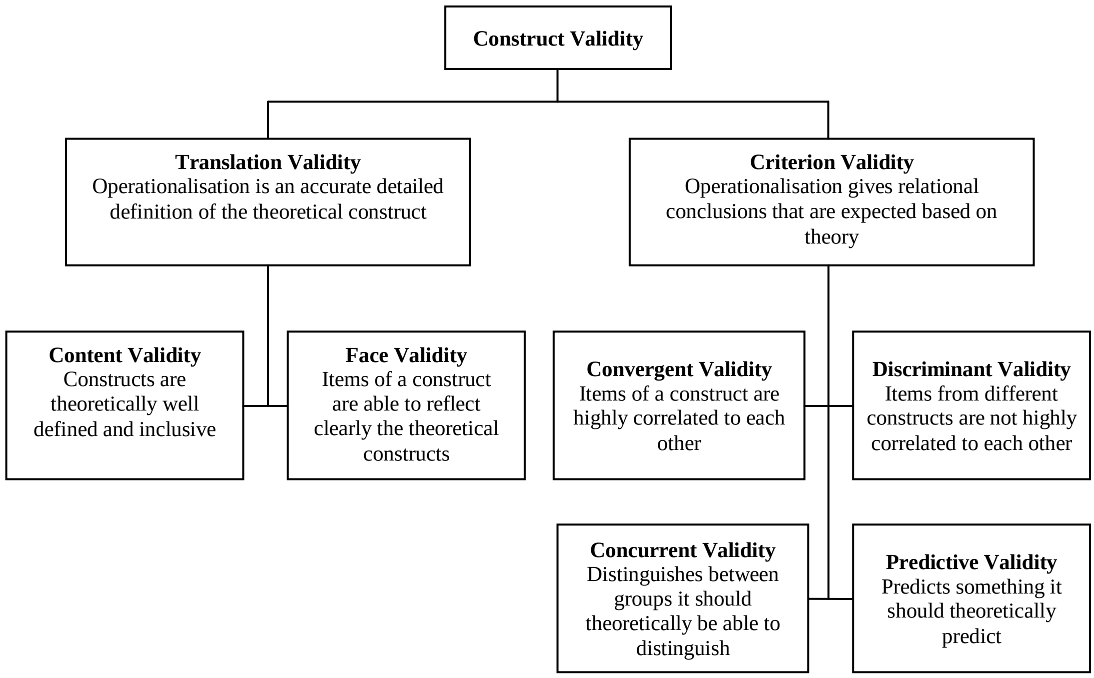


Figure 3.2: Framework for construct validity (source Trochim & Donnelly, 2006)

Translation validity assures that the operationalisation of the construct is accurate, based on theory and that it could be comprehended by the participants. Hence, translation validity involves content validity (which focuses on whether the construct is theoretically sound and provides an all-encompassing representation of the construct) and face validity (which emphasises the need for a clear interpretation of the items, especially by the participants).

Criterion-related validity involves a more relational approach as it verifies whether the construct provides the conclusions that are expected, based on theoretical grounds. Hence, the items of a particular construct should be highly correlated to each other (convergent validity), whilst items from different constructs should not be highly correlated to each other (discriminant validity). In addition, the construct must be able to predict something that it should theoretically predict (predictive validity) and distinguish between the groups that it is expected to distinguish between (concurrent validity). In sum, the instrument has high construct validity if it can establish content, face, convergent, discriminant, concurrent and predictive validity.

The validation of the WIHIC also utilised the construct validity framework suggested by Trochim and Donnely (2006). Since the WIHIC, discussed in Section 3.4.2, was already a well-established learning environment instrument, the validation of WIHIC in this study centred on the criterion validity of the instrument. Therefore, the data analysis focused on the convergent validity, discriminant validity, concurrent validity and predictive validity of the WIHIC. For both the questionnaires, data analysis for the criterion validity utilised SPSS 17.

Exploratory factor analysis was conducted separately for the SALES questionnaire and the WIHIC questionnaire. Since data involving humans are generally related, as recommended by Field (2009), oblique rotation was utilised in the principal component analysis of the items to ensure the extraction of succinct sets of factors. Factor loadings indicated how strongly each item was related to a particular factor, eigenvalues showed the relative importance of each factor, and the cumulative variance was used to check whether a sufficient number of factors had been retained (Field, 2009). The Cronbach alpha coefficient was calculated for each factor to provide an indication of the internal consistency reliability. The factor loadings and internal consistency reliability measure ensured the convergent validity of the questionnaires.

Brown (2006) and Field (2009) explained that oblique rotation in exploratory factor analysis provides realistic representation of how factors are interrelated. According to Field (2009), there should be a moderately strong relationship between factors based on theoretical grounds. However, factor correlations above 0.80 imply overlap of concepts and point towards poor discriminant validity (Brown, 2006). The component correlation matrix obtained from oblique rotation indicates whether the correlation values meet the requirements of discriminant validity. In addition, Trochim and Donnelly (2006) suggested that discriminant validity is achieved when the correlations between a particular item and other items in the same construct are higher than its correlations with items from different constructs. Hence, the correlation matrix from the oblique rotation was analysed to ensure this condition was met. These two procedures ensured the discriminant validity of the instruments.

Concurrent validity was assessed to make sure that each construct was able to distinguish between those groups which it was expected to distinguish between. When Urdan and Schoenfelder (2006) critically examined three theoretical perspectives on student motivation – achievement goal theory (Ames, 1992), self-determination theory (Deci & Ryan, 1985), and social-cognitive theory (Bandura, 1986) – they concluded that these theories corroborate that classroom characteristics strongly influence student motivation within a class. Research evidence substantiates that student motivation in one classroom can be differentiated from student motivation in other classrooms (Ames, 1992; Meece, Anderman E. M. & Anderman L. H., 2006; Ryan & Patrick, 2001; Urdan & Schoenfelder, 2006; Wolters et al., 1996). Furthermore, Tuan et al.'s (2005) research on science classrooms established that students within one class have significantly different motivation from students in other science classes. Given that the theoretical and research underpinnings indicate that student motivation in one classroom can be distinguished from student motivation in other classes, it was decided that the scales of the SALES instrument should have the ability to differentiate between the scores of students in different classes.

Similarly, theoretical and research evidence has established that a unique feature of classroom learning environment questionnaires is their ability to differentiate between classes (Fraser, 1998). Hence, each scale of the WIHIC must have the ability to differentiate the scores of students from different classes. Therefore, to establish concurrent validity, the ability of each scale in both the questionnaires to differentiate between different classes was investigated using ANOVA. The eta^2 statistic, based on the ratio of the between-group effect to the total amount of variance in the data (Field, 2009), was calculated to provide information about the amount of variance attributed to class membership.

Predictive validity was assessed to ensure that the score on the construct predicts scores on other dimensions based on theoretical grounds. Theoretical and research underpinnings, discussed in the literature review, suggested that students' learning goal orientation, task value, self-efficacy and self-regulation should be strongly associated with students' achievement in science. Likewise, past research has ascertained that the dimensions of classroom learning environment instruments are positively associated with students' achievement (Fraser, 1998; Haertel et al., 1981; McRobbie & Fraser, 1993). Students' achievement grade (provided by the science teachers at the time that the questionnaires were administered) was used as an indicator of science achievement. Because the hypothesis was that there is a positive correlation between each of the scale from both instruments and students' science achievement, the correlations were tested using a one-tailed Pearson coefficient.

3.6.2 Evaluation of the Research Model

To investigate the influence of science classroom environment on students' motivation and self-regulation in science learning, Structural Equation Modeling (SEM) was used. SEM is a second-generation statistical technique that enables "researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by modelling the relationships among multiple independent and dependent constructs simultaneously" (Gefen, Straub & Boudreau, 2000, p. 71). SEM has been acknowledged to have advanced the nature of research in various disciplines (Henseler, Ringle & Sinkovics, 2009). As Gefen et al. (2000, p. 6) point out, ''SEM has become de rigueur in validating instruments and testing linkages between constructs".

From several SEM component applications available for researchers, the one selected specifically for this study was Partial Least Square (PLS) Graph version 3.0. Henseler et al. (2009), in their review of PLS, summarised that PLS has been used by a growing number of researchers from various disciplines such as strategic management, management information systems, e-business, organisational behaviour, marketing and consumer behaviour. According to them, in the field of international marketing, more than 30 articles using PLS have been published in double-blind reviewed journals.

The strength of PLS is that it works by "simultaneously assessing the reliability and validity of the measures of theoretical constructs and estimating the relationships among these constructs" (Barclay, Higgins & Thompson, 1995, p. 287). PLS is highly applicable in theory development in particular examining exploratory research models because it has higher levels of statistical power compared to LISREL (Hair, Ringle & Sarstedt, 2011). PLS also overcomes some of the theoretical and estimation problems with regard to improper solutions, model complexity and factor indeterminacy associated with other SEM approaches such as AMOS and LISREL (Hair et al., 2011; Hulland 1999; Hsu, Chen & Hsieh, 2006).

In addition, PLS is a powerful statistical tool for prediction-oriented research (Henseler et al., 2009). Due to the emphasis on theory building and predictive accuracy in PLS, the goodness-to-fit indices, used in LISREL, is not conducted as a part of PLS analysis (Chin, 1998; Gefen et al., 2000; Henseler et al., 2009). Hulland (1999) contends that even if PLS reported goodness-of-fit statistics (such as the NFI or GFI), these statistics are meaningless because the purpose of PLS is not to minimise the difference between the observed and the reproduced covariance matrices. Another major advantage of PLS is that it makes minimal distribution assumptions. Therefore, tests for normality, such as skewness, kurtosis, and Kolmogorov-Smirnov test, need not be undertaken (Chin, 1998). The present study was a prediction-oriented, theory building exploratory research, with a unique and complex research model emerging from a review of literature. Therefore, the application of PLS in this study was both rational and practical.

The data analysis in PLS involved two distinct stages as illustrated in Table 3.2. During the first stage, confirmatory factor analysis, involved the assessment of the measurement properties through examination of convergent validity and discriminant validity. The items were tested for convergent validity by determining item reliability, internal consistency and average variance extracted (AVE) (Fornell & Larcker, 1981).

Table 3.2: Stages of data analysis in Partial Least Square (PLS)

Stage	Type of measurement		Minimum requirement	Source
Stage 1 Assessment of measurement properties	Convergent Validity	➢ Item reliability	≥ 0.70	Chin (1998)
		➢ Internal consistency	≥ 0.70	Fornell & Larcker (1981)
		➢ Average variance extracted (AVE)	≥ 0.50	Fornell & Larcker (1981)
	Discriminant Validity	➢ AVE analysis	Square root of the AVE of a construct is larger than its correlation with other constructs	Barclay, Higgins, & Thompson (1995)
		➢ Cross loading Matrix	Loading of an item within a construct is greater than it's loading in any other construct	Gefen, Straub & Boudreau (2000)
Stage 2 Assessment of research model	• Coefficient of determination		$R^2 \geq 0.10$	Falk & Miller (1992)
	• Test of Hypotheses		Significant t-value	Chin (1998)
	• Multi-group analysis ➢ Smith-Satterthwaite test		Significant t-value	Chin (2004)

Item reliability assesses the loadings for each individual item. The loadings indicate the correlation of the items with their respective constructs. Therefore, maintaining low loading items would decrease the correlation between the items in the construct (Nunnally, 1978). Item reliability also measures the level of random error for each construct. The lower the item loading, the higher is the level of random error. Therefore, this procedure identifies and eliminates the items in a particular construct that could increase the construct's level of random error (Fornell & Larcker, 1981).

Internal consistency is a second-generation procedure that measures reliability. It is proposed as an effective method to overcome the weaknesses of Cronbach alpha, the first generation reliability measure. The total number of items does not influence internal consistency, unlike Cronbach alpha (Hanlon, 2001). Furthermore, Fornell and Larcker (1981) argue that, in PLS, the item loadings are acquired within the model unlike Cronbach's alpha. Nevertheless, the intention and interpretation of both measures of reliability are the same. The minimum value for internal consistency is specified as 0.70 (Barclay et al., 1995; Fornell & Larcker, 1981; Igbaria, Zinatelli, Cragg & Cavaye, 1997; Nunally, 1978). The formula for calculating internal consistency, as specified by Fornell and Larcker (1981), is provided in Equation 2.

Equation 2

$$\text{Internal Consistency} = \frac{(\Sigma\lambda_{yi})^2}{(\Sigma\lambda_{yi})^2 + \Sigma\lambda \mathrm{Var}(\varepsilon_i)}$$

Where λ = component loading to an indicator, y = construct, i = item, $\mathrm{Var}(\varepsilon_i) = 1 - \lambda_{yi}^2$

The final criterion to satisfy convergent validity was the measure of average variance extracted (AVE). AVE is a measure that indicates the amount of variance in the item that is explained by the construct (Fornell & Larcker, 1981). Fornell and Larcker (1981) and Nunnally (1978) specify the rule of thumb for the minimum value of AVE as 0.5. This value ensures adequate construct reliability to achieve convergent validity. Equation 3 gives the formula for the calculation of AVE (Fornell & Larcker, 1981).

Equation 3

$$\text{Average variance extracted (AVE)} = \frac{(\Sigma\lambda_{yi})^2}{\Sigma\lambda_{yi}^{\ 2} + \Sigma\lambda \mathrm{Var}(\varepsilon_i)}$$

Where λ = component loading to an indicator, y = construct, i = item, $\mathrm{Var}(\varepsilon_i) = 1 - \lambda_{yi}^2$

The determination of item reliability, internal consistency and average variance extracted (AVE) establishes the convergent validity of the items in each construct.

The goal of convergent validity is to ensure that items in a construct are correlated and measure the same underlying dimension intended for the construct.

The discriminant validity of the items was assessed by applying two analytical procedures suggested by Barclay et al. (1995). First, the square root of the AVE of the items were calculated and this value was then compared to the inter-construct correlation. Barclay et al. (1995) specify that discriminant validity is achieved when the square root of the AVE of a construct is larger than its correlations with other constructs. Second, the matrix of cross-loadings of items was generated. Gefen et al. (2000) stipulate that the loading of an item within the construct it intends to measure must be higher than its loading with any other construct. The two techniques examined the extent to which a construct differs from other constructs in the survey. The goal of discriminant validity is to ensure that the individual constructs in the questionnaires are discriminated from each other by the instrument.

The second stage was the assessment of the research model outlined in Figure 3.1. The first step was to assess the explanatory power of the proposed model (see Table 3.2). This was done by estimating the variance associated with the endogenous constructs (dependent variables or consequents), in this case, students' learning goal orientation, self-efficacy, task value and self-regulation in science learning. The overall result determined how much the variance of students' self-regulation in science learning can be explained by the constructs in this model. Falk and Miller (1992) proposed that the minimum R^2 should be 0.10. Chin (1998) contends that the R^2 values of 0.67, 0.33 or 0.19 can be respectively considered as substantial, moderate or weak. Finally, the hypothesis outlined in the research model was tested. The positive or negative value of path coefficient and the corresponding *t*-value for each of the hypothetical relationship was calculated. The goal was to determine the relationships that were significant in the research model.

For the moderating effects of gender, the multi-group analysis method, recommended by Chin (2004), was utilised. First, the sample was subdivided into two subgroups according to gender. Subsequently, the measurement properties for each subgroup were examined and adjusted to achieve the requirements of convergent validity and discriminant validity. The explanatory power of the research model for boys and girls were then evaluated separately and the standardised path coefficients for each subgroup were calculated to determine the significant relationships in each model. When the statistical analysis showed that there were differences between the subgroups, the objective was then to determine whether the differences were significant or not. First, the data was tested using the Kolmogrov-Smirnov test of normality using SPSS 17. The result indicated that the data was not distributed normally. Therefore, the Smith-Satterthwaite *t*-test, utilised in data that violate the normal distribution, was chosen. The equation for the Smith-Satterthwaite *t*-test is depicted in Equation 4.

Equation 4

$$t = \frac{Path_{\text{sample\_1}} - Path_{\text{sample\_2}}}{\sqrt{S.E.^2_{\text{sample\_1}} - S.E.^2_{\text{sample\_2}}}}$$

Where *S.E.* = standard errors for structural path

3.7 Summary

The theoretical framework for this study, presented as the research model, hypothesised that each of the seven psychosocial aspects of the learning environment (student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity) individually influences each of the three motivation constructs (learning goal orientation, task value and self-efficacy) and self-regulation in science learning. Each of the three motivation constructs (learning goal orientation, task value and self-efficacy) was also envisaged to influence self-regulation in science learning. Additionally, the research model predicts that gender would moderate the hypothesised relationships between each of the three students' motivational beliefs construct and students' self-regulation in science learning.

Since the nature of this study is exploratory, adopting the positivist paradigm assisted in the postulation of a theoretically grounded research model and enabled the process of testing the effectiveness of the research model. The well-defined deductive mode of inquiry aimed to achieve objectivity, measurability and controllability. Hence, this study intended to create an understanding of measurable elements of the psychosocial learning environment that influences students' self-regulation in science learning. In addition, this objective and unbiased research method could easily be replicated to check on its validity and reliability.

Two instruments were used in this study, these being the newly developed SALES questionnaire and the WIHIC questionnaire. The development of the SALES questionnaire followed a three-stage approach. Stage 1, identifying and defining salient student motivation and self-regulation scales, was undertaken to maximise content validity of the instrument by ensuring that scales were based on a sound theoretical framework. Stage 2 commenced with the writing of new items or adaption of items from previously validated questionnaires for each scale. Subsequently, ten experienced science teachers were requested to evaluate the comprehensibility, clarity, and accuracy of the items and assess whether each item was representative of its corresponding scales. Stage 3 began with a pilot study on year 8 students followed by semi-structured interviews to confirm whether the students were responding to the items on the basis intended by the questionnaire. The final step is the large-scale administration of the survey to students from years 8, 9 and 10 in Perth public schools to establish criterion-related validity.

The second instrument used in the present study was the WIHIC, a widely used learning environment questionnaire, that has an impressive validity in a range of contexts and countries. This questionnaire, specifically designed for high school science classrooms, incorporates the best features of extant learning environment instruments, by adapting salient scales and including others to assess aspects of constructivism and other relevant contemporary classroom elements. The final version of the WIHIC consists of seven eight-item scales, namely, student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity.

The data collection procedures for this study involved two phases, a pilot study and the main study. Prior to the pilot study, ten senior science teachers, each of whom had more than fifteen years experience teaching science in lower secondary classes, assessed the items and scales in the questionnare. The pilot study was conducted with

52 students from two year 8 science classes taught by different science teachers. Data related to the students' science grades indicated that the sample had a wide range of science achievement. The researcher interviewed twelve students, who expressed their willingness to participate in the semi-structured interview, after they completed the pilot study survey. For the main study, five public schools in the Perth metropolitan area, all with similar socio-economic background, volunteered to participate. The 1,360 students (719 of whom were boys and 641 of whom were girls) in grades 8, 9 and 10 who provided useable qustionnaires were from 78 lower secondary science classes.

Trochim and Donnelly's (2006) framework for construct validity guided the validation of the newly developed SALES questionnaire. According to this framework, a construct must fulfil both translation and criterion-related validity requirements. Translation validity involves content validity (the construct is theoretically sound and the items provide an all-encompassing representation of the construct) and face validity (clear interpretation of the items, especially by the participants). Criterion-related validity verifies whether the construct provides the conclusions that are expected, based on theoretical grounds. This involves convergent validity (items of a particular construct are highly correlated to each other), discriminant validity (items from different constructs are not highly correlated to each other), predictive validity (the construct must be able to predict something that it should theoretically predict) and concurrent validity (the construct must be able to distinguish between the groups that it is expected to distinguish between). The validation of the WIHIC also utilised the construct validity framework focusing on the criterion related convergent, discriminant, concurrent and predictive validity. Data analysis for the criterion related validity utilised SPSS 17.

Structural Equation Modeling (SEM) was used to examine the influence of psychosocial classroom environment on students' motivation and self-regulation in science learning. The SEM component application selected specifically for this study was Partial Least Square (PLS) Graph version 3.0, an established powerful statistical tool for prediction-oriented research. In addition, PLS overcomes some of the theoretical and estimation problems associated with other SEM approaches and has higher levels of statistical power when compared to LISREL. The data analysis in

PLS commenced with the assessment of the measurement properties through confirmatory factor analysis followed by assessment of the research model. The analyses of the explanatory power of the research model indicated how much of the variance in students' self-regulation in science learning can be accounted by the constructs in the model. The significance of the standardised path coefficients for each of the hypothesised relationships determined the relationships that were significant in the research model. To examine the moderating role of gender, multi-group analysis was applied. Separate PLS analysis was done for the boys' and girls' subgroups. The Smith-Satterthwaite *t*-test was then conducted to determine whether the differences between the subgroups were statistically significant. The next chapter presents the results for the first part of the research process, validation of the questionnaires.

CHAPTER 4

RESULTS – VALIDATION OF THE QUESTIONNAIRES

4.1 Introduction

The construct validity framework, described in Chapter 3, guides the data analysis procedures for the validation of the questionnaires utilised in this study. This chapter describes, in detail, the results of the data analyses for both questionnaires. The sample demographics for the main study are presented in Section 4.2. In Section 4.3, the results of the validation of the SALES questionnaire are provided. Qualitative data analysis was used to establish the content and face validity of the questionnaire whilst quantitative data analysis was used to ascertain convergent, discriminant, concurrent and predictive validity of the questionnaire. Finally, the results of data analyses for the WIHIC, to determine convergent, discriminant, concurrent and predictive validity are presented in Section 4.4.

4.2 Sample Demographics

The participants for the present study involved 1,371 students from grades 8, 9 and 10 in five public schools in Perth, Western Australia. Since all the students who were present in the classroom during the survey participated in the survey, the response rate can be concluded as 100%. Alreck and Settle (1995) recommend data cleanup before commencing data analysis. This process involved the review of the data line by line to check for errors due to missing or irrational data. The detailed scanning identified eleven records that were incomplete. These eleven data were eliminated and the final 1,360 valid responses were utilised for data analysis. Table 4.1 summarises the sample in terms of the respondents' grade and gender. The sample was made up of 719 boys and 641 girls. As the table elucidates, students' data were almost equally represented from grades 8 and 10 and slightly more data were from students in year 9.

Table 4.1: Sample demographics according to gender and grade

Year	Male	Female	Total
8	221	203	424
9	272	239	511
10	226	199	425
Total	719	641	1,360

The application of both exploratory and confirmatory factor analyses for data from a specified sample adds weight to the validity and reliability of the measures; with exploratory factor analysis generating a theory about the constructs underlying the measures, and confirmatory factor analysis confirming the generated theory (Hatcher, 1994). The two analyses, however, cannot be done by using the same data set as this would amount to mere data fitting rather than testing theoretical constructs (DeCoster, 1998). Hence, when both exploratory and confirmatory factor analyses are conducted using data from the same sample, researchers are required to split the data into two halves (Bandalos, 1993; Johnson & Stevens, 2001; Lee, Johanson & Tsai, 2008; Morris, Lee & Barnes, 2008). Hence, before analyses, the data collected from 1,360 students were randomly divided and named "odd" and "even" data. The "even" data were utilised for exploratory factor analysis of the questionnaire with SPSS version 17.0 whilst the "odd" data were used in the PLS based SEM analysis which incorporates confirmatory factor analysis. Table 4.2 summarises the "odd" and "even" sample in terms of the respondents' grade and gender.

Table 4.2: Sample demographics according to gender and grade for odd and even data

Year	Even		Odd	
	Male	Female	Male	Female
8	113	98	108	105
9	142	112	130	127
10	105	110	121	89
Total	360	320	359	321

4.3 Validation of the SALES Questionnaire

As described in Section 3.3.1, this study utilised a framework for construct validity (Figure 3.1) recommended by Trochim and Donnelly (2006). According to this framework, a construct must fulfil both translation and criterion-related validity requirements. The translation validity, described in Section 4.3.1, comprises of content and face validity whilst the criterion-related validity, described in Section 4.3.2, encompasses convergent, discriminant, concurrent and predictive validity.

4.3.1 Translation Validity

Translation validity includes content validity, which focuses on theoretically sound representation of the construct, and face validity, which emphasises a clear interpretation of the items within a construct by participants.

4.3.1.1 Content validity

A review of theoretical and research literature, presented in Sections 2.3 and 2.4, led to the identification of four scales for inclusion in this survey, these being, learning goal orientation, task value, self-efficacy and self-regulation of effort. The key role of learning goal orientation in students' motivation to learn is corroborated by the prominent achievement goal theory (Kaplan & Maehr, 2007). Science learning goal orientation refers to the degree to which the student perceives him/herself to be participating in a science classroom for the purpose of learning, understanding and mastering science concepts, as well as improving science skills.

Task value is a key component of a core motivational framework, the expectancy-value theory (Eccles & Wigfield, 2002). Science task value involves the degree to which the student perceives the science learning tasks in terms of interest, importance and utility. Bandura's (1977) well-recognised and well-researched self-efficacy theory substantiated the need for self-efficacy to be included in this survey. Self-efficacy in science learning assesses the degree of student's confidence and beliefs in his/her own ability in successfully performing science-learning tasks. Pintrich and De Groot (1990) identified management and control of effort in classroom academic tasks as an integral component of self-regulated learning. Self-regulation of effort in science learning involves the degree to which the student controls and regulates his/her effort in science learning tasks. Therefore, sound theoretical underpinnings ensured the content validity of the survey.

After establishing the pertinent scales for students' motivation and self-regulation in science learning, items were developed to accurately assess these scales. Some of these items were adapted from existing motivation and self-regulation questionnaires while the others were new. In particular, the Motivated Strategies Learning Questionnaire (MSLQ, Pintrich et al., 1991), Patterns of Adaptive Learning Survey (PALS, Midgley et al., 1996), Students Motivation towards Science Learning (SMTSL, Tuan et al., 2005) and Science Motivation Questionnaire (SMQ, Glynn et al., 2009) were drawn upon.

This study undertook five thorough revisions of the list of items to:

a) rephrase ambiguous sentences to provide clear and concise statements;
b) simplify items that were too long to ensure succinct representation of the constructs;
c) ensure that the wording of individual items was familiar to grade 8 students;
d) ensure that lower secondary students could easily understand and complete the survey without experiencing fatigue; and
e) remove negatively-worded items to eliminate unnecessary confusion;

Although, negatively-worded items have been commonly used to guard against passive responses, Barnette (2000) questions the utility of such items, as they cannot be considered direct opposites of their positively-worded counterparts. In addition, studies reveal that positively-worded items are likely to improve response accuracy and internal consistency (Chamberlain & Cummings, 1984; Schreisheim, Eisenbach & Hill, 1991; Schriesheim & Hill, 1981). It was considered appropriate, therefore, to use only items with a positive scoring direction for the SALES instrument. To provide contextual cues and to minimise confusion to students, it was also considered appropriate to group together in blocks items that belong to the same scale instead of arranging them randomly or cyclically (Aldridge et al., 2000).

Once the items were developed and modified, the survey was given, first, to ten experienced science teachers who were teaching in Perth metropolitan schools and, second, to 52 students in two mixed-ability grade 8 classes. In the first step, the teachers reviewed the questionnaire based on the teacher evaluation form (refer to Appendix 1).

They were asked to indicate their opinions about whether:
a) each item was representative of the corresponding construct;
b) individual items were phrased appropriately for lower secondary students;
c) additional items were required to encompass the intended construct; and
d) the instructions were comprehensible.

Two of the ten teachers were interviewed to further clarify their assessment of the instruments. Analysis of the teachers' reviews provided valuable insights that helped to refine and improve the items. For example, two of the teachers stated that 'science concepts' might not be comprehended by lower secondary students and this phrase was replaced with 'science ideas'.

4.3.1.2 Face validity

Once modifications, based on the teachers' constructive feedback, had been made, the questionnaire was then administered to 52 students in two mixed-ability grade 8 science classes to:
a) help to establish face validity (to ensure that students interpreted the items in the ways intended by the researchers);
b) determine the time taken to complete the survey; and
c) evaluate the appropriateness of the layout and design of the survey.

The major function of the pilot study was to examine the face validity of the survey to ensure that students had interpreted the items in ways that were intended by the researchers (as recommended by Cohen, Manion & Morrison, 2000). Munby (1997) argues that the most salient check on face validity involves seeking the opinions of a representative sub-sample about their comprehension of items. Therefore, twelve students, who participated in the pilot study, were interviewed to confirm that they responded to the items on the basis intended by the questionnaire. Care was taken to ensure that students with differing academic achievement in science were selected from the pool of students who volunteered to be interviewed, to provide a wide variation in perspectives.

The interview utilised a semi-structured interview protocol (refer to Appendix 2), focusing on students' responses to selected items in each scale and their overall comprehension of the items. The interview data indicated that the items were clearly worded and easily understood by all of the students, including those in lower science achievement groups. In all cases, the students could clearly explain their conceptions of the items and the reasons for their choice of response. Because students' responses during the interview supported the face validity of the survey instrument and indicated that the wording of individual items was familiar to grade 8 students, no changes were required.

As recommended by De Vaus (2002) and Dillman (2000), the layout and design of the survey, its ability to hold students' interest and the amount of time required to administer the questionnaire were also evaluated. An average time of ten minutes was taken by the students to complete the survey. Observations of students completing the pilot test and analysis of student interviews indicated that lower secondary students could easily understand and complete the survey without experiencing fatigue.

Table 4.3 provides the scale description and sample item for each of the SALES questionnaire subscales. The respondents indicate the extent to which they disagree or agree with the given statements by checking the appropriate number on a Likert scale ranging from 1 (strongly disagree), 2 (disagree), 3 (not sure), 4 (agree) to 5 (strongly agree). The full questionnaire of 32 items is provided in Appendix 4.

Table 4.3: Scale description and sample item for each SALES scale

Scale	Scale description	Sample item
Learning goal orientation	The degree to which the student perceives him/herself to be participating in a science classroom for the purpose of learning, understanding and mastering science concepts, as well as improving science skills.	In this science class, it is important for me to learn the science content that is taught.
Task value	The degree to which the student perceives the science learning tasks in terms of interest, importance and utility.	In this science class, what I learn can be used in my daily life.
Self-efficacy	The degree to which the student is confident and believes in his/her own ability in successfully performing science-learning tasks.	In this science class, even if the science work is hard, I can learn it.
Self-regulation	The degree to which the student controls and regulates his/her effort in science learning tasks.	In this science class, even when tasks are uninteresting, I keep working.

4.3.2 Criterion-Related Validity

Criterion-related validity involves a more relational approach as it verifies whether the construct provides the conclusions that are expected, based on theoretical grounds. Hence, the items of a particular construct should be highly correlated to each other (convergent validity), whilst items from different constructs should not be highly correlated to each other (discriminant validity). In addition, the construct must be able to predict something that it should theoretically predict (predictive validity) and distinguish between the groups that it is expected to distinguish between (concurrent validity). To establish criterion-related validity, the final version of the survey was administered to students from 78 classes in five public schools in the Perth metropolitan area. The “even” data from the administration were analysed using SPSS version 17.

4.3.2.1 Convergent validity

Factor loadings and internal consistency reliability measures were computed to confirm the convergent validity of the questionnaire. First, the multivariate normality and sampling adequacy of the data were tested. Bartlett's test of sphericity indicated that $\chi^2 = 15070.580$ and this value was statistically significant ($p<0.001$). The Kaiser-Maiyer-Olkin measure of adequacy was high (0.969), confirming the appropriateness of the data for further analysis. Exploratory factor analysis was then carried out to extract salient factors.

Field (2009) explains that, because data involving humans are correlated, oblique rotation is recommended to obtain a set of relevant factors. Principal component analysis of the 32 items extracted the four succinct sets of factors of learning goal orientation, task value, self-efficacy and self-regulation. Table 4.4 details the results of the oblique rotation. Factor loadings indicate how strongly each item is related to a particular factor, eigenvalues show the relative importance of each factor, and the cumulative variance can be used to check whether a sufficient number of factors have been retained (Field, 2009). The results indicate that the eigenvalue for each factor was greater than 1, as recommended by Kaiser (1960), whilst the cumulative variance for all four factors was high at 64.104% (Table 4.4). Furthermore, all items loaded above 0.50 (with the lowest being 0.558) on their respective factor and did not load on any other factor. Therefore, all of the items were retained.

The Cronbach alpha coefficient was calculated for each factor to provide an indication of the internal consistency reliability. By convention, a lenient cut-off of 0.60 is common in exploratory research; the alpha should be at least 0.70 or higher for a satisfactory scale; and a cut-off of 0.80 is required for a 'good' scale (Cohen et al., 2000). The results, portrayed in Table 4.5 show that the Cronbach alpha coefficient for each factor was above 0.90, thereby attesting the reliability of the constructs. The factor loadings and internal consistency measure confirmed the convergent validity of the questionnaire.

Table 4.4: Factor loading, eigenvalue and percentage of variance for the SALES scales

Item	Factor loading			
	Self-efficacy	Self-regulation	Learning goal orientation	Task value
SE1	0.755			
SE2	0.858			
SE3	0.616			
SE4	0.651			
SE5	0.733			
SE6	0.651			
SE7	0.749			
SE8	0.753			
SR1		0.795		
SR2		0.840		
SR3		0.815		
SR4		0.669		
SR5		0.558		
SR6		0.623		
SR7		0.674		
SR8		0.776		
LG1			0.655	
LG2			0.715	
LG3			0.725	
LG4			0.805	
LG5			0.784	
LG6			0.746	
LG7			0.805	
LG8			0.556	
TV1				0.835
TV2				0.687
TV3				0.762
TV4				0.812
TV5				0.704
TV6				0.690
TV7				0.577
TV8				0.599
Eigenvalue	15.187	1.988	1.882	1.456
% Variance	47.460	6.212	5.880	4.551
Cumulative % Variance	47.460	53.673	59.553	64.104

Table 4.5: Internal consistency reliability (Cronbach alpha) for the SALES scales

Scale	Number of items	Cronbach alpha
Learning goal orientation	8	0.914
Task value	8	0.917
Self-efficacy	8	0.914
Self-regulation	8	0.917

4.3.2.2 Discriminant validity

Brown (2006) and Field (2009) explained that oblique rotation in exploratory factor analysis provides realistic representation of how factors are interrelated. According to Field (2009), based on theoretical grounds, there should be a moderately strong relationship between factors. However, factor correlations above 0.80 imply overlap of concepts and point towards poor discriminant validity (Brown, 2006). The component correlation matrix obtained from oblique rotation (Table 4.6) showed that the highest correlation was 0.573 and this value met the requirements of discriminant validity.

Table 4.6: Component correlation matrix for the SALES scales

Scale	Self-efficacy	Self-regulation	Learning goal	Task value
Self-efficacy	1.000			
Self-regulation	0.572	1.000		
Learning goal	0.536	0.565	1.000	
Task value	0.573	0.492	0.554	1.000

In addition, Trochim and Donnelly (2006) suggested that discriminant validity is achieved when the correlations between a particular item and other items in the same construct are higher than its correlations with items from different constructs. Analysis of the correlation matrix from the oblique rotation (Appendix 5) showed that this condition was met. Therefore, the discriminant validity of the instrument was supported.

4.3.2.3 Concurrent validity

Concurrent validity was assessed to ensure that each construct was able to distinguish between those groups which it is expected to distinguish. According Urdan and Schoenfelder (2006), the achievement goal theory (Ames, 1992), self-determination theory (Deci & Ryan, 1985), and social-cognitive theory (Bandura, 1986) corroborate that classroom characteristics strongly influence student motivation within a class. The theoretical claim is supported by research evidence that student motivation in one classroom can be differentiated from student motivation in other classrooms (Ames, 1992; Meece et al., 2006; Ryan & Patrick, 2001; Tuan et al., 2005; Urdan & Schoenfelder, 2006; Wolters et al., 1996). To establish concurrent validity, the ability of each scale to differentiate between different classes was investigated using ANOVA. The eta^2 statistic, based on the ratio of the between-group effect to the total amount of variance in the data (Field, 2009), provided information about the amount of variance attributed to class membership. The results, reported in the Table 4.7, shows that the eta^2 value is significant ($p<0.001$) for each scale, suggesting that each scale in the SALES differentiated significantly between classes, thus supporting the concurrent validity of the scales.

Table 4.7: The ability to differentiate between classes (ANOVA results) for the SALES scales

Scale	ANOVA results (Eta^2)
Learning goal orientation	0.242***
Task value	0.207***
Self-efficacy	0.222***
Self-regulation	0.200***

*** $p<0.001$

4.3.2.4 Predictive validity

Predictive validity was assessed to ensure that the score on the construct predicts scores on other dimensions based on theoretical grounds. Theoretical and research underpinnings discussed above suggest that students' learning goal orientation, task value, self-efficacy and self-regulation should be strongly associated with students' achievement in science. Students' science achievement grade (provided by the science teachers at the time that the questionnaires were administered) was used as an indicator of science achievement.

Since this study hypothesised that there is a positive correlation between each of the SALES scale and students' science achievement, correlations were tested using a one-tailed Pearson coefficient. The correlations analysed are between observed aggregate variables. The results, reported in Table 4.8, indicated that all of the scales in the SALES questionnaire had a statistically significant correlation with students' science achievement, thereby supporting the predictive validity of each.

Table 4.8: Pearson correlation between the SALES scales and students science achievement

Scale	Pearson correlation (one-tailed) student science achievement
Learning goal orientation	0.686***
Task value	0.432***
Self-regulation	0.536***
Self-efficacy	0.682***

*** $p<0.001$

4.4 Validation of the What is Happening In this Class? Questionnaire

Since the WIHIC (as discussed in Section 3.4.2) is already a well-established learning environment instrument, the validation of this survey for the present study involved only the criterion-related factors from Trochim and Donnelly's (2006) construct validity framework. The criterion-related validity, described below, encompasses convergent, discriminant, concurrent and predictive validity. The WIHIC was administered with the SALES to the same students from 78 classes in five public schools in the Perth metropolitan area. The "even" data were analysed using SPSS version 17 to establish the criterion-related validity.

4.4.1 Convergent Validity

The multivariate normality and sampling adequacy of the data were tested. Bartlett's test of sphericity indicated that χ^2 = 25,990.144 and this value was statistically significant (p<0.001). The Kaiser-Maiyer-Olkin measure of adequacy was high (0.961), confirming the appropriateness of the data for further analysis.

Exploratory factor analysis was carried out to extract salient factors. The results of exploratory factor analysis of the WIHIC data using oblique rotation confirmed the seven *a priori* factors embedded in the WIHIC, namely, student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. The results, reported in Table 4.9, indicated that all items loaded above 0.50 on their respective factors and did not load on any other factor, the eigenvalues for each factor were above 1, and the cumulative variance for the seven factors was a substansial 63.508%.

Table 4.10 reports the results of internal consistency reliability testing for each WIHIC scale. The Cronbach alpha reliability coefficient for each factor was above 0.800. All of the scales, with exception of student cohesiveness and involvement, had a Cronbach alpha value of more than 0.900 attesting the high reliability of the constructs. The factor loadings and internal consistency measure confirmed the convergent validity of the questionnaire. The results also supported the internal consistency reliability of the WIHIC in past studies involving lower secondary science classrooms (Aldridge et al., 1999; Dorman, 2003; Wolf & Fraser, 2008).

Table 4.9: Factor loading, eigenvalue and percentage of variance for the WIHIC scales

Item	Factor Loading						
	IVT	EQ	CP	TO	SC	TS	IGT
IVT1	0.759						
IVT2	0.868						
IVT3	0.622						
IVT4	0.714						
IVT5	0.626						
IVT6	0.660						
IVT7	0.517						
IVT8	0.540						
EQ1		0.689					
EQ2		0.754					
EQ3		0.838					
EQ4		0.861					
EQ5		0.817					
EQ6		0.846					
EQ7		0.729					
EQ8		0.824					
CP1			0.557				
CP2			0.631				
CP3			0.701				
CP4			0.751				
CP5			0.810				
CP6			0.798				
CP7			0.729				
CP8			0.659				
TO1				0.776			
TO2				0.780			
TO3				0.588			
TO4				0.760			
TO5				0.716			
TO6				0.671			
TO7				0.703			
TO8				0.699			

Item	Factor loading						
	IVT	EQ	CP	TO	SC	TS	IGT
SC1					0.754		
SC2					0.727		
SC3					0.625		
SC4					0.819		
SC5					0.587		
SC6					0.511		
SC7					0.700		
SC8					0.523		
TS1						0.724	
TS2						0.749	
TS3						0.746	
TS4						0.715	
TS5						0.767	
TS6						0.749	
TS7						0.675	
TS8						0.542	
IGT1							0.717
IGT2							0.590
IGT3							0.815
IGT4							0.620
IGT5							0.813
IGT6							0.838
IGT7							0.862
IGT8							0.757
Eigenvalue	19.729	4.547	3.631	2.835	2.030	1.790	1.453
% Variance	34.426	8.119	6.484	5.063	3.624	3.196	2.595
Cumulative % Variance	34.426	42.546	49.030	54.093	57.717	60.913	63.508

Table 4.10: Internal consistency reliability (Cronbach alpha) for the WIHIC scales

Scale	Cronbach alpha
Student cohesiveness	0.844
Teacher support	0.927
Involvement	0.893
Investigation	0.931
Task orientation	0.917
Cooperation	0.921
Equity	0.942

4.4.2 Discriminant Validity

As explained in the previous chapter, oblique rotation in exploratory factor analysis offers a representation of how factors are interrelated (Brown, 2006; Field, 2009). Based on theoretical grounds, there should be a moderate relationship between factors (Field, 2009). However, factor correlations above 0.80 imply overlap of concepts and point towards poor discriminant validity (Brown, 2006). The principal component correlation matrix obtained from oblique rotation, reported in Table 4.11, indicates that the highest correlation was 0.57 and this value met the requirements of discriminant validity.

Table 4.11: Component correlation matrix for the WIHIC scales

Component	SC	TS	INV	IVT	TO	CO	EQ
SC	1.000						
TS	0.295	1.000					
INV	0.331	0.279	1.000				
IVT	0.337	0.456	0.315	1.000			
TO	0.289	0.170	0.415	0.171	1.000		
CO	0.341	0.509	0.256	0.282	0.185	1.000	
EQ	0.531	0.283	0.364	0.470	0.173	0.395	1.000

4.4.3 Concurrent Validity

The ability to differentiate between classrooms is one of the desirable characteristics of any classroom learning environment scale. Ideally, students in the same classroom would have relatively similar perceptions of their learning environment whilst differing to the perceptions of students in other classrooms. To establish concurrent validity, the ability of each WIHIC scale to differentiate between classes was investigated using ANOVA. The eta^2 statistic, provided information about the amount of variance attributed to class membership for each scale. The results, reported in Table 4.12, show that all eta^2 values were significant for each WIHIC scale with the exception of student cohesiveness. The significant results suggest that these scales in the WIHIC differentiated significantly between classes, thus supporting the concurrent validity of the scales. The inability of the student cohesiveness scale to differentiate between classes could be because student cohesiveness is influenced more by adolescent peer relations than by what takes place in the lower secondary science classrooms.

Table 4.12: The ability to differentiate between classes (ANOVA results) for the WIHIC scales

Scale	ANOVA results (Eta^2)
Student cohesiveness	0.133
Teacher support	0.286**
Involvement	0.155*
Investigation	0.183**
Task orientation	0.228**
Cooperation	0.221**
Equity	0.245**

** $p<0.001$
 * $p<0.05$

4.4.4 Predictive Validity

Theoretical and research underpinnings suggest that students' science classroom learning environment should be associated with students' achievement in science. A one-tailed Pearson coefficient was used because the hypothesis was that there is a positive correlation between each of the WIHIC scale and students' science achievement. The correlations analysed are between observed aggregate variables. Results of the data analyses, displayed in Table 4.13, indicate that all of the WIHIC scales had a statistically significant correlation with students' science achievement, thereby supporting the predictive validity of the seven scales.

Table 4.13: Pearson correlation between the WIHIC scales and students' science achievement

Scale	Pearson Correlation (one-tailed)
Student cohesiveness	0.216*
Teacher support	0.312*
Involvement	0.309*
Investigation	0.340*
Task orientation	0.562*
Cooperation	0.273*
Equity	0.279*

* $p<0.001$

4.5 Summary

The total number of useable responses involved 1,360 students in 78 lower secondary science classes, 719 of whom were boys and 641 of whom were girls. The data collected from the 1,360 students were divided into two halves and labelled "odd" and "even" data. The "even" data were utilised for the validation of both questionnaires.

The development and validation of the newly developed SALES questionnaire (research objective 1), was guided by Trochim and Donnelly's (2006) construct validity framework. Qualitative data were analysed to establish content and face validity. An extensive review of literature undertaken to identify and define salient student motivation and self-regulation scales maximised the content validity of the instrument by ensuring that the scales were based on a sound theoretical framework. The systematic and thorough approach undertaken in the writing of individual items within each scale reinforced the scale's content validity. The evaluation, provided by ten experienced science teachers, helped to fine-tune the questionnaire. The results of the pilot study, conducted with 52 students in two grade 8 science classes, coupled with semi-structured interview of twelve grade 8 students, were used to establish the face validity of the instrument.

The "even" half of the data collected from the sample of 1,360 students were analysed to determine the criterion-related validity. Exploratory factor analysis of the 32 items in the questionnaire extracted the four succinct factors of learning goal orientation, task value, self-efficacy and self-regulation. The principal component correlation matrix, from the oblique rotation, established discriminant validity whilst the high Cronbach alpha coefficients indicated the reliability of the scales. These results supported the convergent and discriminant validity of the questionnaire. The ability of each scale to differentiate between different classes, ascertained through the significant eta^2 statistics, supported the concurrent validity whilst the significant positive correlations between each scale and students' science achievement, tested using a one-tailed Pearson coefficient, substantiated the predictive validity of the questionnaire.

To facilitate the validation of the WIHIC (research objective 2), the convergent, discriminant, concurrent and predictive validity of the scales in the WIHIC were examined. Exploratory factor analysis of the 56 items of the WIHIC questionnaire extracted the seven factors embedded in the WIHIC whilst the high Cronbach alpha coefficients confirmed the reliability of each of the scales. The component correlation matrix from the principal component analysis using oblique rotation established the discriminant validity of the scales. The ability of each learning environment scale to differentiate between classes, ensured concurrent validity whilst the significant positive correlations between each scale and students' science achievement, corroborated the predictive validity of the scales.

The next chapter presents the results from the second part of the data analyses, the evaluation of the research model, which used Structural Equation Modelling.

CHAPTER 5

RESULTS – EVALUATION OF THE RESEARCH MODEL

5.1 Introduction

Structural Equation Modelling (SEM), described in Section 3.6.2, was utilised in the evaluation of the research model. The Partial Least Square (PLS) based SEM analyses involved assessment of the measurement properties through confirmatory factor analysis followed by assessment of the research model. The confirmatory factor analyses results, reported in Section 5.2, examined both the convergent and the discriminant validity of the SALES and the WIHIC questionnaires. Once the measurement properties were assessed and adjusted, the second stage of the data analysis, the assessment of the research model, was conducted. As explicated in Section 5.3, this included the assessment of the explanatory power of the proposed model and the testing of the hypothetical relationships in the model. The goal was to determine which relationships were significant in the research model. For the moderating effects of gender (explained in Section 5.4), the multi-group analysis method, recommended by Chin (2004), was applied to determine whether the differences between the boys' and girls' structural paths were statistically significant.

5.2 Assessment of the Measurement Properties

In PLS, the confirmatory factor analysis assesses the properties of the measurements utilised in the research model to achieve convergent and discriminant validity. As explained in the Section 4.3, when both exploratory and confirmatory factor analyses are conducted using data from the same sample, the data are split into two halves to prevent mere data fitting (Bandalos, 1993; Johnson & Stevens, 2001; Morris et al., 2008). The data were randomly split into "even" and "odd" data. The 680 "even" data were used for exploratory factor analysis of both questionnaires, described in the last chapter, whilst the 680 "odd" data were used for the PLS analyses. The sample size requirement for PLS data analysis, as detailed by Chin, Marcolin and Newsted

(2003), recommends that the sample size has to be equal to or larger than ten times the largest number of structural paths directed at a particular construct in the research model. If this rule is applied for the present study, the minimum sample required is 110. Based on this specification, the sample size of 680 is more than sufficient to satisfy a robust PLS model.

Confirmatory factor analysis in SEM (including the PLS), unlike exploratory factor analysis, does not evaluate instruments separately. Instead, all of the items from the questionnaires used in the research model are regarded as part of the regression model and analysed simultaneously (Chin, 1995; Gefen et al., 2000). Therefore, both the SALES and the WIHIC questionnaires were assessed together for convergent and discriminant validity.

5.2.1 Convergent Validity

Convergent validity involves determining whether scores on items assessing a single construct are strongly intercorrelated and measure the same underlying dimension. The items are examined, using PLS, for item reliability, internal consistency and average variance extracted to determine whether convergent validity is achieved (Fornell & Larcker, 1981).

In PLS, the loading for each item on each construct is used as a measure of item reliability (Chin, 1998), indicating its correlation with its respective construct. According to Nunally (1978), the lower the item loading, the higher is the level of random error. Therefore, this procedure enables the researcher to identify and eliminate items that might increase the construct's level of random error (Fornell & Larcker, 1981). In confirmatory factor analysis, the item loadings typically are higher than for exploratory factor analysis because the pattern of item loadings is pre-specified (Gefen & Straub, 2005). For PLS, the minimum requirement suggested for item loadings is 0.70 (Chin, 1998; Hulland, 1999). The results indicated that the loadings for all of the items were above the recommended cut-off point, except for items SC2, SC7, SC8 and SR5. Hence, after the first PLS run, these four items were discarded. When the refined set of items was again analysed using PLS, all loadings were found to be above the cut-off point of 0.70 as indicated in Table 5.1.

Table 5.1: Item loading for the WIHIC and SALES scales

Construct	Item	Loading	Standard Error
Student Cohesiveness (SC)	SC1	0.710	0.022
	SC3	0.789	0.022
	SC4	0.708	0.032
	SC5	0.793	0.019
	SC6	0.781	0.032
Teacher Support (TS)	TS1	0.782	0.014
	TS2	0.819	0.019
	TS3	0.850	0.011
	TS4	0.799	0.015
	TS5	0.837	0.018
	TS6	0.846	0.012
	TS7	0.761	0.015
	TS8	0.809	0.020
Involvement (IVT)	IVT1	0.798	0.019
	IVT2	0.774	0.024
	IVT3	0.710	0.024
	IVT4	0.832	0.013
	IVT5	0.707	0.024
	IVT6	0.776	0.019
	IVT7	0.723	0.019
	IVT8	0.729	0.020
Investigation (IGT)	IGT1	0.814	0.015
	IGT2	0.779	0.019
	IGT3	0.843	0.019
	IGT4	0.797	0.017
	IGT5	0.831	0.017
	IGT6	0.824	0.016
	IGT7	0.842	0.011
	IGT8	0.836	0.013
Task Orientation (TO)	TO1	0.774	0.018
	TO2	0.774	0.024
	TO3	0.792	0.017
	TO4	0.763	0.023
	TO5	0.839	0.014
	TO6	0.818	0.016
	TO7	0.827	0.015
	TO8	0.784	0.024
Cooperation (CP)	CP1	0.809	0.017
	CP2	0.791	0.019
	CP3	0.828	0.017
	CP4	0.818	0.015
	CP5	0.736	0.024
	CP6	0.835	0.018
	CP7	0.848	0.014
	CP8	0.781	0.018

Construct	Item	Loading	Standard Error
Equity (EQ)	EQ1	0.827	0.016
	EQ2	0.825	0.016
	EQ3	0.847	0.014
	EQ4	0.854	0.011
	EQ5	0.871	0.012
	EQ6	0.852	0.018
	EQ7	0.836	0.012
	EQ8	0.842	0.015
Learning Goal (LG)	LG1	0.769	0.017
	LG2	0.808	0.017
	LG3	0.814	0.014
	LG4	0.715	0.024
	LG5	0.808	0.018
	LG6	0.839	0.012
	LG7	0.773	0.019
	LG8	0.801	0.014
Task Value (TV)	TV1	0.748	0.020
	TV2	0.793	0.018
	TV3	0.856	0.012
	TV4	0.859	0.011
	TV5	0.791	0.020
	TV6	0.770	0.024
	TV7	0.741	0.022
	TV8	0.806	0.017
Self-Efficacy (SE)	SE1	0.782	0.021
	SE2	0.795	0.020
	SE3	0.803	0.018
	SE4	0.775	0.024
	SE5	0.763	0.020
	SE6	0.813	0.017
	SE7	0.817	0.017
	SE8	0.806	0.012
Self-Regulation (SR)	SR1	0.827	0.015
	SR2	0.810	0.019
	SR3	0.831	0.015
	SR4	0.811	0.016
	SR6	0.825	0.015
	SR7	0.806	0.017
	SR8	0.812	0.0180

Using PLS analysis, the internal consistency for each construct was obtained and these results are reported in Table 5.2. The results show that all the constructs met the criterion for a minimum reliability value of 0.70, as suggested by Fornell and Larcker (1981). The lowest internal consistency was 0.87 for student cohesiveness. All of the other values were above 0.90, with the highest being 0.97 for teacher support. The high internal consistency values for all the constructs provide strong support for the reliability of the measurement properties.

Table 5.2: Internal consistency of the WIHIC and SALES scales

Scale	Internal consistency
Student cohesiveness	0.870
Teacher support	0.940
Involvement	0.915
Investigation	0.943
Task orientation	0.933
Cooperation	0.937
Equity	0.952
Learning goal	0.931
Task value	0.933
Self-efficacy	0.932
Self-regulation	0.934

The final criterion for convergent validity was the measure of average variance extracted (AVE) for each construct. Fornell and Larcker (1981) and Nunnally (1978) specify that, as a rule of thumb, the minimum value for AVE should be 0.50. Results of the statistical analysis, reported in Table 5.3, indicate that the AVE values for each scale were above 0.50, with the lowest being 0.57 (student cohesiveness) and all other values being above 0.60. The measurement properties, therefore, satisfied all three necessary criteria of convergent validity.

Table 5.3: Average variance extracted (AVE) for the WIHIC and SALES scales

Scale	AVE
Student cohesiveness	0.573
Teacher support	0.662
Involvement	0.573
Investigation	0.674
Task orientation	0.635
Cooperation	0.650
Equity	0.713
Learning goal	0.627
Task value	0.635
Self-efficacy	0.631
Self-regulation	0.668

5.2.2 Discriminant Validity

The discriminant validity of the items was assessed by applying two analytical procedures, as suggested by Barclay et al. (1995). The first criterion of discriminant validity was assessed by calculating the square root of the average variance extracted (AVE), and comparing it with the inter construct correlation. The square roots of the AVE were calculated and are represented in bold in the main diagonal of Table 5.4. The off-diagonal elements represent the correlations among the latent variables. Barclay et al., (1995) specify that discriminant validity is achieved when the square root of the AVE of a construct is larger than its correlation with other constructs. The results, reported in Table 5.4, confirm that the discriminant validity was achieved for all scales.

Table 5.4: Inter-construct correlations and square roots of average variance extracted for the WIHIC and SALES scales

Construct	SC	TS	IVT	IGT	TO	CP	EQ	LG	TV	SE	SR
Student cohesiveness (SC)	**0.757**										
Teacher support (TS)	0.307	**0.814**									
Involvement (IVT)	0.487	0.548	**0.757**								
Investigation (IGT)	0.365	0.468	0.674	**0.821**							
Task orientation (TO)	0.437	0.522	0.553	0.596	**0.797**						
Cooperation (CP)	0.629	0.353	0.452	0.413	0.517	**0.806**					
Equity (EQ)	0.369	0.624	0.470	0.433	0.612	0.434	**0.844**				
Learning goal (LG)	0.378	0.436	0.439	0.434	0.694	0.398	0.492	**0.792**			
Task value (TV)	0.328	0.503	0.452	0.498	0.609	0.324	0.483	0.686	**0.797**		
Self-efficacy (SE)	0.391	0.451	0.558	0.563	0.668	0.375	0.489	0.644	0.696	**0.794**	
Self-regulation (SR)	0.438	0.468	0.510	0.581	0.691	0.443	0.509	0.660	0.632	0.679	**0.817**

(The bold elements in the main diagonal are the square roots of AVE)

The second discriminant validity criterion is achieved when the loadings of an item within a construct are greater than its loadings on any other construct. First, the latent variable scores for each item were calculated using PLS. These scores were then correlated with the original items. The results of the loading and cross loading correlations, depicted in Appendix 6, indicate that this criterion was also met. The results of the two analyses, reported in Table 5.4 and Appendix 6, confirm that the individual constructs in the questionnaires are discriminated from each other by the instruments.

5.3 Assessment of the Research Model

Gefen et al. (2000) have specified two non-parametric methods to test the relationships between constructs namely ‘bootstrap’ and ‘jackknife’. ‘Bootstrap’, the more advanced method, was selected for this study as it produces both the coefficient of determination (R^2) values and the *t*-values. The R^2 value is interpreted in a similar way as in multiple regression analysis and estimates the variance associated with endogenous constructs (dependent variables or consequents). As such, the explanatory power within the model and the proposed overall model could be evaluated. The *t*-value is equivalent to the *t*-test as it evaluates the significance of the hypothesised relationships in the research model. Section 5.3.1 reports the coefficient of determination of the endogenous constructs, in this case, students’ learning goal orientation, self-efficacy, task value and self-regulation in science learning whilst Section 5.3.2 reports the the path coefficients and the positive or negative values of the hypothetical relationships outlined in the research model.

5.3.1 Coefficient of Determination

The explanatory powers of the model were assessed by calculating the coefficient of determination (R^2) of the endogenous constructs (Santosa, Wei & Chan, 2005). Falk and Miller (1992) propose that the minimum R^2 should be 0.10. The results, reported in Table 5.5, indicate that for each scale the R^2 value is much higher than this minimum requirement.

Table 5.5: Coefficient of determination (R^2) of the endogenous constructs

Endogenous construct	R^2
Task value (TV)	0.44
Learning goal (LG)	0.50
Self-efficacy (SE)	0.52
Self-regulation (SR)	0.69

The findings imply that 52% of the variation in students' self-efficacy scores in science learning can be accounted for by their perceptions of their classroom learning environment. In addition, 44% and 50% of the variation in students' scores for task value and learning goal orientation, respectively, were attributable to psychosocial elements in their classroom learning environment. The overall model explained a substantial 69% of the variance of students' self-regulation in science learning.

5.3.2 Testing the Hypotheses

Table 5.6 reports the path coefficient and *t*-value for each of the hypothesised relationships in the research model. The results indicate that 19 of the 31 possible relationships were statistically significant ($p<0.05$) and that all of the statistically significant relationships were positive in direction. Of the seven learning environment scales, the three scales of student cohesiveness, investigation and task orientation were the most likely to influence students' learning goal orientation, science task value and self-efficacy in science learning. The same three scales also were statistically significantly ($p<0.05$) related to students' self-regulation in science learning. The findings also indicate that teacher support is likely to influence both students' learning goal orientation and task value. Additionally, the involvement scale had a statistically significant influence on students' self-efficacy. Finally, the findings indicate that all three of the motivational constructs strongly influenced students' self-regulation in science learning. All of these statistically significant relationships in the research model are illustrated in Figure 5.1

Table 5.6: Standardised path coefficients and *t*-values for the hypothesised relationships in the research model

Hypothesised relationship	Standardised path coefficient	*t*-value
Student cohesiveness (SC) → Learning goal (LG)	0.078	2.327**
Student cohesiveness (SC) → Task value (TV)	0.070	1.689*
Student cohesiveness (SC) → Self-efficacy (SE)	0.080	2.016*
Student cohesiveness (SC) → Self-regulation (SR)	0.090	2.791**
Teacher support (TS) → Learning goal (LG)	0.081	1.734*
Teacher support (TS) → Task value (TV)	0.194	3.986***
Teacher support (TS) → Self-efficacy (SE)	0.020	0.481
Teacher support (TS) → Self-regulation (SR)	0.014	0.450
Involvement (IVT) → Learning goal (LG)	0.026	0.569
Involvement (IVT) → Task value (TV)	-0.003	0.075
Involvement (IVT) → Self-efficacy (SE)	0.164	4.594***
Involvement (IVT) → Self-regulation (SR)	-0.049	1.320
Investigation (IGT) → Learning goal (LG)	0.114	3.322***
Investigation (IGT) → Task value (TV)	0.158	3.485***
Investigation (IGT) → Self-efficacy (SE)	0.155	3.718***
Investigation (IGT) → Self-regulation (SR)	0.121	3.573***
Task orientation (TO) → Learning goal (LG)	0.589	13.924***
Task orientation (TO) → Task value (TV)	0.384	7.765***
Task orientation (TO) → Self-efficacy (SE)	0.437	10.044***
Task orientation (TO) → Self-regulation (SR)	0.494	9.643***
Cooperation (CP) → Learning goal (LG)	-0.011	0.267
Cooperation (CP) → Task value (TV)	-0.071	1.574
Cooperation (CP) → Self-efficacy (SE)	-0.076	1.336
Cooperation (CP) → Self-regulation (SR)	-0.020	0.565
Equity (EQ) → Learning goal (LG)	0.063	1.070
Equity (EQ) → Task value (TV)	0.069	1.221
Equity (EQ) → Self-efficacy (SE)	0.068	1.388
Equity (EQ) → Self-regulation (SR)	-0.028	0.818
Learning goal (LG) → Self-regulation (SR)	0.099	2.106*
Task value (TV) → Self-regulation (SR)	0.103	2.293*
Self-efficacy (SE) → Self-regulation (SR)	0.152	3.980***

Notes: *$p<0.05$; **$p<0.01$; ***$p<0.001$

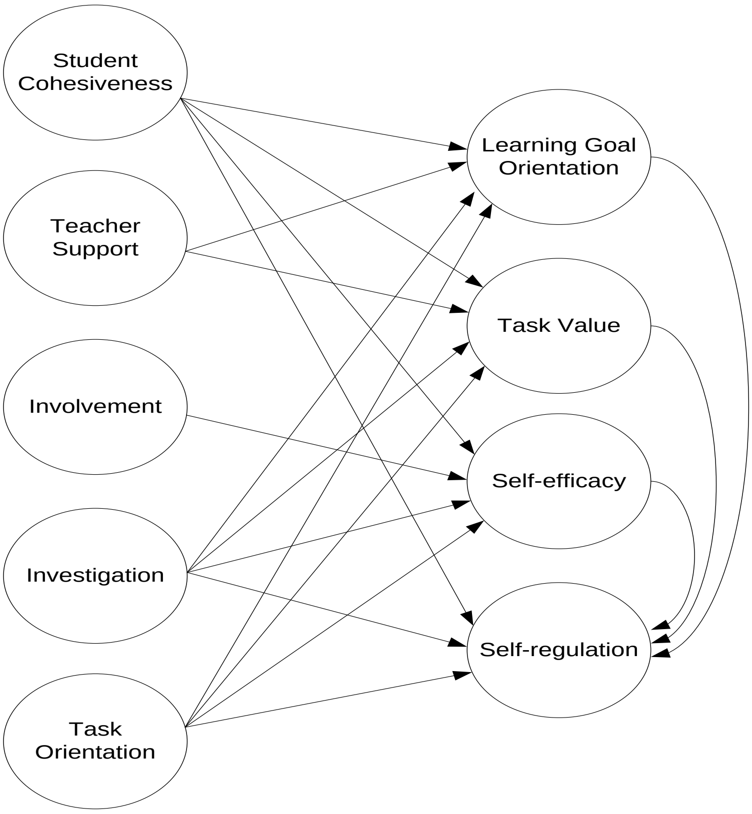


Figure 5.1: Statistically significant relationships among variables in the research model

5.4 Moderating Role of Gender in the Relationships between Students' Motivational Beliefs and Self-Regulation

The literature review (Section 2.5) and the resulting research model (presented in Section 3.2) envisaged a moderating role of gender in the relationships between students' motivational beliefs and self-regulation in science learning. Multi-group analysis, recommended by Chin (2004), was utilised to investigate the moderating role of gender. Since this section of the research model does not include the psychosocial learning environment and the WIHIC scales, in accordance with PLS, a different analysis was conducted involving the SALES only.

First, the modified research model, comprising of students' motivational beliefs and self-regulation in science learning (shown in Figure 5.2), was evaluated to examine the hypothesised relationships and enable comparisons between subgroups. The sample was then subdivided into two subgroups, based on gender, and the measurement properties for each subgroup were examined individually. This was followed by a separate assessment of the explanatory power of the boys' and girls' research models and examining the hypothesised relationships in each model. Finally, the Smith-Satterthwaite *t*-test was applied to determine whether the differences in the relationships between the subgroups were statistically significant.

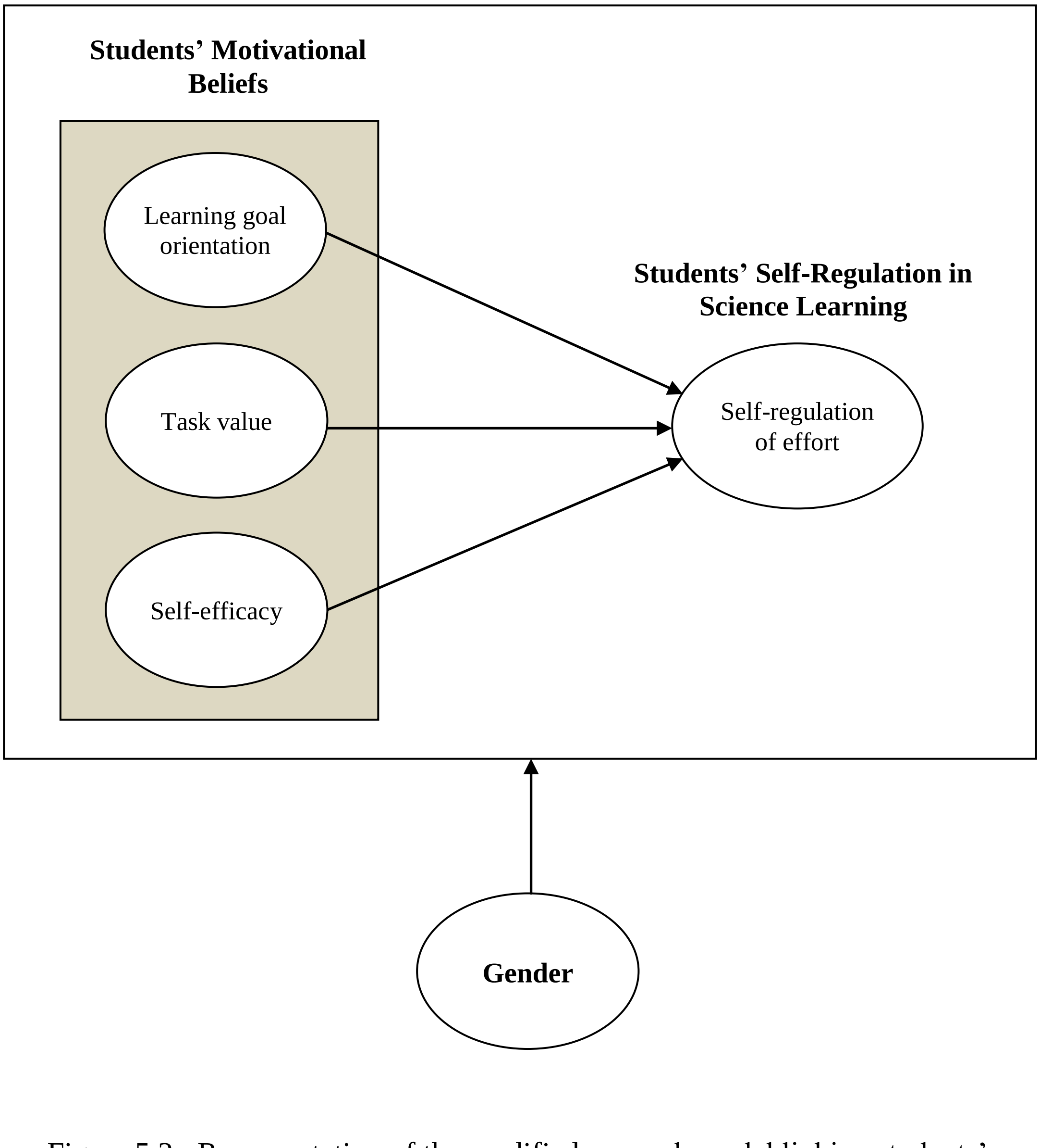


Figure 5.2: Representation of the modified research model linking students' motivational beliefs and self-regulation in science learning

5.4.1 Assessment of the Measurement Properties

As discussed previously, the assessment of the measurement properties in SEM is done by confirmatory factor analysis and, in this case, involved examining the convergent validity and discriminant validity of the 32 items in the SALES questionnaire. As suggested by Fornell and Larcker (1981), convergent validity was determined by calculating item reliability, internal consistency and average variance extracted (AVE).

The loadings for each individual item were used as an indication of item reliability. The results reported in Table 5.7 indicate that the minimum requirement of 0.70 (suggested by Fornell & Larcker, 1981) was fulfilled by the all of the items. The internal consistency for each construct was calculated using PLS analysis and the results are displayed in Table 5.7. All of the constructs meet the criterion for a minimum value of 0.70. The high internal consistency values for all the constructs ensure the reliability of the measurement properties. The final criteria used to satisfy convergent validity was the average variance extracted (AVE). Fornell and Larcker (1981) and Nunnally (1978) specify the rule of thumb for the minimum value of AVE as 0.50. Results of the statistical analysis, reported in Table 5.7, show that all the AVE values are above 0.50. Therefore, the measurement model satisfied all three necessary criteria and achieved convergent validity.

The next step in the assessment of the measurement properties involved testing discriminant validity. To meet the discriminant validity criteria, the square roots of the AVE were calculated and reported in the main diagonal of Table 5.8. The off-diagonal elements represent the correlations among the latent variables. Barclay et al. (1995) specify that discriminant validity is achieved when the square root of the AVE of a construct is larger than its correlation with other constructs. The results, reported in Table 5.8, confirm that all the constructs met this criterion.

Table 5.7: Item loading, internal consistency and average variance extracted

Construct	Item	Loading	Standard Error	Internal consistency	Average variance extracted
Learning goal orientation (LG)	LG1	0.771	0.021	0.931	0.627
	LG2	0.810	0.016		
	LG3	0.816	0.017		
	LG4	0.710	0.028		
	LG5	0.806	0.018		
	LG6	0.894	0.013		
	LG7	0.772	0.022		
	LG8	0.802	0.014		
Task value (TV)	TV1	0.749	0.021	0.933	0.635
	TV2	0.793	0.019		
	TV3	0.856	0.013		
	TV4	0.859	0.012		
	TV5	0.791	0.019		
	TV6	0.770	0.020		
	TV7	0.739	0.020		
	TV8	0.807	0.019		
Self-efficacy (SE)	SE1	0.782	0.016	0.932	0.631
	SE2	0.796	0.019		
	SE3	0.805	0.016		
	SE4	0.776	0.020		
	SE5	0.763	0.018		
	SE6	0.812	0.018		
	SE7	0.815	0.017		
	SE8	0.804	0.015		
Self-regulation (SR)	SR1	0.827	0.014	0.934	0.668
	SR2	0.808	0.019		
	SR3	0.830	0.015		
	SR4	0.814	0.016		
	SR6	0.827	0.016		
	SR7	0.806	0.017		
	SR8	0.810	0.016		

Table 5.8: Inter-construct correlations and square roots of average variance extracted

Construct	LG	TV	SE	SR
Learning goal orientation (LG)	**0.792**			
Task value (TV)	0.687	**0.797**		
Self-efficacy (SE)	0.644	0.696	**0.794**	
Self-regulation (SR)	0.661	0.633	0.680	**0.817**

(The bold elements in the main diagonal are the square roots of average variance extracted)

The second discriminant validity criterion is achieved when the loadings of an item within a construct is greater than its loading in any other construct. The results of cross loading correlations, reported in Appendix 7, show that all items loaded higher on the construct they were measuring than on any other construct in the model. Therefore, the second criterion of discriminant validity was also met. The implication of the results is that the individual constructs in the questionnaires are discriminated from each other by the instrument.

5.4.2 Assessment of the Modified Research Model

The explanatory power of the modified research model was assessed by calculating the coefficient of determination (R^2) of the endogenous constructs (Santosa et al., 2005). The results, reported in Table 5.9, indicate that the overall model explains a sizeable 55.9 % of the variance for students' self-regulation in science learning. The result of the hypotheses testing confirmed that all of the predicted relationships were statistically significant with the most significant being the influence of science self-efficacy on students' self-regulation in science learning. All of the significant relationships were positive in direction.

Table 5.9: Standardised path coefficients, *t*-values and coefficient of determination (R^2)

Construct	Standardised path coefficient	*t*-value
Learning goal (LG) → Self-regulation (SR)	0.314	7.244*
Task value (TV) → Self-regulation (SR)	0.166	3.837*
Self-efficacy → Self-regulation (SR)	0.362	8.388*
R^2	55.9%	

Notes: *p<0.001

5.4.3 Moderating Effect of Gender

To examine the hypothesis on the moderating effects of gender in the relationships between students' motivational beliefs and self-regulation in science learning, the multi-group analysis method, as recommended by Chin (2004), was utilised. First, the sample was divided into two groups according to gender. The measurement properties for each subgroup were then examined separately for item reliability, internal consistency and average variance extracted to determine the convergent validity for the items.

The same minimum value of 0.70 was applied for item reliability. The results reported in Table 5.10 indicate that all of the items in each subgroup fulfilled this requirement. The specification for the minimum value of internal consistency is 0.70 whilst AVE value should be greater than 0.50. Results of statistical analysis, reported in Table 5.10, show that all of the constructs in the model fulfil these criteria for both the boys' and girls' subgroup. Therefore, the convergent validity for each subgroup was established.

The discriminant validity of the items was assessed by applying the two analytical procedures suggested by Barclay et al. (1995) separately for each subgroup. First, the results reported in Table 5.11 shows that, for each subgroup, the square root of the AVE of a construct is larger than its correlations with other constructs.

In addition, the data analysis for the cross loadings matrix found that, for each subgroup, the loading of an item within the construct it intended to measure was higher than its loading with any other construct (reported in Appendix 8). Hence, discriminant validity for the constructs in each subgroup was achieved.

Table 5.10: Item loading, internal consistency and average variance extracted for boys' and girls' subgroup

Construct	Item	Boys			Girls		
		Loading	Internal consistency	Average variance extracted	Loading	Internal consistency	Average variance extracted
Learning goal orientation (LG)	LG1	0.803	0.939	0.660	0.722	0.918	0.582
	LG2	0.837			0.781		
	LG3	0.850			0.767		
	LG4	0.715			0.705		
	LG5	0.833			0.765		
	LG6	0.846			0.828		
	LG7	0.784			0.758		
	LG8	0.820			0.772		
Task value (TV)	TV1	0.755	0.937	0.651	0.745	0.927	0.613
	TV2	0.800			0.783		
	TV3	0.874			0.829		
	TV4	0.882			0.830		
	TV5	0.786			0.800		
	TV6	0.763			0.782		
	TV7	0.755			0.713		
	TV8	0.828			0.777		
Self-efficacy (SE)	SE1	0.793	0.937	0.651	0.761	0.924	0.603
	SE2	0.813			0.769		
	SE3	0.832			0.767		
	SE4	0.791			0.753		
	SE5	0.747			0.782		
	SE6	0.834			0.791		
	SE7	0.825			0.799		
	SE8	0.813			0.789		
Self-regulation (SR)	SR1	0.829	0.939	0.657	0.779	0.926	0.611
	SR2	0.807			0.780		
	SR3	0.826			0.818		
	SR4	0.841			0.779		
	SR5	0.700			0.689		
	SR6	0.846			0.808		
	SR7	0.816			0.779		
	SR8	0.810			0.816		

Table 5.11: Inter-construct correlations and square roots of average variance extracted for gender subgroups

Construct	Male				Female			
	LG	TV	SE	SR	LG	TV	SE	SR
Learning goal (LG)	**0.812**				**0.763**			
Task value (TV)	0.717	**0.807**			0.647	**0.783**		
Self-efficacy (SE)	0.666	0.700	**0.807**		0.642	0.693	**0.777**	
Self-regulation (SR)	0.684	0.665	0.707	**0.811**	0.636	0.586	0.693	**0.782**

(The bold elements in the main diagonal are the square roots of average variance extracted)

The path coefficients and *t*-values of the hypothesised relationships were calculated to evaluate the significance of the relationships in each subgroup. The standardised path coefficient indicates whether the direction of the relationship is either positive or negative whilst the *t*-value assesses whether this relationship is significant or not. The results of the hypotheses testing are summarised in Table 5.12.

Table 5.12: Standardised path coefficients, *t*-values and coefficient of determination (R^2) for gender subgroups

Path	Boys		Girls	
	Standardised path coefficient	*t*-value	Standardised path coefficient	*t*-value
Learning goal → Self-regulation	0.300	4.091**	0.294	5.908**
Task value → Self-regulation	0.184	2.826*	0.025	0.556
Self-efficacy → Self-regulation	0.378	6.086**	0.443	7.976***
R^2	59.6%		54.7%	

Notes: ***p*<0.001; **p*<0.01

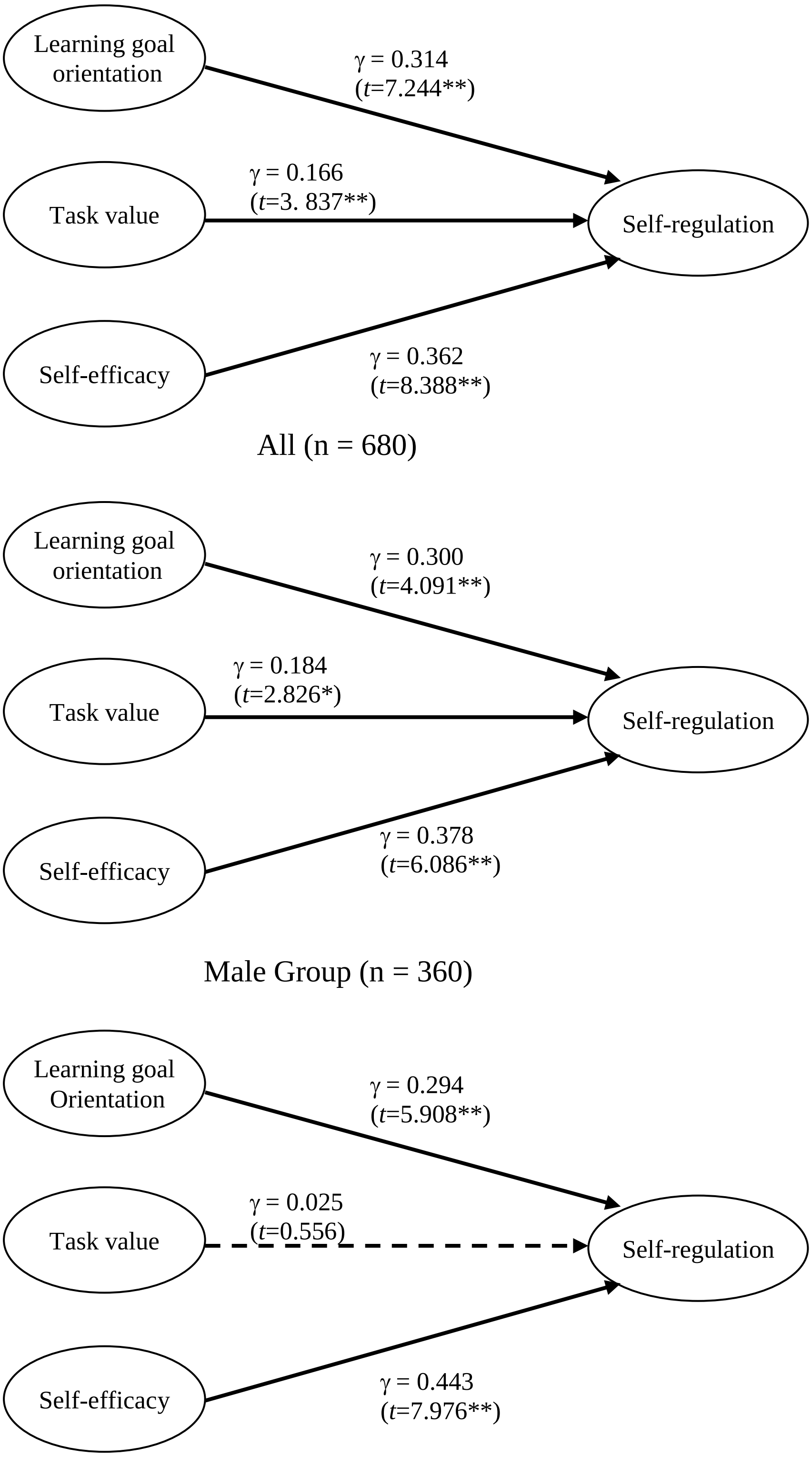
The results of the statistical analysis show that all three hypotheses were supported for the boys' subgroup whilst, for the girls' subgroup, only two hypotheses were supported. The explanatory power of the boys' research model was 59.6% whilst for girls it was 54.7%. The results also indicate that there were differences between the subgroups. The objective then is to determine whether the differences were statistically significant or not. First, the data was tested using the Kolmogrov-Smirnov test of normality. The results indicated that the data were not distributed normally. Therefore, the Smith-Satterthwaite *t*-test (which is utilised when data violates the normal distribution) was selected. Thereafter, the results of the *t*-tests for each subgroup are detailed in Table 5.13.

Table 5.13: Results of Smith-Satterthwaite *t*-test for gender subgroups

Path	Boys		Girls		*t*-statistic (2 tailed)
	Standardised path coefficient	Standard errors	Standardised path coefficient	Standard errors	
Learning goal → Self-regulation	0.300	0.073	0.294	0.050	0.068
Task value → Self-regulation	0.184	0.065	0.025	0.046	1.989*
Self-efficacy → Self-regulation	0.378	0.062	0.443	0.056	-0.780

Notes: *$p<0.05$

The results indicate that there were significant differences in path coefficients between the two subgroups, namely, the paths between task value and self-regulation in science learning. For boys, this path is significant but for girls it is not. The results of hypothesis testing for the main model, boy's subgroup and girl's subgroup are illustrated in Figure 5.3.



Female Group (n = 320)

Notes: ***p*<0.001; **p*<0.01

Figure 5.3: Significance of the hypothesised relationships in the research model for all samples, boys' subgroup and girls' subgroup

5.5 Summary

Partial Least Square (PLS) based Structural Equation Modeling (SEM) data analyses were utilised to investigate the influence of psychosocial learning environment on students' motivation and self-regulation (research objective 3) and the influence of students' motivation on their self-regulation in science learning (research question 4). The data analyses in PLS involved assessment of the measurement properties followed by the assessment of the research model. Assessment of the measurement properties was facilitated by confirmatory factor analysis to establish convergent validity and discriminant validity. The confirmatory factor analysis in PLS, unlike exploratory factor analysis, does not evaluate instruments separately. Hence, all of the items from both questionnaires (the SALES and WIHIC) were regarded as part of the regression model and analysed simultaneously. The items were tested for convergent validity by determining item reliability, internal consistency and average variance extracted. The results indicated that all items loaded above the recommended cut-off point of 0.70 except for items SC2, SC7, SC8 and SR5. Hence, after the first PLS run, these four items were discarded. When the refined set of items was again analysed, using PLS, all loadings met the minimum requirement of 0.70. The results of reliability analysis indicated a high internal consistency value for each of the subscales. In addition, the measure of average variance extracted (AVE) for each subscale met the minimum value for AVE. These three results corroborated the convergent validity of the questionnaire. Results of the discriminant validity analyses of the items, assessed by applying two analytical procedures suggested by Barclay et al. (1995), established the discriminant validity of the scales.

In the next step, the explanatory power of the research model was assessed by calculating the coefficient of determination (R^2) of the endogenous constructs. The results indicated that the overall model explained a substantial 69% of the variance on students' self-regulation in science learning. In addition, 52% of the variations in students' self-efficacy scores in science learning were accounted for by their perceptions of their classroom learning environment. At the same time, 44% and 50% of the variation in students' scores for task value and learning goal orientation, respectively, were attributable to psychosocial elements in their classroom learning environment.

Examination of the path coefficient and *t*-value for each hypothesised relationship in the research model indicated that 19 of the 31 possible relationships were statistically significant. The results showed that three of the seven learning environment scales, these being student cohesiveness, investigation and task orientation, were likely to influence students' learning goal orientation, task value, self-efficacy and self-regulation in science learning. The findings also indicate that teacher support is likely to influence both students' learning goal orientation and task value. The involvement scale had a statistically significant influence on students' self-efficacy. In addition, the findings indicated that all three motivational constructs strongly influenced students' self-regulation in science learning.

Finally, data were analysed to investigate the moderating role of gender in the relationships between students' motivational beliefs and self-regulation in science learning (research objective five). Since the research objective only involves students' motivation and self-regulation, a modified research model, which does not include the psychosocial learning environment and the WIHIC scales, was analysed. In accordance with PLS, the assessment of the measurement properties (involving only the SALES) and assessment of research model was redone. The results from the assessment of the measurement properties confirmed the convergent and discriminant validity of the SALES questionnaire. The assessment of the modified research model revealed that the three hypothesised relationships were significant and the explanatory power of the research model was 55.9%. These results confirmed the strong influence of students' motivational beliefs on their self-regulation in science learning. The data were then split into two subgroups, one for boys and the other for girls. The measurement properties and research model were again assessed for each subgroup and the results indicated that the measurement properties for each subgroup met the convergent and discriminant validity criteria. The explanatory power of the boys' research model was 59.6% whilst for girls it was 54.7%. Results of hypotheses testing showed that all three hypotheses were supported for the boys' subgroup. For the girls' subgroup only two hypotheses were supported, the exception being for the influence of task value on self-regulation in science learning, which was not statistically significant for girls. All of the statistically significant relationships in the research model are discussed further in the next chapter for their possible implications for science teaching.

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Introduction

The final chapter of the thesis presents a discussion of the findings, contributions of the research, research limitations and suggestions for future research. The discussions are based on the results of the data analyses as detailed in Chapters 4 and 5. Section 6.2 presents the discussions of each finding based on the order of the research objectives stated in Chapter 1. The discussions are coupled with the possible implications of the findings. Section 6.3 summarises the theoretical, methodological and practical contributions of the study. Section 6.4 highlights the limitations of the study and Section 6.5 provides suggestions for future research. The thesis concludes with a final comment in Section 6.6.

6.2 Discussion of Findings

The discussion of the findings is segregated into five sections, from Section 6.2.1 to Section 6.2.5, in accordance with the research objectives presented in Section 1.3. Along with the discussions, suggestions for the possible practical implications of the findings are presented.

6.2.1 Validity of the Students' Adaptive Learning Engagement in Science (SALES) Questionnaire

Research Objective 1: To develop and validate the Students' Adaptive Learning Engagement in Science (SALES) questionnaire to assess lower secondary students' motivation and self-regulation in science learning

The initial focus of this study was to develop and validate a questionnaire to assess students' motivation and self-regulation in science learning. Development of the new Students' Adaptive Learning Engagement in Science (SALES) questionnaire involved a multi-stage approach, designed to ensure that Trochim and Donnelly's (2006) framework for construct validity, illustrated in Figure 3.2, was satisfied. This framework was used to guide the validation of the SALES questionnaire to ensure that both the translation and criterion-related validity requirements were fulfilled.

Translation validity includes content validity which focuses on theoretically sound representation of the constructs and face validity which emphasises on clear interpretations of the items within a construct by participants. Therefore, as a first step, content validity was established by basing the constructs in the survey on sound theoretical grounds that included achievement goal theory, expectancy-value theory and theories related to self-efficacy and self-regulated learning. An extensive review of related literature provided a sound basis upon which the constructs were developed and served to ensure that the items, within each construct, were an accurate representation of the construct. Once the items for each construct were developed and modified, ten experienced science teachers were asked to review the survey, using a teacher evaluation form, to ensure that the individual items were suitable and encompassed the intended constructs. Two of these teachers were interviewed to further refine and clarify the items. The refined survey was used in a pilot study involving 52 students from two mixed-ability grade 8 classes. The major function of the pilot study was to examine the face validity of the survey to ensure that the researcher and participants ascribed similar meaning and interpretation to the items. Twelve students, who participated in the pilot study, were interviewed to confirm that they responded to the items on the basis intended by the questionnaire. The students indicated that the items were clear, concise and easily understood. The students' responses supported the face validity of the survey instrument.

The final version of the survey was administered to students from 78 classes in five public schools in the Perth metropolitan area resulting in 1360 useable data. Criterion-related validity of the newly-developed questionnaire was established by examining the convergent validity, discriminant validity, concurrent validity and predictive validity of the survey. Convergent and discriminant validity were established through exploratory factor analysis and internal consistency reliability measure. The results of the exploratory factor analysis showed that the items can be extracted into four succinct scales, with all items loading on their *a priori* scale and no other scale. The internal consistency reliability values for each of the scales were all above 0.90. The factor loadings and internal consistency measure confirmed the convergent validity of the questionnaire.

The discriminant validity of the questionnaire was established using the component correlation and correlation matrices obtained through principal components analysis using oblique rotation. The results indicated that the values in the component correlation matrix met the requirements of discriminant validity. In addition, in the correlation matrix, correlations between a particular item and other items in the same construct were higher than its correlations with items from different constructs. These two analyses supported the discriminant validity of the survey to ensure that the individual constructs in the questionnaires were discriminated from each other by the instrument. The results of ANOVA analysis indicated that the eta^2 value was significant for each scale, suggesting that each scale in the SALES differentiated significantly between classes, thus supporting the concurrent validity of the scales. Finally, predictive validity was attested when, using one-tailed Pearson correlation analysis, each of the scales in the survey were statistically significantly associated with students' achievement in science.

The results of the quantitative and qualitative data analyses supported the validity of this self-report survey and fulfilled the requirements for both translation and criterion-related validity. The final version of the survey has high content, face, convergent, discriminant, predictive and concurrent validity when used in lower secondary science classes. These results imply that data collected using this survey are likely to be valid and reliable. As discussed in section 2.3.4 and 2.4.3, the development of this survey is to overcome the unavailability of an economical and theoretically inclusive instrument to measure students' motivation and self-regulation in science learning. This survey provides a convenient tool that can be used by researchers and teachers to gather information about important aspects of students' adaptive learning engagement in science.

It is anticipated that the information gathered using this tool can be used to guide classroom teachers in improving their teaching practise. As contended by Zimmerman (2002), teacher's seldom assess their students' motivational beliefs and self-regulation in learning in order to identify difficulties before they become problematic. In an era in which studies of interventions, aimed at improving students' motivational beliefs and self-regulated learning have shown promising results (Perels et al., 2005; Schunk, 2005; Schunk & Ertmer, 2000; Taboada et al. 2009; Wigfield et al., 2008), this new survey provides a reliable tool that teachers and researchers could utilise to identify students' motivational beliefs and self-regulatory practices.

6.2.2 Validity of the What is Happening In this Class? (WIHIC) Questionnaire

Research Objective 2: To validate the What is Happening In this Class? (WIHIC) questionnaire when used to assess lower secondary science classes in Western Australia.

Since the WIHIC is already a well-established learning environment instrument, the validation of this survey for the present study involved only the criterion-related factors from Trochim and Donnely's (2006) construct validity framework. To date, no studies that have validated the WIHIC have applied this comprehensive construct validity framework. To address this, the present study examined convergent, discriminant, concurrent and predictive validity of the WIHIC. The results of exploratory factor analysis of the WIHIC data using oblique rotation confirmed the seven distinct *a priori* factors embedded in the WIHIC, namely, student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. The Cronbach alpha reliability coefficient for each factor was above 0.87 indicating a high internal consistency reliability. In addition, the correlation matrix obtained through principal components analysis using oblique rotation indicated that each scale distinctively measures a different facet of learning environment. These results supported the convergent and discriminant validity of items in each of the learning environment scales.

The concurrent validity, the ability of each of the WIHIC scale to differentiate between different classes, was investigated using ANOVA. The eta^2 statistic, which provides information about the amount of variance attributed to class membership for each scale, was significant for each scale in the WIHIC except for student cohesiveness. The significant results suggest that six of the seven scales in the WIHIC differentiated significantly between classes, thus supporting the concurrent validity of the scales. The inability of the student cohesiveness scale to differentiate between classes could be because student cohesiveness is influenced more by adolescent peer relations than by what takes place in the lower secondary science classrooms. Finally, results of one-tailed Pearson correlation analysis indicated that each WIHIC scale had a statistically significant correlation with students' science achievement, thereby supporting the predictive validity of the seven scales.

Although the reliability and validity of the WIHIC has been confirmed in numerous studies across the world including recent studies in Australia (Dorman et al., 2006), Canada (Zandvliet & Fraser, 2005), India (den Brok et al., 2005), Indonesia (Fraser et al., 2010; Wahyudi & Treagust, 2006), New Zealand (Saunders & Fisher, 2006), Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008), Turkey (Telli et. al, 2006), UAE (Afari et al., in press; MacLeod & Fraser, 2010) and the US (Allen & Fraser, 2007; Gabler & Fraser, 2007; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008), for the first time, the widely used WIHIC questionnaire underwent rigorous validity analyses using Trochim and Donnely's construct validity framework, to concomitantly determine convergent, discriminant, predictive and concurrent validity. The findings indicate that the WIHIC questionnaire has high convergent, discriminant, predictive and concurrent validity when used in lower secondary science classes.. Hence, the present study further establishes that data collected using the WIHIC is likely to be valid and reliable.

6.2.3 Influence of Learning Environment on Students' Motivation and Self-Regulation

Research Objective 3: To investigate the psychosocial learning environment elements that influence lower secondary students' motivation and self-regulation in science learning.

The research model for this study (illustrated in Figure 3.1) which postulates the influence of psychosocial learning environment on students' motivation and self-regulation, was evaluated using Partial Least Square (PLS) based Structural Equation Modeling (SEM) analyses. This involved assessment of the measurement properties through confirmatory factor analysis followed by assessment of the research model. The confirmatory factor analyses, examined both the convergent and the discriminant validity of the SALES and the WIHIC questionnaires. The items were tested for convergent validity by determining item reliability, internal consistency and average variance extracted. The results indicated that all item loadings achieved the minimum requirement of 0.70. The results of reliability analysis indicated a high internal consistency value for all the scales. In addition, the measure of average variance extracted (AVE) for each scale met the minimum value for AVE. These three results corroborated the convergent validity of the questionnaire. Results of the discriminant validity analyses of the items, assessed by applying two analytical procedures suggested by Barclay et al. (1995), established the discriminant validity of the scales.

The explanatory power of the research model was assessed by calculating the coefficient of determination (R^2) of the endogenous constructs. The results indicated that the overall model explained a substantial 69% of the variance in students' self-regulation in science learning. In addition, 52% of the variance in students' self-efficacy scores in science learning were accounted for by their perceptions of their classroom learning environment. In addition, 50% and 44% of the variation in students' scores for learning goal orientation and task value, respectively, were attributable to psychosocial elements in their classroom learning environment.

The findings suggest that three aspects of the psychosocial learning environment (investigation, task orientation and student cohesiveness) are likely to influence students' learning goal orientation, task value, self-efficacy and self-regulation in science learning. The findings also indicate that teacher support is likely to influence both students' learning goal orientation and task value. Additionally, the involvement scale had a statistically significant influence on students' self-efficacy. The implications of these statistically significant relationships between the learning environment dimensions and student motivation and self-regulation in science learning are discussed below.

The statistically significant influence of the investigation scale on both students' motivation and self-regulation suggests that students who are encouraged to utilise skills and processes related to inquiry and who investigate their own ideas are more likely to be motivated to learn and to regulate their effort in science learning. Minner, Levy and Century (2010), in their recent synthesis of research on inquiry-based instruction, concluded that it is an apparent and consistent trend, for students who actively think and participate in the investigation process of inquiry-based learning, to have increased science conceptual knowledge. Shraw, Crippen & Hartley (2006) drew on self-regulated learning research from science education literature to conclude that inquiry-based learning is an essential instructional strategy for improving self-regulation in science classrooms. The findings of the present study further highlight the importance of investigation in science learning specifically for promoting students' motivation and self-regulation in science learning. The results suggest that students' motivation and self-regulation probably could be improved by providing them with more opportunities to engage in investigative tasks and activities that enable them to actively construct their knowledge of science concepts. This suggestion is also in line with Britner and Pajares's (2006) recommendation that teachers should implicitly encourage lower-secondary science students' to engage in authentic inquiry-oriented science investigations.

Shraw et. al (2006) suggest that inquiry teaching, which enables the creation of a learning environment in which students are able to use process-oriented approaches that include posing questions, constructing solutions and testing results, will invariably increase students' motivation and self-regulation in science learning. Research evidence suggests that at least three inquiry-based activities are essential, these being; scaffolded experimental design (Khishfe & Fouad, 2002); discussion of results (Halpern, 1998; Kuhn, 1999); and reflection on the process of inquiry (Toth, Suthers & Lesgold, 2002; Van See, 2000). Some recommended active investigation instructional strategies are predict-observe-explain (Windschitl, 2002) and question-asking (Chinn & Brown, 2002).

The learning environment scale with the greatest influence on students' motivation and self-regulation in science learning was task orientation, suggesting that students need to be aware of the importance of completing planned activities and staying on the subject matter. In other words, it is time well spent when teachers consistently encourage students to get a certain amount of work done in class. In addition, the results suggest that teachers wishing to improve motivation and self-regulation should highlight to students the goals of each activity and ensure that students understand what they are required to accomplish in each task.

The findings of the present study lend support to Middleton and Midgley's (2002) suggestion that, for students to succeed in academic tasks, teachers need to apply academic press by constantly challenging students to understand what is being taught in class and to complete their assigned work. According to Killen (2001) and Spady (1994), to enable students to be task-oriented, teachers must first ensure that students are provided with goals, both short-term and long-term. Seifert (2004) reiterates that teachers need to first communicate the objectives of the lesson – what is it the students should learn. If the goals are clear and relevant, then the students are more likely to be engaged in their learning process. Aldridge, Fraser, Dorman and Bell (2012) further suggest that, coupled with the requirement to have set goals, is the need to clarify teacher expectations and to provide frequent feedback and reinforcement to optimise students' time-on-task. These focus on task-orientation by the teacher could increase both students' motivation and self-regulation in science learning.

The third scale, student cohesiveness, was found to have a statistically significant influence on student motivation and self-regulation, thus highlighting the importance of supportive relationships between students in the classroom. The result suggests that social acceptance by peers and the need to have friends are important aspects that can affect students' learning engagement. Hence, students' supportive relationships with their peers should be cultivated as a way of increasing students' motivation and self-regulation in science learning.

To create a cohesive learning environment teachers need to create policies and practices that help students to feel that they are accepted and supported by their peers. Ryan and Patrick (2001) suggest that, when students believe they are encouraged to know, interact with and help with classmates during lessons and when they view their classroom as one where their ideas are respected and not belittled, they tend to engage in adaptive patterns of learning. This learning environment also allows students to make mistakes without running the risk of being ridiculed. Urdan and Schoenfelder (2006) acknowledge that the peer relationship dimension is important, particularly for lower-secondary students because the transition from elementary to high school is a critical period that can disrupt their earlier childhood friendship networks (Urdan & Schoenfelder, 2006). If students are provided with opportunities to interact and work together so that they get to know each other well and to build positive social bonds during science lessons, they are more likely to become cohesive and to experience increased motivation and self-regulation in their science learning.

The teacher support scale, was a statistically significant influence on both students' learning goal orientation and task value. The finding that teacher support influences learning goal orientation suggests that the supportive role of the teacher is influential in terms of promoting learning goal structures in science classrooms. Second, the influence of teacher support on task value suggests that teachers play a major role in helping students to recognise the value of the tasks that they are undertaking in class. The implication is that teachers could play a supportive role in the classroom by becoming more concerned, helpful, friendly and trustworthy to promote students' learning goal orientation and science task value.

Aldridge et al. (2012) suggested that teachers could provide support by helping students to gain the courage and confidence needed to tackle new problems, take risks in their learning and to complete challenging tasks. It is also likely that teachers could be seen as more supportive by their students when they show genuine concern and interest in their students' learning. Meece (1991) suggested that teacher's inadvertly provide support to students when they promote meaningful learning by facilitating collaboration among students and making learning materials relevant and interesting to students. These supportive roles of the teacher could develop students to value science tasks, thereby encouraging them to focus on learning, understanding and mastering these tasks.

The data analysis indicated that involvement had a statistically significant influence on students' self-efficacy in science learning. This finding made intuitive sense because students who are involved in classroom activities that encourage them to ask questions, give opinions and explain ideas and that make use of students' ideas and suggestions in classroom discussions are more likely to have confidence in their science abilities. The strong influence of involvement on self-efficacy suggests that teachers who provide opportunities for students to take part in peer and class discussions are likely to elevate their students' confidence level. However, it is important to keep in mind Britner and Pajares's (2006) recommendation that student involvement should be in accordance to the abilities of the student.

To promote students' involvement in class, teachers could encourage students to think of learning as an active process that involves a conscious intention to make sense of new ideas or experiences and improve their own knowledge and capabilities, rather than simply to reproduce or remember (Curriculum Council, 1998). Aldridge et al. (2012) suggests that students be given opportunities to participate in discussions and encouraged to develop attentive interest in what is happening in the classroom. Taylor and Campbell-Williams (1993) reiterate that students who could negotiate ideas and understandings with peers and teachers, rather than listening passively are more involved in their learning process. The students who become involved are more likely to increase their self-efficacy in science learning.

In sum, this section highlights the present study's findings on the elements in the psychosocial learning environment that are likely to influence students' motivation and self-regulation in science learning. This is coupled with discussions on the possible implications of these findings. Hence, teachers intending to improve their students' motivation and self-regulation in science learning could consider implementing the propositions dicussed in this section.

6.2.4 Influence of Students' Motivation on Self-Regulation

Research Objective 4: To investigate whether lower secondary students' motivational beliefs influence their self-regulation in science learning.

The research model, (illustrated in Figure 3.1) envisaged the influence of students' motivation on their self-regulation in science learning. The evaluation of this research model, discussed in Section 6.2.3, indicated that all three motivational constructs (learning goal, task value and self-efficacy) were strong predictors of students' self-regulation in science learning. This result corroborates the self-regulated learning theory that contends that motivational beliefs are the precursors of self-regulated learning (Schunk & Zimmerman, 2008; Wolters, 2010; Zimmerman 2002)). The results also support Boekaerts and Cascallar's (2006) contention that that students' motivational beliefs play a vital function in ensuring students' successful engagement in self-regulated learning. In addition, the results are consistent with Pintrich's (2003), review of past research which concluded that research evidence indicates that students who are more academically motivated show higher self-regulation in learning.

The influence of learning goal on students' self-regulation is consistent with Kaplan and Maehr's (2007) analysis of goal orientation theory which found firm theoretical and research evidence that learning goal orientation is a key predictor of students' motivated behaviour such as persistence and effort. The results are similar to findings from past research which indicate that students who perceive the teacher as emphasising learning goals are more inclined to use self-regulatory strategies in their learning (Ames & Archer, 1988; Kaplan & Midgley, 1999; Newman, 1998; Ryan et al., 1998; Urdan & Midgley, 2003). The results suggest that promoting students' self-regulation in science learning could be more successful with prior emphasis on increasing students' learning goal orientation.

Past research has indicated that the students of teachers who consistently emphasise the value of mastering and understanding the information presented in class are likely to perceive a higher learning goal orientation (Stipek, Givvin, Salmon & MacGyvers, 1998; Turner, Midgley, Meyer, Gheen, Anderman, Kang & Patrick, 2002; Urdan, Midgley & Anderman, 1998). In line with this, teachers could on a regular basis, draw their students' attention to the importance of mastering and understanding science learning activities to develop their students' learning goal orientation. In addition, as suggested by Britner (2008), to support students in becoming more learning goal oriented, teachers could discourage competition and criticism in favour of a more cooperative and supportive classroom climate. As reiterated by Pajares (2008), a classroom structure that is less focused on competition could promote students' learning goal orientation and, at the same time, increase students' self-efficacy. Teachers could also take note of Fryer and Elliot's (2008) recommendation that to promote students' learning goal orientation, teachers should praise students' efforts rather than their results.

Additionally, Meece (1991) suggested that teachers could provide support for complex and challenging tasks, rather than use grades or normative assessment. Cleary and Chen (2009) reiterated that, over the past couple of decades, motivational researchers have advocated the reformation of educational practices, particularly in middle school settings, to include greater emphasis on learning goal orientation, de-emphasising normative based comparisons and providing students with more choice and autonomy during learning and classroom instruction (Ames, 1992; Dweck & Leggert; 1998; Midgeley & Edelin, 1998). The present study suggests that supporting these initiatives could also increase with students' self-regulation in science learning.

The influence of task value on students' self-regulation in science learning, reported in the present study, corroborates Wolters and Rosenthal (2000) contention that, theoretically, students who are convinced that their learning activity is important, interesting and useful are more inclined to expend greater effort and persist longer towards completing an activity. The results are also consistent with the past research which have supported theoretical claims about the association between students' perception of task value and their choice to participate and sustain effort in academic tasks (Schunk et. al, 2008; Pintrich and De Groot, 1990; Simpkins et al., 2006; Wolters et. al, 1996).

The statistically significant influence of task value on students' self-regulation in science learning suggests the importance of promoting students' perceptions of science learning tasks in terms of interest, importance and utility. Past researchers have also advocated that strong efforts to make learning intrinsically enjoyable, important and useful should be a focus of middle school years (Midgley & Edelin, 1998; Reeve & Jang, 2006; Urdan & Midgley, 2006). In a review of past research, Renninger and Hidi (2011) conclude that a focus on activities and tasks that feature novelty, challenge and the supportive role of those people who have an assumed role in interest development (such as parents, teachers or peers) do promote students' intrinsic value.

Additionally, Palmer (2009) contends that there are a number of key factors that could generate students' intrinsic value in a science classroom, including, novelty, availability of choice, physical activity and social involvement. Hence, science teachers could consider fusing these interest enhancing factors in pedagogical strategies to promote their students' intrinsic value of science learning tasks. Watt (2010) asserts that the explication of the social uses and purposes of science could help to heighten students' utility value, especially in girls. Teachers could incorporate this proposition and consistently emphasise the significance of science learning materials and science-related fields to their students to improve students' science utility value.

The finding that a positive relationship exists between students' self-efficacy beliefs and their self-regulation in learning, supports the general consensus among theorists (Pajares, 2002; Zimmerman, 2000; Zimmerman & Bandura, 1994). This finding also is consistent with studies by Sungur (2007) and Greene et. al (2004) both of which reported that self-efficacy had a significant positive influence on students' self-regulatory strategy use. The findings imply that, to encourage self-regulated learners in lower secondary science classes, educators must first implement strategies that could effectively increase student self-efficacy towards science learning.

Britner and Pajares (2006) suggest that teachers select pedagogical strategies that are likely to elevate their students' confidence to improve self-efficacy in science learning. For example, teachers could tailor science tasks to the abilities of individuals to ensure confidence-building success and to reduce efficacy-diminishing failures. Pajares (2008) contends that students who set short term goals and monitor their progress accordingly are likely to develop stronger self-efficacy than students who set long term goals. Hence, teachers could utilise this proposition by encouraging students to set short term goals for each unit of study, thereby building their competency and confidence in achieving the set goals. Additionally, the setting of short term goals could also encourage students to be more task-oriented in science classrooms.

In sum, the research findings indicate that students' learning goal orientation, task value and self-efficacy influence their self-regulation in science learning. This section examines the possible implications of these findings to science teachers. Hence, teachers intending to improve their students' self-regulation in science learning could consider implementing the propositions dicussed in this section.

6.2.5 The Moderating Effect of Gender

Research Objective 5: To investigate the moderating role of gender in the relationships between lower secondary students' motivational beliefs and self-regulation in science learning.

A modified research model, comprising of students' motivational beliefs and self-regulation in science learning (shown in Figure 5.2), was evaluated to examine the hypothesised relationships and enable comparisons between gender subgroups. First, confirmatory factor analysis of the measurement properties involved the examination of convergent and discriminant validity. The PLS analysis confirmed that the measurement properties satisfied all three necessary criteria of item reliability, internal consistency and average variance extracted (AVE) to achieve convergent validity. In addition, all of the the constructs met the two discriminant validity criteria recommended by PLS. The analysis of the explanatory power of the modified research model indicated that the overall model explains a sizeable 55.9 % of the variance for students' self-regulation in science learning.

The sample was then subdivided into two subgroups, based on gender, and the measurement properties for each subgroup were examined individually. Results of the PLS analyses showed that the measurement properties of both the boys' and girls' subgroups met the requirements for convergent and discriminant validity. The analysis for the explanatory power of the research model for each subgroup indicated that the boys' research model explained 59.6% of the variance for students' self-regulation in science learning whilst for the girls it was 54.7%. All three hypotheses were supported for the boys' subgroup whilst, for the girls' subgroup, only two hypotheses were supported. The Smith-Satterthwaite *t*-test indicated that there were significant differences in path coefficients between the two subgroups, namely, the paths between task value and self-regulation in science learning. For boys, this path was significant but for girls it was not.

The findings indicate that the most significant motivational belief that influences students' self-regulation in science learning is self-efficacy. The influence of this scale was statistically significant for each of the the boys' and girls' subgroup models. Although past research has emphasised the influence of self-efficacy in science learning for girls (Britner, 2008), the findings from the present research suggest that both genders need to develop self-efficacy to facilitate their self-regulation in science learning.

The second significant motivational scale predicting students' self-regulation in science learning was learning goal orientation. This scale was statistically significant for each of the the boys' and girls' subgroup models. This result highlights the importance of emphasising learning goal orientation in science classrooms as a means of increasing both girls' and boys' self-regulation in science learning.

Finally, the results suggest that science task value has a statistically significant influence on students' self-regulation in science learning. However, the multi-group analysis revealed that the influence of this construct on self-regulation is only statistically significant for boys and not for girls. The Smith-Satterwaithe *t*-test further confirms that the role of task value statistically differs for males and females. This result suggests that, in order to self-regulate in science learning, boys need to value the science tasks that are being taught in classrooms. However, for girls, task value would appear to have limited impact on their self-regulation. On the basis of these findings, the present study speculates that interventions which emphasise task value are especially helpful for the self-regulation of boys rather than girls. DeBacker and Nelson (2000) also recommend that, for boys, highlighting the value and importance of the science that they learn is integral to enhancing their motivation to learn science. The results of the present study further suggests that this type of intervention will increase boys' self-regulation in science learning. However, as cautioned by Watt (2006), any emphases on boys' academic progress must be balanced by retaining a focus on the development of girls' in order to overcome continuing gender discrepancies in the field of science and mathematics education.

6.3 Contributions of Study

The findings of the present study have theoretical, methodological and practical contributions. The theoretical contributions are discussed in Section 6.3.1 followed by the methodological contributions in Section 6.3.2. Finally, the practical contributions are summarised in Section 6.3.2.

6.3.1 Theoretical Contributions

Theoretically, the present study made distinctive contributions to the field of learning environment as well as science education as it was first study within field of learning environment research to examine the influence of psychosocial learning environment on both student motivation and self-regulation in the area of science learning. A major contribution of this study is the identification of salient psychosocial elements in the classroom learning environment that influence students' motivation and self-regulation in science learning. The study found that students' perceptions of investigation, task orientation and student cohesiveness were key determinants of students' learning goal orientation, task value, self-efficacy and self-regulation in science learning. In addition, the extent to which students' perceive the teacher to be supportive was strongly associated with their learning goal orientation and task value, whilst student involvement was a strong predictor of self-efficacy in science learning.

Additionally, the research gap in the examination of the influence of the students' motivational beliefs on their self-regulation in science learning was bridged through this study. The findings indicated that all three motivational constructs (learning goal, task value and self-efficacy) were strong predictors of students' self-regulation in science learning. These findings add to the literature on lower secondary students who undergo a critical developmental period during the transition from primary to secondary school.

Finally, to add to the literature on gender differences, this study revealed the moderating role of gender on the relationships between students' motivational beliefs and their self-regulation in science learning. The findings indicate that, for both girls and boys, the most influential motivational belief on students' self-regulation is self-efficacy followed by learning goal orientation. However, although for boys the influence of task value was significant, for girls this construct appeared to have a limited impact on their self-regulation in science learning.

6.3.2 Methodological Contributions

The major methodological contribution of the present study is the development and validation of an instrument to measure students' motivation and self-regulation in science learning. A comprehensive and rigorous construct validity framework was used to establish the validity of the newly-developed instrument. This exacting method ensured that the final version of the instrument has high content, face, convergent, discriminant, predictive and concurrent validity. Future researchers who wish to develop and validate new questionnaires could replicate the research methods applied in this study. In addition, this is the first time that the widely-used WIHIC questionnaire was validated with these methods to concomitantly establish convergent, discriminant, predictive and concurrent validity.

The second methodological contribution of this study is the use of PLS (Partial Least Squares) a SEM (Structural Equation Modelling) based data analyses. The PLS analyses enabled the confirmatory factor analysis of both the SALES and the WIHIC questionnaires. The confirmatory factor analysis added rigor and credibility to both instruments. Furthermore, because the PLS is a powerful statistical tool for prediction-oriented research, it was able to effectively test and validate the complex exploratory research model. The use of multi-group analysis to examine gender moderation permitted the present study to evolve from traditional gender difference studies that generally evaluate mean level differences in key dimensions of motivation and self-regulation. The alternate research method derived important information on the moderating role of gender in the relationships between students' motivational beliefs and self-regulation.

6.3.3 Practical Contributions

The newly-developed survey could be valuable for researchers and teachers, providing an expedient tool for gathering information on important aspects of students' learning engagement in science. This easily obtained snapshot of information could be used by the teachers to step back from their teaching and reflect on their students' adaptive learning engagement in science. The teachers could also use this feedback to refocus their teaching practises and provide opportunities for the development of students' motivational beliefs and self-regulation.

For researchers, the use of this survey, in conjunction with other techniques such as interviews and observations could lead towards a more comprehensive understanding of students' adaptive learning engagement in science. This instrument also could be used to examine the influence of students' motivation and self-regulation on different criterion variables such as science attitude and achievement. In addition, longitudinal studies could use this instrument to track the changes in students' motivation and self-regulation as they progress through school.

Research on interventions for improving students' learning goal orientation, self-efficacy, and self-regulation of effort has yielded promising results. Therefore, this survey could also be used to evaluate the effectiveness of intervention programmes designed to increase the interest, confidence, and competence in science of students as they progress through school. Although the focus of this research is on science learning, this survey might be modified for assessing students' motivation and self-regulation in other subjects.

Urdan and Schoenfelder (2006) argue that student motivation is influenced not only by students' individual differences but, to a large extent, also by the social and academic features of the classroom learning environment. They suggest that altering controllable factors such as the curriculum, teaching style and school or classroom policies could enhance student motivation towards learning. The findings from the present research offer potentially important insights into how changing psychosocial elements of the classroom learning environment could promote lower secondary students' motivation towards science learning and, in turn, encourage them to proactively regulate their own learning progress.

Another major contribution of this study is the identification of salient motivational beliefs that influence students' self-regulation. The results revealed that the motivational beliefs of learning goal orientation, task value and self-efficacy significantly influenced students' self-regulation in science learning. These findings provide possible opportunities for science teachers to implement interventions and strategies intended to increase students' self-regulation in science learning.

The core feature of a pedagogical intervention model would be to target and develop students' motivational beliefs in particular students' learning goal orientation, task value and self-efficacy in science learning, particularly at middle school years when significant shifts in self-regulatory demands and expectations occur. Boekaerts and Cascallar (2006) suggest that , based on past research (Boekaerts, 2006; Perry, 2002), intervention programs where teachers and researchers work in collaboration as partners could provide insights into changes that occur in students' motivation and self-regulation and the processes underlying these changes.

Science educators must be aware of the pivotal role that motivational beliefs play in facilitating boys' and girls' self-regulation in science learning particularly in lower secondary level when shifts in students' self-regulation are most likely to occur (Britner, 2008). The findings of this study suggests that school science reform efforts could involve implementing motivation enhancing interventions targeted specifically at boys and girls. In particular, the emphasis would be to boost both boys' and girls' learning goal orientation and self-efficacy in science learning. Additionally, for boys, the intervention strategies could focus on heightening boys' perspectives of science task value. Imperatively, the strategies targeted towards improving girls' self-regulation in science learning should be intensified so that existing gender imbalance could be corrected.

6.4 Limitations of Study

The use of the PLS based SEM approach and multi-group analysis to analyse the data provided renewed rigor and depth to the interpretation of results. However, reliance on self-report data, as suggested by Dunning, Health and Suls (2004), has the potential for flawed self-assessments to confound the results. Comparatively, data derived from other sources such as teachers and parents could be a more objective source.

To establish concurrent validity, the ANOVA analysis was used to investigate the variance components attributable to each of the class level. However, this method could be improved by using multilevel analysis and nesting students within classes. The multilevel analysis was not done because along with the ANOVA analysis, the instruments had also been examined through exploratory factor analysis and confirmatory factor analysis.

Another limitation of this study is that, although data was collected from students in grades 8, 9 and 10, grade level differences were not examined as it would have required complex multi-group PLS analyses extending beyond the scope of this research. Additionally, due to this study's emphasis on gender moderation, further investigation on grade levels would have required complex analyses due to the splitting of the data into multiple sub-groups.

The task value scale in the SALES is a composite task value measure that combines intrinsic value, utility value and interest. This scale was not desegregated to three different scales to facilitate the measurement of the different values component. However, given that the focus of this study is to develop an economical and theoretically inclusive scale. The separation of task value into three different constructs would not benefit the development of an economical scale.

In addition, due to the cross-sectional nature of this study, the changes in students' motivation and self-regulation were not tracked over time. The snapshot of information used in the data analyses has the potential to fluctuate as students' progress in their schooling years. However, the employment of longitudinal study was beyond the scope of the present study.

6.5 Future Research

In the present study, four constructs of students' motivational beliefs and self-regulation were conceptualised, based on theoretical and research grounds. However, there could be other salient constructs, such as outcome expectation, that could be investigated. In addition, the task value scale in the SALES is a composite task value measure that combines intrinsic value, utility value and interest. This scale could be desegregated to three different scales to enable the measurement of students' perceptions of different values component. Therefore, future research in this direction is recommended.

Although the validity of the SALES survey was corroborated by extensive qualitative and quantitative methods, these findings could be verified and enriched through further qualitative methods. Therefore, a multi-method approach of data collection including case studies, classroom observations, and in-depth interviews with students and teachers would not only provide contextual and rich descriptions in exploring students' motivational beliefs and self-regulation in science learning, but also might provide valuable insights into improving the newly-developed survey.

A multi-method approach to data collection, involving qualitative data collection from both students and teachers could also lead to a more comprehensive understanding of the learning environment's influence on students' motivation and self-regulation in science learning. Gender discrepancies in the relationships between students' motivational beliefs and their self-regulation could also be explored further through qualitative methods.

Future studies could disaggregate the data according to grade-level or age and examine how the influence of classroom learning environment changes with students' grade level. In addition, longitudinal studies could be conducted into changes in students' learning environment and its influence on students' motivation and self-regulation. Employment of longitudinal research, by tracking the same students over their lower secondary studies could potentially elucidate the possible motivational and self-regulatory fluctuations across time. This method could also reveal whether the causal interpretations, between student's motivation and self-regulation in science learning, are consistent as the students progress in their schooling years.

The final recommendation is that future studies could consider testing for gender moderation between the learning environment scales and students' motivation and self-regulation scales. This analysis could provide better understanding of the moderating role of gender in the relationships between psychosocial learning environment and student's motivation and self-regulation in science learning.

6.6 Final Comment

This study, in addition to achieving all of the research objectives, engendered possible future research directions and provided important theoretical, methodological and practical contributions. The theoretical contributions add to the literature on science education whilst the methodological contributions present viable improved research methods for future researchers. The practical implications present possible opportunities for educators to plan, and to put into practice, effective pedagogical strategies aimed at increasing student motivation and self-regulation in science learning. Although the focus of this research is on science learning, the findings probably could help educators to understand and improve student motivation and self-regulation in other subject areas.

The teacher's role has evolved over the years. There has been a shift of emphasis from teachers' instructional techniques to developing students' adaptive learning techniques. An integral role of the teacher today is to increase students' motivation and develop the skills or strategies that help to make the student become a self-regulated learner. Fundamentally, teachers are required to structure the students' learning environment so that students are able to take ownership of their own learning. The confluence of the classroom learning environment field with the student motivation and self-regulation field provided the impetus for this research.

The findings of the study specify the psychosocial classroom learning environment elements that could possibly be a significant influence on both student motivation and self-regulation in science learning. It is hoped that the research presented here would generate valuable shared information that could transform future science classrooms so that they are filled with motivated and self-regulated learners.

REFERENCES

Afari, E., Aldridge, J. M., Fraser, B. J., & Khine, M. S. (in press). Students' perceptions of the learning environment and attitudes in game-based mathematics classrooms. *Learning Environments Research.*

Alderman, M. K. (1999). *Motivation for achievement: Possibilities for teaching and learning.* Mahwah, NJ: Lawrence Erlbaum Associates.

Aldridge, J. M., & Fraser, B. J. (2000). A cross-cultural study of classroom learning environments in Australia and Taiwan. *Learning Environments Research*, *3*, 101–134.

Aldridge, J. M. & Fraser, B. J., (2008). *Outcomes-focused learning environments: Determinants and effects*. Rotterdam, The Netherlands: Sense Publishers.

Aldridge, J. M., Fraser, B. J., Bell, L., Dorman, J. (2012). Using a new learning environment questionnaire for reflection in teacher action research. *Journal of Science Teacher Education, 23,* 259–290.

Aldridge, J. M., Fraser, B. J., & Huang, I. T. C. (1999). Investigating classroom environments in Taiwan and Australia with multiple research method. *The Journal of Educational Research, 93,* 48–62.

Aldridge, J. M., Fraser, B. J., & Sebela, M. P. (2004). Using teacher action research to promote constructivist learning environments in South Africa. *South African Journal of Education, 24*, 245–253.

Aldridge, J. M., Fraser, B. J., Taylor, P. C., & Chen, C. C. (2000). Constructivist learning environments in a cross-national study Taiwan and Australia. *International Journal of Science Educational, 22*, 37–55.

Allen, D., & Fraser, B. J. (2007). Parent and student perceptions of classroom learning environment and its association with student outcomes. *Learning Environments Research, 10*, 67–82.

Alreck, P. L. & Settle, R. B. (1995). *The survey research handbook: Guidelines and strategies for conducting a survey* (2nd ed). Chicago: Irwin Professional Publishing.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*, 261–271.

Ames, C., & Archer, J. (1988). Achievement goal in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*, 260–267.

Andrew, S. (1988). Self-efficacy as a predictor of academic performance in science. *Journal of Advanced Nursing, 27*, 596–693.

Anderman, E. M., & Young, A. J. (1994). Motivation and strategy use in science: Individual differences and classroom effects. *Journal of Research in Science Teaching, 31*, 811–831.

Anderson, G. J., & Walberg, H. J. (1968). Classroom climate and group learning. *International Journal of Educational Sciences, 2*, 175–180.

Asghar, M., & Fraser, B. J. (1995). Classroom environment and attitudes to science in Brunei Darussalam. *Journal of Science and Mathematics Education in Southeast Asia, XVII*, 41–47.

Baker, D. (2002). Editorial: Where is gender and equity in science education? *Journal of Research in Science Education, 39*, 659–664.

Baker, S., Chard, D., Kettlerlin-Geller, L., Apichatabutra, C., & Doabler, C. (2009). Teaching writing to at-risk students: The quality of evidence for self-regulated strategy development. *Exceptional Children, 75,* 303–318.

Bandalos, D. L. (1993). Factors influencing cross-validation of confirmatory factor analysis models. *Multivariate Behavioral Research*, *28*, 351–374.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (pp. 307–337). Greenwich, CT: Information Age.

Bandura, A., Barbaranelli, C., Vittorio Caprara, G., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development*, *72*, 187–206.

Barclay, D., Higgins, C., & Thompson, R. (1995). The partial least squares (PLS) approach to causal modeling: Personal computer adoption and uses as an illustration. *Technology Studies, 2*, 285–309.

Barnette, J. J. (2000). Effects of stem and Likert response option reversals on survey internal consistency: If you feel the need, there is a better alternative to using those negatively worded stems. *Educational and Psychological Measurement*, *60*, 361–370.

Bembenutty, H. (2007). Self-regulation of learning and academic delay of gratification: Gender and ethic differences among college students. *Journal of Advanced Academics, 18,* 586–616.

Bereby-Meyer, Y., & Kaplan, A. (2005). Motivational influences on transfer of problem-solving strategies. *Contemporary Educational Psychology, 30*, 1–22.

Blumenfeld, P. C. (1992). Classroom learning and motivation: Clarity and expanding goal theory. *Journal of Educational Psychology, 84,* 272–281.

Blumenfeld, P. C., & Meece, J. L. (1988). Task factors, teacher behaviour and students' involvement and use of learning strategies in science. *The Elementary School Journal, 88,* 235–250.

Boekaerts, M. (1993). Being concerned with well-being and with learning. *Educational Psychologist, 28,* 149–167.

Boekaerts, M. (2006). Self-regulation and effort investment. In E. Sigel & K. A. Renninger (Eds), *Handbook of child psychology: Child Psychology in Practice* (pp. 345–377). New York: John Wiley and Sons.

Boekaerts, M., & Cascallar, E. (2006). How far have we moved toward the integration of theory and practice in self-regulation? *Educational Psychology Review, 18,* 199–210.

Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied Psychology: An International Review, 54*, 199–231.

Boekaerts, M., De Koning, E., & Vedder, P. (2006). Goal directed behaviour and contextual factors in the classroom: An innovative approach to the study of multiple goals. *Educational Psychologist, 41,* 33–54.

Bong, M. (2001). Role of self-efficacy and task value in predicting college students' course enrolments and intentions. *Contemporary Educational Psychology, 26*, 553–570.

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review, 15*, 1–40.

Britner, S. L. (2008). Motivation in high school science students: A comparison of gender differences in life, physical, and earth science classes. *Journal of Research in Science Teaching, 45*, 955–970.

Britner, S. L., & Pajares, F. (2001). Self-efficacy beliefs, motivation, race and gender in middle school science. *Journal of Women and Minorities in Science and Engineering, 7*, 271–285.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43*, 485–499.

Brookhart, S. M., Walsh, J. M., & Zientarski, W. A. (2006). The dynamics of motivation and effort for classroom assessments in middle school science and social studies. *Applied Measurement in Education, 19*, 151–184.

Brown, T. A. (2006). *Confirmatory factor analysis for applied research.* New York: Guilford Press.

Butler, D., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*, 245–281.

Chamberlain, V. M., & Cummings, M. N. (1984). Development of an instructor/course evaluation instrument. *College Student Journal, 18*, 246–250.

Chin, W. W. (1995). PLS is to LISREL as principal component analysis is to common factor analysis. *Technology Studies, 2*, 315–319.

Chin, W. W. (1998). Issues and opinion on Structural Equation Modeling. *MIS Quarterly, 22*, vii–xvi.

Chin, W. W. (2004). *Multi-group analysis with PLS.* Retrieved on 10th October, 2010, from http://discnt. cba.uh.edu/chin-/plsfaq/-multigroup.htm.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study an electronic-mail adoption study. *Information Systems Research*, *14,* 189–217.

Chinn, C., & Brown, D. A. (2002). Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education, 24,* 521–549.

Chionh, Y. H., & Fraser, B. J. (2009). Classroom environment, achievement, attitudes and self-esteem in geography and mathematics in Singapore. *International Research in Geographical and Environmental Education, 18,* 29–44.

Cleary, T. J., & Chen, P. P. (2009). Self-regulation, motivation, and math achievement in middle school: Variations across grade level and math context. *Journal of School Psychology, 47,* 291–314.

Cleary, T., Platten, P., & Nelson, A. (2008). Effectiveness of the self-regulation empowerment program with urban high school students. *Journal of Advanced Academics*, *20*, 70–107.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education.* London: RoutledgeFalmer.

Corno, L. (1994). Student volition and education: Outcomes, influences, and practices. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulation of learning and performance* (pp. 229–254). Hillsdale, NJ: Lawrence Erlbaum Associates.

Creton, H., Hermans, J., & Wubbels, T. (1990). Improving interpersonal teacher behaviour in the classroom: A systems communication perspective. *South Pacific Journal of Teacher Education, 18*, 85–94.

Crosbie-Brunett, M., & Lewis, E. A. (1993). Theoretical contributions from social and cognitive behavioral psychology. In P. G. Boss, W. J. Doherty, R. LaRossa, W. R. Schumm & S. K. Streinmetz (Eds.), *Sourcebook of family theories and methods: A contextual approach* (pp. 531–557). New York: Plenum Press.

Curriculum Council. (1998). *Curriculum framework.* Perth: Curriculum Council of Western Australia.

Cury, F., Elliot, A. J., Da Fonseca, D., & Moller, A. C. (2006). The social-cognitive model of achievement motivation and the 2×2 achievement goal framework. *Journal of Personality and Social Psychology*, *90*, 666–679.

De Vaus, D. A. (2002). *Surveys in social research.* Sydney, NSW: Allen & Unwin.

Debacker, T. K., & Nelson, R. M. (2000). Motivation to learn science: Differences related to gender, class type, and ability. *The Journal of Educational Research*, *93*, 245–254.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum Press.

DeCoster, J. (1998). *Overview of factor analysis.* Retrieved on 22nd February, 2010, from http://www.stat-help.com/factor.pdf den Brok, P., Fisher, D., & Koul, R. (2005). The importance of teacher interpersonal behaviour for secondary science students' attitudes in Kashmir. *Journal of Classroom Interaction, 40*, 5–19.

Denissen, J. J., Zarrett, N. R., & Eccles, J. S. (2007). I like to do it, I'm able, and I know I am: Longitudinal couplings between domain specific achievement, self-concept, and interest. *Child Development*, *78*, 430–447.

Dillman, D. A. (2000). *Mail and internet surveys: The tailored design method*. New York: John Wiley & Sons Inc.

Dignath, C. Buettner, G., & Langfeldt, H. (2008). How can primary school students learn self-regulated learning strategies most effectively?: A meta-analysis on self-regulation training programmes. *Educational Psychology Review, 3,* 101–129.

Dorman, J. P. (2001). Associations between classroom environment and academic efficacy. *Learning Environments Research*, *4*, 243–257.

Dorman, J. P. (2003). Cross-national validation of the What Is Happening In this Class? (WIHIC) questionnaire using confirmatory factor analysis. *Learning Environments Research*, *6*, 231–245.

Dorman, J. P. (2008). Use of multitrait-multimethod modelling to validate actual and preferred forms of the What Is Happening In this Class? (WIHIC) questionnaire. *Learning Environments Research*, *11*, 179–193.

Dorman, J. P., & Adams, J. (2004). Associations between students' perceptions of classroom environment and academic efficacy in Australian and British secondary schools. *International Journal of Research and Method in Education*, *27*, 69–85.

Dorman, J. P., Fisher, D. L., & Waldrip, B. G. (2006). Learning environments, attitudes, efficacy and perceptions of assessment: A LISREL analysis. In D. L. Fisher & M. S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 1–28). Singapore: World Scientific.

Dorman, J. P., & Fraser, B. J. (2009). Psychosocial environment and affective outcome in technology-rich classrooms: Testing a causal model. *School Psychology of Education, 12*, 77–99.

Duckworth, A. L., & Seligman, M. E. P. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of Educational Psychology, 98*, 198–201.

Duncan, T. G., & McKeachie, W. J. (2005). The making of the Motivated Strategies for Learning Questionnaire. *Educational Psychologist, 40*, 117–128.

Dunning, D., Health, C., & Suls, J. M. (2004). Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science in the Public Interest, 5,* 69–106.

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology, 98*, 382–393.

Dweck, C. S. (1986). Motivational process affecting learning. *American Psychologist, 41,* 1040–1048.

Dweck, C. S., & Leggett, E. L. (1988). A social–cognitive approach to motivation and personality. *Psychological Review, 95*, 256−273.

Dykman, B. M. (1998). Integrating cognitive and motivational factors in depression: Initial tests of a goal orientation approach. *Journal of Personality and Social Psychology, 74,* 139–158.

Eccles, J. S. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75–146). San Francisco: Freeman.

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly, 11*, 135–172.

Eccles, J. S. (1993). School and family effects on the ontogeny of children's interests, self-perceptions, and activity choice. In J. Jacobs (Ed.), *Nebraska symposium on motivation, 1992: Developmental perspectives on motivation* (pp. 145–208). Lincoln, NB: University of Nebraska Press.

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York: Guilford.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco, CA: W. H. Freeman.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the achiever: The structure of adolescents' academic achievement related beliefs and self-perceptions. *Personality and Social Psychology Bulletin, 21*, 215–225.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109–132.

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self and task perceptions during elementary school. *Child Development, 64*, 830–847.

Eisenberg, N., Martin, C. L., & Fabes, R. A. (1996). Gender development and gender effects. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 358–396). New York: Simon & Schuster Macmillan.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34*, 169–189.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology, 54,* 5–12.

Elliot, A. J., & McGregor, H. (1999). Test anxiety and the hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 76*, 628–644.

Elliot, A. J., McGregor, H., & Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology, 91*, 549–563.

Elliot, A. J., & Murayama, K. (2008). On the measurement of achievement goals: Critique, illustration, and application, *Journal of Educational Psychology, 100,* 613–628.

Falk, R. F., & Miller, N. B. (1992). *A primer for soft modelling*. Akron, OH: University of Akron Press.

Field, A. (2009). *Discovering statistics using SPSS*. London: SAGE Publications Ltd.

Fisher, D. L., & Fraser, B. J. (1983). A comparison of actual and preferred classroom environment as perceived by science teachers and students. *Journal of Research in Science Teaching, 20*, 55–61.

Fisher, D. L., Harrison, A., Hofstein, A., & Henderson, D. (1998). Laboratory learning environments and practical tasks in senior secondary science classes. *Research in Science Education, 28*, 353–363.

Fisher, D. L., Rickards, T., & Fraser, B. (1996). Assessing teacher-student interpersonal relationships in science classes. *Australian Science Teachers Journal*, *42*, 28–33.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*, 39–50.

Fraser, B. J. (1979). *Test of enquiry skills handbook.* Hawthorn, Australia: The Australian Council for Educational Research Limited.

Fraser, B. J. (1990). *Individualised Classroom Environment Questionnaire: Handbook and test master set*. Hawthorn, Australia: The Australian Council for Educational Research.

Fraser, B. J. (1991). Two decades of classroom environment research. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences* (pp. 3 –27). Oxford: Pergamon Press.

Fraser, B. J. (1998). Science learning environments: Assessment, effects and determinants. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education* (pp. 527–564). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Fraser, B. J. (1999). ‘Grain sizes’ in learning environment research: Combining qualitative and quantitative methods. In H. C. Waxman & H. J. Walberg (Eds), *New directions for teaching practice and research* (pp. 285–296). Berkeley, CA: McCutchan.

Fraser, B. J. (2001). Twenty thousand hours: Editors introduction. *Learning Environments Research*, *4*, 1–5.

Fraser, B. J. (2007). Classroom learning environments. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 103–124). Mahwah, NJ: Lawrence Erlbaum Associates.

Fraser, B. J. (in press). Classroom learning environments: Retrospect, context and prospect. In B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds.), *The second international handbook of science education*. New York: Springer.

Fraser, B. J., Aldridge, J. M., & Adolphe, F. S. G. (2010). A cross-national study of secondary science classroom environments in Australia and Indonesia. *Research in Science Education, 40,* 551–571.

Fraser, B. J., Aldridge, J. M., & Soerjaningsih, W. (2010). Instructor-student interpersonal interaction and student outcomes at the university level in Indonesia. *The Open Education Journal, 3*, 32–44.

Fraser, B. J., Anderson, G. J., & Walberg, H. J. (1982). *Assessment of learning environments: Manual for Learning Environment Inventory (LEI) and My Class Inventory (MCI)* (3rd version). Perth: Western Australian Institute of Technology.

Fraser, B. J., & Butts, W. L. (1982). Relationship between perceived levels of classroom individualization and science-related attitudes. *Journal of Research in Science Teaching*, *19*, 143–154.

Fraser, B. J., & Chionh, Y. H. (2000, April). *Classroom environment, self-esteem, achievement, and attitudes in geography and mathematics in Singapore.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Fraser, B. J., Giddings, G. J., & McRobbie, C. J. (1995). Evolution and validation of a personal form of an instrument for assessing science laboratory classroom environments. *Journal of Research in Science Teaching, 32*, 399–422.

Fraser, B. J., & Lee, S. S. U. (2009). Science laboratory classroom environments in Korean high schools. *Learning Environments Research, 12*, 67–84.

Fraser, B. J., McRobbie, C. J., & Fisher D. L. (1996, April). *Development, validation and use of personal and class forms of a new classroom environment instrument.* Paper presented at the annual meeting of the American Educational Research Association, New York.

Fraser, B. J., Pearse, R., & Azmi. (1982). A study of Indonesian students' perceptions of classroom psychosocial environment. *International Review of Education, 28,* 337–355

Fraser, B. J., & Treagust, D. F. (1986). Validity and use of an instrument for assessing classroom psychological environment in higher education. *Higher Education, 15*, 37–57.

Fryer, J. W., & Elliot, A. J. (2008). Self regulation of achievement goal pursuit. In D. H. Schunk & B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research, and applications* (pp. 53–76). New York: Lawrence Erlbaum Associates.

Gabler, C. T., & Fraser, B. J. (2007, April). *Sustained, job embedded professional development and the learning environment of middle-school mathematics classrooms.* Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Gefen, D., Straub, D., & Boudreau, M. (2000). Structural Equation Modeling techniques and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, *7,* 1–78.

Gefen, D., & Straub, D. (2005). A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example. *Communications of the Association for Information Systems, 16,* 91–109.

Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2007). Nonscience majors learning science: A theoretical model of motivation. *Journal of Research in Science Teaching, 44*, 1088–1107.

Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. *Journal of Research in Science Teaching, 46*, 127–146.

Greene, B. A., DeBacker, T. K., Ravindran, B., & Krows, A. J. (1999). Goals, values, and beliefs as predictors of achievement and effort in high school mathematics classes. *Sex roles: A Journal of Research, 40*, 421–458.

Greene, B. A., Miller, R. B., Crowson, H. M., Duke, B. L., & Akey, K. L. (2004). Predicting high school students' cognitive engagement and achievement: Contributions of classroom perceptions and motivation. *Contemporary Educational Psychology, 2*, 462–482.

Guba, E. G. (1990). The alternative paradigm dialog. In. E. G. Guba (Ed.), *The Paradigm Dialog* (pp. 17-30). Newbury Park, CA: Sage.

Guthrie, J., McRae, A., & Klauda, S. (2007). Contributions of concept-oriented reading instruction to knowledge about interventions for motivations in reading. *Educational Psychologist, 42*, 237–250.

Gwilliam, L. R., & Betz, N. E. (2001). Validity measures of math- and science-related self-efficacy for African Americans and European Americans. *Journal of Career Assessment, 9*, 261–281.

Haertel, G. D., Walberg, H. J., & Haertel, E. H. (1981). Socio psychological environments and learning: A quantitative synthesis. *British Educational Research Journal, 7*, 27–36.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*, 139–151.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains. *American Psychologist*, *53*, 449–455.

Hanlon, D. (2001). *Vision and support in new venture start-ups: Frontiers for Entrepreneurship Research.* Retrieved on 28th January, 2011, from http://www.babson.edu/entrep-/fer-/babson-2001/XI/-XIB/XIB/xi-b.htm.

Hanrahan, M. (2002, July). *Learning science: Revisiting humanist dimensions of intellectual engagement.* Paper presented at the annual meeting of the Australasian Science Education Research Association, Townsville, Australia.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., Carter, S. M., & Elliot, A. J. (2000). Short-term and long-term consequences of achievement goals in college: Predicting continued interest and performance over time. *Journal of Educational Psychology, 92*, 316–330.

Harrington, R. A., & Enochs, L. G. (2009). Accounting for preservice teachers' constructivist learning environment experiences. *Learning Environments Research*, *12*, 45–65.

Hatcher, L. (1994). *A step-by-step approach to using the SAS system for factor analysis and structural equation modeling.* Cary, NC: SAS Institute Press.

Haworth, C. M. A, Dale, P. S, & Plomin, R. (2010). Sex differences in school science performance from middle childhood to early adolescence. *International Journal of Educational Research, 49,* 92–101.

Helding, K. A., & Fraser, B. J. (in press). Effectiveness of NBC (National Board Certified) teachers in terms of learning environment, attitudes and achievement among secondary students. *Learning Environments Research.*

Henderson, D., & Fisher, D. (1998). Assessing learning environments senior science laboratories. *Australian Science Teachers' Journal, 1*, 57–62.

Henderson, D., Fisher, D. & Fraser, B. J. (2000). Interpersonal behaviour, learning environments and student outcomes in senior biology classes. *Journal of Research in Science Teaching, 37*, 26–43.

Hensler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of Partial Least Square path modeling in international marketing. *Advances in International Marketing, 20*, 277–319.

Hesse. M. (1980). *Revolutions and reconstructions in the philosophy of science.* Brighton: Harvester Press.

Hessler, R. M. (1992). *Social research methods.* New York: West Publishing Company.

Higgins, E. T. (2007). Value. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (pp. 454–472). New York: Guilford Press.

Hijzen, D., Boekaerts, M., & Vedder, P. (2007). Exploring the links between students' engagement in cooperative learning, their goal preferences and appraisals of instructional conditions in the classroom. *Learning and Instruction, 17*, 673–687.

Hill, J., & Lynch, M. (1983). The intensification of gender-related role expectations during early adolescence. In J. Brooks-Gunn & A. Petersen (Eds.), *Girls at puberty: Biological and psychosocial perspectives* (pp. 201–228). New York: Plenum.

Hirata, S., & Sako, T. (1998). Perceptions of school environment among Japanese junior high school, non-attendant, and juvenile delinquent students. *Learning Environment Research, 1*, 321–331.

Hofstein, A., Gluzman, R., Ben Zvi, R., & Samuel, D. (1979). Classroom learning environment and student attitudes towards chemistry. *Studies in Educational Evaluation, 5*, 231–236.

Hsu, S., Chen, W., & Hsieh, M. (2006). Robustness testing of PLS, LISREL, EQS and ANN-based SEM for measuring customer satisfaction. *Total Quality Management & Business Excellence, 17*, 355–371.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal, 20,* 195–204.

Humphrey, L. L. (1984). Children's self-control in relation to perceived social environment. *Journal of Personality and Social Psychology, 46,* 178–188.

Igbaria, M., Zinatelli, N., Cragg, P., & Cavaye, A. L. (1997). Personal computing acceptance factors in small firms: A structural equation model. *MIS Quarterly 21*, 279–302.

Ivie, R., Czujko, R., & Stowe, K. (2002). Women physicists speak: The 2001 international study of women in physics. In B. K. Artline & D. Li (Eds.), *Women in physics: The IUPAP international conference on women in physics* (pp. 49–70). Melvile, NY: American Institute of Physics.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509–527.

Johnson, D. W., Johnson, R. T., & Smith, K. (2007). The state of cooperative learning in postsecondary and professional settings. *Educational Psychology Review, 19*, 15–29.

Johnson, B., & Stevens, J. J. (2001). Exploratory and confirmatory factor analysis of the School-Level Environment Questionnaire (SLEQ). *Learning Environments Research, 4*, 111–122.

Joiner, K. F., Malone, J. A., & Haimes, D. H. (2002). Assessment of classroom environments in reformed calculus education. *Learning Environments Research*, *5*, 51–76.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*, 141–151.

Kaplan, A. (2004). Achievement goals and intergroup relations. In P. R. Pintrich & M. L. Maehr (Eds.), *Advances in research on motivation and achievement Vol. 13: Motivating students, improving schools: The legacy of Carol Midgley* (pp. 97– 136). United Kingdom: Elsevier.

Kaplan, A., Lichtinger, E., & Gorodetsky, M. (2009). Achievement goal orientations and self-regulation in writing: An integrative perspective. *Journal of Educational Psychology*, *101,* 51–69.

Kaplan, A., & Maehr, M. (1999). Achievement goals and student well-being. *Contemporary Educational Psychology*, *24*, 330–358.

Kaplan, A., & Maehr, M. L. (2007). The contribution and prospects of goal orientation theory. *Educational Psychology Review, 19,* 141–187.

Kaplan, A., & Midgley, C. (1997). The effect of achievement goals: Does level of perceived academic competence make a difference? *Contemporary Educational Psychology, 22*, 415– 435.

Kaplan, A., & Midgley, C. (1999). The relationship between perceptions of the classroom goal structure and early adolescents' affect in school: The mediating role of coping strategies. *Learning and Individual Differences, 11*, 187–212.

Keyser, V., & Barling, J. (1981). Determinant of children’s self-efficacy beliefs in an academic environment. *Cognitive Therapy and Research, 5*, 29–40.

Khine, M. S., & Fisher, D. L. (2002, April). *Analysing interpersonal behavior in science classrooms: Association between students’ perceptions and teachers’ cultural background*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, New Orleans, LA.

Khishfe, R, & Fouad, A. (2002). Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science. *Journal of Research in Science Teaching, 39*, 551–578.

Khoo, H. S., & Fraser, B. J. (2008). Using classroom psychosocial environment in the evaluation of adult computer application courses in Singapore. *Technology, Pedagogy and Education, 17*, 67–81.

Killen, R. (2000). *Outcomes-based education: Principles and possibilities.* Retrieved on 17th May, 2012, from http://freedownload.is/pdf/outcomes-based-education-principles-and-possibilities-8251012.html.

Kim, H., Fisher, D. L., & Fraser, B. J. (2000). Environment and teacher interpersonal behaviour in secondary science classes in Korea. *Evaluation Research in Education, 14*, 3–22.

Kokkinos, C. M., Charalambous, K., & Davazoglou, A. (2009). Interpersonal teacher behavior in primary school classrooms: A cross-cultural validation of the Greek adaptation of the Questionnaire on Teacher Interaction (G-QTIP). *Learning Environments Research, 12*, 101–114.

Koul, R. B., & Fisher, D. L. (2005). Cultural background and students’ perception of science classroom learning environment and teacher interpersonal behaviour in Jammu, India. *Learning Environments Research, 8*, 195–211.

Kuhn, D. (1999). A developmental model of critical thinking. *Educational Researcher*, *28*, 16–26.

Kupermintz, H. (2002). Affective and cognitive factors as aptitude resources in high school science achievement. *Educational Assessment, 8,* 123–137.

Kuyper, H., van der Werf, M. P. C., & Lubbers, M. J. (2000). Motivation, meta-cognition and self-regulation as predictors of long term educational attainment. *Educational Research and Evaluation*, *6*, 181–201.

Lau, S., & Roeser, R. W. (2002). Cognitive abilities and motivational processes in high school students' situational engagement and achievement in science. *Educational Assessment, 8,* 139–162.

Lawrenz, F. (1976). The prediction of student attitude towards science from student perception of the classroom learning environment. *Journal of Research in Science Teaching, 13,* 509–515.

Leary, T. (1957). *An interpersonal diagnosis of personality*. New York: Ronald-Press Company.

Lee, O., & Anderson, C. W. (1993). Task engagement and conceptual change in middle school science classrooms. *American Educational Research Journal, 30,* 585–610.

Lee, O., & Brophy, J. (1996). Motivational patterns observed in sixth-grade science classrooms. *Journal of Research in Science Teaching*, *33,* 585–610.

Lee, S. U., Fraser, B. J., & Fisher, D. L. (2003). Teacher-student interactions in Korean high school science classrooms. *International Journal of Science and Mathematics Education, 1*, 67–85.

Lee, M., Johanson, R. E., & Tsai, C. (2008). Exploring Taiwanese high school students' conceptions of and approaches to learning science through a structural equation modeling analysis. *Science Education, 92,* 191–220.

Lent, R. W., Brown, S. D., & Gore, P. A., Jr. (1997). Discriminant and predictive validity of academic self-concept, academic self-efficacy, and mathematics-specific self-efficacy. *Journal of Counseling Psychology, 44,* 307–315.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology, 31*, 356–362.

Lewin, K. (1936). *Principles of topological psychology*. New York: McGraw.

Levy, I., Kaplan, A., & Patrick, H. (2004). Early adolescents' achievement goals, social status, and attitudes towards cooperation with peers. *Social Psychology of Education, 7*, 127–159.

Lightburn, M. E., & Fraser, B. J. (2007). Classroom environment and student outcomes among students using anthropometry activities in high school science. *Research in Science and Technological Education, 25*, 153–166.

Lorsbach, A. W., & Jinks, J. L. (1999). Self-efficacy theory and learning environment research. *Learning Environments Research, 2*, 157–167.

Lyman, R. D., Prentice-Dunn, S. Wilson, D. R., & Bonfilio, S. A. (1984). The effect of success or failure on self-efficacy and task persistence of conduct-disordered children. *Psychology in the Schools, 21*, 516–519.

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli, E. A., Jr. (1999). Effects of self-efficacy-enhancing interventions on the mathematics/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology, 46,* 233–243.

Margianti, E. S., Fraser, B. J., & Aldridge, J. M. (2001, April). *Classroom environment and students' outcomes among university computing students in Indonesia.* Paper presented at the annual meeting of the American Educational Research Association, Seattle.

Marsh, H. W., Köller, O., Trautwein, U., Lüdtke, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*, 397–416.

Martin, A. J. (2004). School motivation of boys and girls: Differences of degree, differences of kind, or both? *Journal of Psychology, 56*, 133–146.

Martin, A. J. (2007). Examining a multidimensional model of student motivation and engagement using a construct validation approach. *British Journal of Educational Psychology, 77*, 413–440.

Martin-Dunlop, C., & Fraser, B. J. (2008). Learning environment and attitudes associated with an innovative course designed for prospective elementary teachers. *International Journal of Science and Mathematics Education, 6,* 163–190.

MacLeod, C., & Fraser, B. J. (2010). Development, validation and application of a modified Arabic translation of the What Is Happening In this Class? (WIHIC) questionnaire. *Learning Environments Research, 13*, 105–125.

McRobbie, C., & Fraser, B. (1993). Associations between student outcomes and psychosocial science environment. *The Journal of Educational Research, 87*, 78–85.

Meece, J. L. (1991). The classroom context and students' motivational goals. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement*, vol. 7 (pp. 261–285). Greenwich, Connecticut: JAI.

Meece, J. L., Anderman E. M., & Anderman L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *Annual Review of Psychology, 57*, 487–503.

Meece, J. L., & Eccles, J. (1993). Introduction: Recent trends in research on gender and education. *Educational Psychologist, 28*, 313–319.

Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology, 44*, 351–373.

Meece, J. L., & Jones, M. G. (1996). Gender differences in motivation and strategy use in science: Are girls rote learners? *Journal of Research in Science Teaching, 33*, 393–404.

Meece, J. L., & Painter, J. (2008). The motivational roles of cultural differences and cultural identity in self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research, and applications* (pp. 339–367). Mahwah, NJ: Erlbaum.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its consequences for young adolescents' course enrolment intentions and performances in mathematics. *Journal of Educational Psychology*, *82*, 60–70.

Middleton, M. J., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology, 89*, 710–718.

Middleton, M. J., & Midgley, C. (2002). Beyond motivation: Middle school students' perceptions of press for understanding in math. *Contemporary Educational Psychology, 27*, 373–391.

Midgley, C. (2002). *Goals, goal structures, and patterns of adaptive learning.* Mahwah, NJ: Lawrence Erlbaum.

Midgley, C., & Edelin, K. C. (1998). Middle school reform and early adolescent well-being: The good news and the bad. *Educational Psychologist, 33*, 195–206.

Midgley, C., Kaplan, A., & Middleton M. J. (2001). Performance-approach goals: Good for what, for whom, under what circumstances, and at what cost? *Journal of Educational Psychology, 93*, 77–86.

Midgley, C., Maehr, M. L., Hicks, L., Roeser, R., Urdan, T., Anderman, E., & Kaplan, A. (1996). *The Patterns of Adaptive Learning Survey (PALS).* Ann Arbor, MI: The University of Michigan.

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction-what is it and does it matter?: Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching, 47*, 474–496.

Moos, R. H. (1974). *Evaluating educational environments: Procedures, measures, findings, and policy implications.* San Francisco, CA: Jossey-Bass.

Moos, R. H. (1979). *Evaluating educational environments: Procedures, measures, findings and policy implications.* San Francisco: Jossey-Bass.

Moos, R. H., & Houts, P. S. (1968). The assessment of the social atmospheres of psychiatric wards. *Journal of Abnormal Psychology, 73*, 595–604.

Moos, R. H., & Moos, B. S. (1978). Classroom social climate and student absences and grades. *Journal of Educational Psychology, 70*, 263–269.

Moos, R. H., & Trickett, E. (1974). *Classroom Environment Scale manual.* Palo Alto: Consulting Psychology Press.

Moos, R. H., & Trickett, E. (1987). *Classroom Environment Scale manual* (2nd Ed.). Palo Alto: Consulting Psychology Press.

Morris, T. L., Lee, S., & Barnes, L. L. B. (2008). The development and use of an instrument to measure willingness to seek help from peers and teachers when studying college mathematics. *Learning Environments Research, 11*, 227–243.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 18*, 30–38.

Munby, H. (1997). Issues of validity in science attitude measurement. *Journal of Research in Science Teaching, 34*, 337–341.

Murray, H. A. (1938). *Explorations in personality*. New York: Oxford University Publishing.

Nair, C. S., & Fisher, D. (2000). Transition from senior secondary to higher education: A learning environment perspective. *Research in Science Education, 30,* 435–450.

Napier, J. D., & Riley, J. (1985). Relationship between affective determinants and achievement in science for seventeen-year olds. *Journal of Research in Science Teaching*, *22*, 365–383.

Nevgi, A. (2002). Measurement of learning strategies: Creating a self-rating tool for students of virtual university. In H. Niemi & P. Ruohotie (Eds.), *Theoretical understandings for learning in the virtual university* (pp. 197–220). Hämeenlinna: Research Centre for Vocational Education and Training.

Newman, R. S. (1998). Students' help seeking during problem solving: Influences of personal and contextual achievement goals. *Journal of Educational Psychology, 90,* 644–658.

Niemi, H., Nevgi, A., & Virtanen, P. (2003). Towards self-regulation in web-based learning. *Journal of Educational Media, 28,* 49–71.

Nix, R. K., & Fraser, B. J. (in press). Using computer-assisted teaching to promote constructivist practices in teacher education. In F. Columbus (ed.), *Computer-assisted teaching: New developments*. New York: Nova Science Publisher.

Nix, R .K., Fraser, B. J., & Ledbetter, C. E. (2005). Evaluating an integrated science learning environment using the Constructivist Learning Environment Survey. *Learning Environments Research, 8*, 109–133.

Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill.

Ogbuehi, P. I., & Fraser, B. J. (2007). Learning environment, attitudes and conceptual development associated with innovative strategies in middle-school mathematics. *Learning Environments Research, 10*, 101–114.

Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. London: The Nuffield Foundation.

Ozkal, K., Tekkaya, C., Cakiroglu, J., & Sungur, S. (2009). A conceptual model of relationships among constructivist learning environment perceptions, epistemological beliefs, and learning approaches. *Learning and Individual Differences*, *19*, 71–79.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*, 543– 578.

Pajares, F. (1997). Current directions in self-efficacy research. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (pp. 1–49). Greenwich, CT: JAI Press.

Pajares, F. (2001). Toward a positive psychology of academic motivation. *Journal of Educational Research*, *95*, 27–35.

Pajares, F. (2002). Gender and perceived self-efficacy in self-regulated learning. *Theory into Practice*, *41*, 116–125.

Pajares, F. (2006). Self-efficacy during childhood and adolescence: Implications for teachers and parents. In F. Pajares & T. Urdan (Eds.), *Adolescence and education: Self-efficacy beliefs of adolescents* (pp. 339–367). Greenwich, CT: Information Age Publishing.

Pajares, F. (2008). Motivational role of self-efficacy beliefs in self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research, and applications* (pp. 111–139). New York: Lawrence Erlbaum Associates.

Pajares, F., Britner, S. L., & Valiante, G. (2000). Relation between achievement goals and self beliefs of middle school students in writing and science. *Contemporary Educational Psychology*, *25*, 406–422.

Pajares, F., & Schunk, D.H. (2001). Self-beliefs and school success: Self-efficiency, self-concept, and school achievement. In R. Riding & S. Rayner (Eds.), *Perception* (pp. 239–266). London: Ablex.

Pajares, F., & Valiante, G. (1997). Influence of self-efficacy on elementary students' writing. *Journal of Educational Research*, *90*, 353–360.

Pajares, F., & Valiante, G. (2001). Gender differences in writing motivation and achievement of middle school students: A function of gender orientation? *Contemporary Educational Psychology*, *26,* 366–381.

Palmer, D. H. (2009). Student interest generated during an inquiry skills lesson. *Journal of Research in Science Teaching*, *46*, 147–165.

Pekrun, R. (1993). Facets of adolescents' academic motivation: A longitudinal expectancy-value approach. In P. Pintrich & M. L. Maehr (Eds.), *Advances in motivation and achievement* (pp. 139–189). Greenwich, CT: JAI.

Pekrun, R. (2009). Emotions at school. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation in school* (pp. 575–604). New York: Taylor Francis.

Perels, F., Gurtler, T., & Schmitz, B. (2005). Training of self-regulatory and problem-solving competence. *Learning and Instruction, 15*, 123–139.

Perry, N. E. (2002). Using qualitative methods to enrich understandings of self-regulated learning. *Educational Psychologist, 37*, 1–3.

Pickett, L., & Fraser, B. J. (2009). Evaluation of a mentoring program for beginning teachers in terms of the learning environment and student outcomes in participants' school classrooms. In A. Selkirk & M. Tichenor (Eds.), *Teacher education: Policy, practice and research* (pp. 1–51). New York: Nova Science Publishers.

Piero, M. M., & Fraser, B. J. (2009). Assessment and investigation of science learning environments in the early childhood grades. In M. Ortiz & C. Rubio (Eds), *Educational evaluation: 21st century issues and challenges* (pp. 349–365). New York: Nova Science Publishers.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451–502). San Diego, CA: Academic.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95,* 667–686.

Pintrich, P. R., & De Groot E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*, 33–40.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, *63*, 167–199.

Pintrich, P. R., & Schrauben, B. (1992). Students’ motivational beliefs and their cognitive engagement in classroom tasks. In D. Schunk & J. Meece (Eds.), *Student perceptions in the classroom: Causes and consequences* (pp. 149–183). Hillsdale, NJ: Lawrence Erlbaum Associates.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801–813.

Pintrich, P. R., & Zusho, A. (2007). Student motivation and self-regulated learning in the college classroom. In R. Perry & J. C. Smart (eds.), *The scholarship of teaching and learning in higher education: An evidence-based perspective* (pp. 731–810). Dordrecht: Springer.

Power C. N., & Tisher, R. P. (1979). A self-paced environment. In H. J. Walberg (Ed.), *Educational environments and effects: Evaluation, policy and productivity* (pp. 200–217). Berkeley: McCutchen Publishing Corporation.

Programme for International Student Assessment (2009). *Equally prepared for life?: How 15 year-old boys and girls perform in school.* Paris: OECD Publishing.

Quek, C. L., Wong, A. F. L., & Fraser, B. J. (2005). Student Perceptions of Chemistry Laboratory Learning Environments, Student–Teacher Interactions and Attitudes in Secondary School Gifted Education Classes in Singapore. *Research in Science Education, 35*, 299–321.

Reeve, J. M., & Jang, H. (2006). What teachers say and do to support students' autonomy during a learning activity. *Journal of Educational Psychology, 98*, 209−218.

Renninger, K. A., & Hidi, S. (2011): Revisiting the conceptualization, measurement, and generation of Interest. *Educational Psychologist, 46*, 168–184

Rentoul, A. J., & Fraser, B. J. (1979). Conceptualization of enquiry-based or open classrooms learning environments. *Journal of Curriculum Studies, 11*, 233–245.

Rickards, T., den Brok, P., & Fisher. D. (2005). The Australian science teacher: Typology of teacher-student interpersonal behaviour in Australian science classes. *Learning Environments Research, 8*, 267–287.

Robinson, E., & Fraser, B. J. (in press). Kindergarten students' and parents, perceptions of science classroom environments: Achievement and attitudes. *Learning Environments Research*.

Roeser, R. W., Midgley, C., & Urdan, T. C. (1996). Perceptions of the school psychological environment and early adolescents' psychological and behavioral functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology, 88*, 408–422.

Rutter, M., Maughan, B., Mortimore, P., Ouston, J., & Smith, A. (1979). *Fifteen thousand hours: Secondary schools and their effects on children*. Cambridge, MA: Harvard University Press.

Ryan, A. M., Gheen, M. H., & Midgley, C. (1998). Why do some students avoid asking for help?: An examination of the interplay among students' academic efficacy, teachers' social-emotional role, and the classroom goal structure. *Journal of Educational Psychology, 90*, 528–535.

Ryan A. M., & Patrick, H. (2001). The classroom social environment and changes in adolescents' motivation and engagement during middle school. *American Educational Research Journal, 38*, 437–460.

Santosa, P. I., Wei, K. K., & Chan, H. C. (2005). User involvement and user satisfaction with information-seeking activity. *European Journal of Information Systems, 14*, 361–370.

Saunders, K. J., & Fisher, D. L. (2006). An action research approach with primary pre-service teachers to improve university and primary school classroom environments. In D. L. Fisher & M. S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 247–272). Singapore: World Scientific.

Schraw, G., Cripen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*, 111–139.

Schriesheim, C. A., Eisenbach, R. J., & Hill, K. D. (1991). The effect of negation and polar opposite item reversals on questionnaire reliability and validity: An experimental investigation. *Educational and Psychological Measurement, 51,* 67–78.

Schriesheim, C. A., & Hill, K. D. (1981). Controlling acquiescence response bias by item reversals: The effect on questionnaire validity. *Educational and Psychological Measurement, 41,* 1101–1114.

Schunk, D. H. (1989). Self-efficacy and cognitive skill learning. In C. Ames & R. Ames (Eds.), *Research on motivation in education: Goals and cognitions* (pp. 13–44). San Diego, CA: Academic.

Schunk, D. H. (2004). *Learning theories: An educational perspective.* Upper Saddle River, NJ: Pearson Prentice Hall.

Schunk, D. H. (2005). Commentary on self-regulation in school contexts. *Learning and Instruction, 15*, 173–177.

Schunk, D. H., & Ertmer, P. A. (2000). Self-regulation and academic learning: Self-efficacy enhancing interventions. In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 631–649). San Diego, CA: Academic Press.

Schunk, D. H., & Hanson, A. R. (1985). Peer models: Influence on children's self-efficacy and achievement. *Journal of Educational Psychology, 77*, 313–322.

Schunk, D. H., & Miller, S. D. (2002). Self-efficacy and adolescents' motivation. In F. Pajares & T. Urdan (Eds.), *Academic motivation of adolescents* (pp. 29–52). Greenwich, CT: Information Age.

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 16–31). New York: Academic Press.

Schunk, D. H., & Pajares, F. (2005). Competence beliefs in academic functioning. In A. J. Elliot & C. Dweck (Eds.), *Handbook of competence and motivation* (pp. 85–104). New York: Guilford Press.

Schunk, D. H., Pintrich, P. R., & Meece, J. L. (2008*). Motivation in education* (3rd ed.). Upper Saddle River, NJ: Pearson.

Schunk, D. H., & Zimmerman, B. J. (2007). Influencing children's self-efficacy and self-regulation of reading and writing through modeling. *Reading & Writing Quarterly*, *23*, 7–25.

Schunk, D. H., & Zimmerman, B. J. (2008). Motivation: An essential dimension of self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), *Motivation and self-regulated learning: Theory, research, and applications* (pp. 1–30). New York: Lawrence Erlbaum Associates.

Seifert, T. L. (2004). Understanding student motivation. *Educational Research*, *46*, 137–149.

Shaughnessy, M. F. (2004). An interview with Anita Woolfolk: The educational psychology of teacher efficacy. *Educational Psychology Review*, *16*, 153–176.

She, H. C., & Fisher, D. L. (2000). The development of a questionnaire to describe science teacher communication behavior in Taiwan and Australia. *Science Education, 84,* 706–726.

Shell, D. F., Colvin, C., & Bruning, R. H. (1995). Self-efficacy, attribution, and outcome expectancy mechanisms in reading and writing achievement: Grade-level and achievement-level differences. *Journal of Educational Psychology, 87*, 386–398.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42,* 70–83.

Sjøberg, S., & Schreiner, C. (2010). *The ROSE project: An overview and key findings*. Oslo: University of Oslo.

Spady, W. (1994). *Outcome-based education: Critical issues and answers*. Arlington, VA: American Association of School Administrators.

Stajkovic, A.D., & Sommer, S.M. (2000). Self-efficacy and causal attributions: Direct and reciprocal links. *Journal of Applied Social Psychology, 30*, 707–737.

Stern, G. G., Stein, M. I, & Bloom, B. S. (1956). *Methods in personality assessment*. Glencoe, IL: Free Press.

Stipek, D., Givvin, K., Salmon, J., & MacGyvers, V. (1998). Can a teacher intervention improve classroom practices and student motivation in mathematics? *Journal of Experimental Education, 66*, 319–337.

Sungur, S. (2007). Modeling the relationships among students’ motivational beliefs, metacognitive strategy use, and effort regulation. *Scandinavian Journal of Educational Research, 51,* 315–326.

Taboada, A., Tonks, S., Wigfield, A., & Guthrie, J. (2009). Effects of motivational and cognitive variables on reading comprehension. *Reading and Writing, 22*, 85–106.

Tan, I. G. C., Sharan, S., & Lee, C. K. E. (2007). Group investigation effects on achievement, motivation, and perceptions of students in Singapore. *Journal of Educational Research, 100*, 142–154.

Taylor, P. C., & Campbell-Williams, M. (1993). Discourse toward balanced rationality in the high school mathematics classroom: Ideas from Habermas's critical theory. In J. A. Malone, & P. C. S. Taylor (Eds.), *Constructivist interpretations of teaching and learning mathematics* (Proceeding of Topic Group 10 at the Seventh International Congress on Mathematical Education; pp. 135–148). Perth, Western Australia: Curtin University of Technology.

Taylor, P. C., Fraser, B. J., & Fisher, D. L. (1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research, 27*, 293–302.

Telli, S., Cakiroglu, J., & den Brok, P. (2006). Turkish secondary education students' perceptions of their classroom learning environment and their attitude towards biology. In D. L. Fisher & M. S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 517–542). Singapore: World Scientific.

Telli, S., den Brok, P., & Cakiroglu, J. (2010). The importance of teacher-student interpersonal relationships for Turkish students' attitudes towards science. *Research in Science & Technological Education, 28*, 261–276.

Theobald, M. A. (2006). *Increasing student motivation: Strategies for middle and high school teachers.* Thousand Oaks, CA: Corwin.

Thomson, S. Wernet, N., Underwood, C., & Nicholas, M. (2008). *Highlights from TIMMS 2007 from Australia's perspective: Highlights from the full report, taking a closer look at mathematics and science in Australia*. Retrieved on 27th December, 2010, from http://research.acer.edu.au/timss_2007/1/.

Tobin, K., & Fraser, B. J. (1998). Qualitative and quantitative landscapes of classroom learning environments. In B. J. Fraser & K. G. Tobin, *The international handbook of science education* (pp. 623–640). Dordrecht: Kluwer Academic.

Toth, E. E., Suthers, D. D., & Lesgold, A. M. (2002). The effects of representational guidance and reflective assessment on scientific inquiry. *Science Education, 86*, 264–286.

Treagust, D. F. (1991). A case study of two exemplary biology teachers. *Journal of Research in Science Teaching, 28*, 329–342.

Trickett, E. J., & Moos, R. H. (1973). Social environment of junior high and high school classrooms. *Journal of Educational Psychology, 65*, 93–102.

Trochim, W. M., & Donnelly, J. P. (2006). *The research methods knowledge base* (3rd ed.). Cincinnati, OH: Atomic Dog.

Tuan, H., Chin, C., & Shieh, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*, 639–654.

Turner, J. C., Midgley, C., Meyer, D. K., Gheen, M., Anderman, E. M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. *Journal of Educational Psychology, 94*, 88–106.

Tytler, R. (2007). *Re-imagining science education: Engaging students in science for Australia's future*. Camberwell, Victoria: ACER Press.

Uguroglu, M. E., Schiller, D. P., & Walberg, H. J. (1981). A multidimensional motivational instrument. *Psychology in the Schools, 18*, 279–285.

Urdan, T. C. (1997). Achievement goal theory: Past results, future directions. In M. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (pp. 99–142). Greenwich, CT: JAI Press.

Urdan, T., & Midgley, C. (2003). Changes in the perceived classroom goal structure and pattern of adaptive learning during early adolescence. *Contemporary Educational Psychology, 28*, 524–551.

Urdan, T., Midgley, C., & Anderman, E. (1998). The role of classroom goal structure in students' use of self-handicapping strategies. *American Educational Research Journal, 35*, 101–122.

Urdan, T., & Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships, and competence beliefs. *Journal of School Psychology, 44*, 331–349.

Urdan, T., Ryan, A. M., Anderman, E. M., & Gheen, M. H. (2002). Goals, goal structures, and avoidance behaviors. In C. Midgley (Ed.), *Goals, goal structures and patterns of adaptive learning* (pp. 55–83). Mahwah, New Jersey: Erlbaum.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briére, N. M., Senècal, C., & Valliéres, E. F. (1992). The academic motivation scale: A measure of intrinsic, extrinsic and amotivation in education. *Educational and Psychological Measurement, 52*, 1003–1019.

Van See, E. H. (2000). Analysis of a student-generated discussion. *Journal of Science Education, 22*, 115–142.

VanderStoep, S., Pintrich, P. R., & Fagerlin, A. (1996). Disciplinary differences in self-regulated learning in college students. *Contemporary Educational Psychology*, *21*, 345–362.

Wahyudi, & Treagust, D. F. (2006). Science education in Indonesia: A classroom learning environment perspective. In D. L. Fisher & M. S. Khine (Eds.), *Contemporary approaches to research on learning environments* (pp. 221–246). Singapore: World Scientific.

Walberg, H. J. (1968a). Structural and affective aspects of classroom climate. *Psychology in the Schools, 5*, 247–253.

Walberg, H. J. (1968b). Teacher personality and classroom climate. *Psychology in the Schools*, *5*, 163–169.

Walberg, H. J., & Anderson, G. J., (1968). Classroom climate and group learning. *Journal of Educational Psychology, 59*, 414–419.

Waldrip, B. G., & Fisher, D. L. (2003). Identifying exemplary science teachers through their classroom interactions with students. *Learning Environment Research*, *6*, 157–174.

Walker, C. O., Greene, B. A., & Mansell, R. A. (2006). Identification with academics, intrinsic/extrinsic motivation and self-efficacy as predictors of cognitive engagement. *Learning and Individual Differences, 16,* 1–12.

Watt, H. M. G. (2004). Development of adolescents' self perceptions, values and task perceptions according to gender and domain in 7th through 11th grade Australian students. *Child Development, 75,* 1556–1574.

Watt, H. M. G. (2005). Exploring adolescent motivations for pursuing maths-related careers. *Australian Journal of Educational and Developmental Psychology, 5*, 107–116.

Watt, H. M. G. (2006). The role of motivation in gendered educational and occupational trajectories related to math. *Educational Research and Evaluation, 12*, 305–322.

Watt, H. M. G. (2008a). Gender and occupational outcomes: An introduction. In H. M. G. Watt & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 3–24). Washington, DC: APA books.

Watt, H. M. G. (2008b). A latent growth curve modeling approach using an accelerated longitudinal design: The ontogeny of boys' and girls' talent perceptions and intrinsic values through adolescence, *Educational Research and Evaluation, 14*, 287–304.

Watt, H. M. G. (2010). Gender and occupational choice. In J. C. Chrisler & D. R. McCreary (Eds.), *Handbook of gender research in psychology* (pp. 379–400). New York: Springer.

Weiner, B. (1990). History of motivational research in education. *Journal of Educational Psychology*, *82*, 616–622.

Weinstein, C. E., Schulte, A., & Palmer, D. R. (2002). *The learning and study strategies in inventory* (2nd ed.). Clearwater, FL: H and H Publishing.

Welch, W. W., & Walberg, H. J. (1972). A national experiment in curriculum evaluation. *American Educational Research Journal, 9,* 373–383.

Whitley, B. E. J. (1997). Gender differences in computer-related attitudes and behavior: A meta-analysis. *Computers in Human Behavior, 13*, 1–22.

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*, 49–78.

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review, 30,* 1–35.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12,* 265–310.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of motivation. *Contemporary Educational Psychology, 25,* 68–81.

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs and values from childhood through adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 92–120). San Diego: Academic Press.

Wigfield, A., Eccles, J. S., Mac Iver, D., Reuman, D., & Midgley, C. (1991) Transitions at early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school, *Developmental Psychology, 27,* 552–565.

Wigfield, A., Eccles, J. S., & Pintrich, P. R. (1996). Development between the ages of 11 and 25. In R. C. Calfee & D. C. Berliner (Eds.), *Handbook of educational psychology* (pp. 148–185). New York: Prentice Hall International.

Wigfield, A., Eccles, J. S., & Rodriguez, D. (1998). The development of children's motivation in school contexts. In A. Iran-Nejad & P. D. Pearson (Eds), *Review of research in education* (pp. 73–118). Washington, DC: American Educational Research Association.

Wigfield, A., Guthrie, J., Perencevich, K., Taboada, A., Klauda, S., McRae, A., & Barbosa, P. (2008). Role of reading engagement in mediating effects of reading comprehension instruction on reading outcomes. *Psychology in the Schools, 45,* 432–445.

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy-value theory. In K. R. Wentzel & A. Wigfield (Eds), *Handbook of motivation in school* (pp. 55–76). NewYork: Routledge Taylor Francis Group.

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical theory approaches*. Thousand Oaks, CA: Sage Publications.

Windschitl, M. (2002). Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice? *Science Education, 87*, 112–143.

Wolf, S. J., & Fraser, B. J. (2008). Learning environment, attitudes and achievement among middle school science students using inquiry-based laboratory activities. *Research in Science Education, 38*, 321−341.

Wolters, C. A. (1999). The relation between high school students' motivational regulation and their use of learning strategies, effort, and classroom performance. *Learning and Individual Differences*, *11*, 281–300.

Wolters, C. A. (2010). *Self-regulated learning and the 21st century competencies.* Retrieved on 10th August, 2010, from http://www7.nationalacademies.org /DBASSE/Wolters_Self-_Regulated_Learning_Paper.pdf

Wolters, C. A., & Pintrich, P. R. (1998). Contextual differences in student motivation and self-regulated learning in mathematics, english, and social studies classrooms. *Instructional Science, 26*, 27–47.

Wolters, C. A., & Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *International Journal of Educational Research, 33,* 801–820.

Wolters, C. A., Yu, S. L., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences, 8,* 211–238.

Wubbels, T., & Levy, J. (Eds). (1993). *Do you know what you look like?: Interpersonal relationships in education*. London: Falmer Press.

Xiang, P., McBride, R. E., & Bruene, A. (2004). Fourth graders' motivation in an elementary physical education running program. *Elementary School Journal, 104*, 253–266.

Yarrow, A. Millwater, J., & Fraser, B. (1997). Improving university and primary school classroom environments through preservice teachers' action research. *International Journal of Practical Experiences in Professional Education, 1*, 68–93.

Zandvliet, D. B., & Fraser, B. J. (2004). Learning environments in information and communications technology classrooms. *Technology, Pedagogy and Education, 13*, 97–123.

Zandvliet, D. B., & Fraser, B. J. (2005). Physical and psychosocial environments associated with networked classrooms. *Learning Environments Research, 8,* 1–17.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*, 215–246.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81,* 329–339.

Zimmerman, B. J. (1998). Academic studying and the development of personal skill: A self-regulatory perspective. *Educational Psychologist*, *33,* 73–86.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, *25*, 82–91.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice*, *41*, 64–70.

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal*, *45*, 166–183.

Zimmerman, B. J., & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal*, *31*, 845–862.

Zimmerman, B. J., & Martinez-Ponz. M. (1990). Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*, 51–59.

Appendix 1

Teacher evaluation form

Teacher Evaluation Form

A. Evaluation of items

Please consider the adequacy of the following items for each construct according to the 4-point rating scale shown as below:

1 = inappropriate

2 = needs major alternation

3 = appropriate but needs minor alteration

4 = very appropriate

For items rated "3" or below, please give suggestions for improvement

1. LEARNING GOAL ORIENTATION

Learning goal orientation assesses the degree to which the student perceives him/herself to be participating in a science classroom for the purpose of learning, understanding and mastering science concepts as well as improving science skills.

Items	Rating	Suggestions
In this science class …		
1. One of my goals is to learn new concepts.		
2. One of my goals is to learn as much as I can.		
3. One of my goals is to master new science skills.		
4. It is important that I understand my work.		
5. It is important that I improve my science skills.		
6. It is important for me to learn the science content that is taught.		
7. Understanding science ideas is important to me		
8. It is important that I understand what is being taught to me.		

2. TASK VALUE

Task value assesses the degree to which the student perceives the science learning tasks in terms of interest, importance and utility.

Items	Rating	Suggestions
In this science class …		
9. What I learn can be used in my daily life.		
10. What I learn is interesting.		
11. What I learn is useful for me to know.		
12. What I learn is helpful to me.		
13. What I learn is relevant to me.		
14. What I learn is of practical value.		
15. What I learn satisfies my curiosity.		
16. What I learn encourages me to think.		

3. SELF-EFFICACY

Self-efficacy assesses the degree to which the student is confident and believes in his/her own ability in successfully performing science-learning tasks.

Items	Rating	Suggestions
In this science class …		
17. I can master the skills that are taught.		
18. I can figure out how to do difficult work.		
19. Even if the science work is hard, I can learn it.		
20. I can complete hard work if I try.		
21. I will receive a good grade.		
22. I can learn the material.		
23. I can understand the concepts taught.		
24. I am good at this subject.		

4. SELF-REGULATION

Self-regulation assesses the degree to which the student is confident and believes in his/her own ability in successfully performing science-learning tasks.

Items	**Rating**	**Suggestions**
In this science class …		
25. Even when tasks are uninteresting, I keep working.		
26. I work hard even if I do not like what I am doing.		
27. I continue working when there are better things to do.		
28. I concentrate so that I won't miss important points.		
29. I finish my work and assignments on time.		
30. I don't give up even when the work is difficult.		
31. I concentrate in class.		
32. I keep going until I finish what I am supposed to do.		

B. Evaluation of the entire instrument as a whole (Refer to attached instrument)

Please "tick" (✓) ***the options as appropriate and suggest revision(s) in the space(s) provided.***

1. The entire instrument adequately measures the relevant constructs.

- [ ] 4 = very adequate and succinct
- [ ] 3 = adequate but needs minor alteration
- [ ] 2 = unable to assess adequacy without item(s) revision
- [ ] 1 = not adequate

For ratings of 3 or below, please suggest the necessary revision(s) to improve the instrument

____

____

____

____

____

____

2. The words in each item are clear and understandable.

- [ ] Yes
- [ ] No

If, no, please indicate the number of the items and provide suggestion for revisions.

____

____

____

____

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____

3. The format is acceptable.

☐ Yes

☐ No

If, no, please suggest changes in format.

____
____
____
____
____
____

4. The instructions for using the instrument are clear.

☐ Yes

☐ No

If, no, please suggest changes to make instructions more clear.

____
____
____
____
____
____

Appendix 2

Semi-structured interview protocol

Semi-Structured Interview Protocol

1. Are the instructions in the survey clear? (If the answer is no, please indicate the section that is confusing)

2. Are there any words in the survey that you did not recognise or understand? (If the answer is yes, please indicate the words that you did not recognise or understand)

3. Are there any items in the survey that were difficult or confusing for you? (If the answer is yes, please indicate the items)

4. When you circled ____ (the scale circled by the student) for item 1, did you understand the item?

5. Why did you circle ____ (the scale circled by the student) for item 1?

Questions 4 and 5 are repeated for four randomly chosen items in each scale.

Appendix 3

What Is Happening In this Class? questionnaire

Used with permission of the authors Aldridge & Fraser (2000)

What Is Happening In this Class?

Directions for Students

These questionnaires contain statements about practices which could take place in this class. You will be asked how often each practice takes place.

There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Think about how well each statement describes what this class is like for you.

For each statement, draw a circle around

1	if the practice takes place	**Almost Never**
2	if the practice takes place	**Seldom**
3	if the practice takes place	**Sometimes**
4	if the practice takes place	**Often**
5	if the practice takes place	**Almost Always**

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

STUDENT COHESIVENESS		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
1.	I make friendships among students in this class.	1	2	3	4	5
2.	I know other students in this class.	1	2	3	4	5
3.	I am friendly to members of this class.	1	2	3	4	5
4.	Members of the class are my friends.	1	2	3	4	5
5.	I work well with other class members.	1	2	3	4	5
6.	I help other class members who are having trouble with their work.	1	2	3	4	5
7.	Students in this class like me.	1	2	3	4	5
8.	In this class, I get help from other students.	1	2	3	4	5

TEACHER SUPPORT		Almost Never	Seldom	Some-times	Often	Almost Always
9.	The teacher takes a personal interest in me.	1	2	3	4	5
10.	The teacher goes out of his/her way to help me.	1	2	3	4	5
11.	The teacher considers my feelings.	1	2	3	4	5
12.	The teacher helps me when I have trouble with the work.	1	2	3	4	5
13.	The teacher talks with me.	1	2	3	4	5
14.	The teacher is interested in my problems.	1	2	3	4	5
15.	The teacher moves about the class to talk with me.	1	2	3	4	5
16.	The teacher's questions help me to understand.	1	2	3	4	5
INVOLVEMENT		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
17.	I discuss ideas in class.	1	2	3	4	5
18.	I give my opinions during class discussions.	1	2	3	4	5
19.	The teacher asks me questions.	1	2	3	4	5
20.	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5
21.	I ask the teacher questions.	1	2	3	4	5
22.	I explain my ideas to other students.	1	2	3	4	5
23.	Students discuss with me how to go about solving problems.	1	2	3	4	5
24.	I am asked to explain how I solve problems.	1	2	3	4	5

INVESTIGATION		Almost Never	Seldom	Some-times	Often	Almost Always
25.	I carry out investigations to test my ideas.	1	2	3	4	5
26.	I am asked to think about the evidence for statements.	1	2	3	4	5
27.	I carry out investigations to answer questions coming from discussions.	1	2	3	4	5
28.	I explain the meaning of statements, diagrams and graphs.	1	2	3	4	5
29.	I carry out investigations to answer questions which puzzle me.	1	2	3	4	5
30.	I carry out investigations to answer the teacher's questions.	1	2	3	4	5
31.	I find out answers to questions by doing investigations.	1	2	3	4	5
32.	I solve problems by using information obtained from my own investigations.	1	2	3	4	5
TASK ORIENTATION		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
33.	Getting a certain amount of work done is important to me.	1	2	3	4	5
34.	I do as much as I set out to do.	1	2	3	4	5
35.	I know the goals for this class.	1	2	3	4	5
36.	I am ready to start this class on time.	1	2	3	4	5
37.	I know what I am trying to accomplish in this class.	1	2	3	4	5
38.	I pay attention during this class.	1	2	3	4	5
39.	I try to understand the work in this class.	1	2	3	4	5
40.	I know how much work I have to do.	1	2	3	4	5

COOPERATION		Almost Never	Seldom	Some-times	Often	Almost Always
41.	I cooperate with other students when doing assignment work.	1	2	3	4	5
42.	I share my books and resources with other students when doing assignments.	1	2	3	4	5
43.	When I work in groups in this class, there is teamwork.	1	2	3	4	5
44.	I work with other students on projects in this class.	1	2	3	4	5
45.	I learn from other students in this class.	1	2	3	4	5
46.	I work with other students in this class.	1	2	3	4	5
47.	I cooperate with other students on class activities.	1	2	3	4	5
48.	Students work with me to achieve class goals.	1	2	3	4	5
EQUITY		**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
49.	The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5
50.	I get the same amount of help from the teacher as do other students.	1	2	3	4	5
51.	I have the same amount of say in this class as other students.	1	2	3	4	5
52.	I am treated the same as other students in this class.	1	2	3	4	5
53.	I receive the same encouragement from the teacher as other students do.	1	2	3	4	5
54.	I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5
55.	My work receives as much praise as other students' work.	1	2	3	4	5
56.	I get the same opportunity to answer questions as other students.	1	2	3	4	5

Appendix 4

Students' Adaptive Learning Engagement in Science questionnaire

Students’ Adaptive Learning Engagement in Science

Directions for Students

Here are some statements about you as a student in this class. Please read each statement carefully. Circle the number that best describes what you think about these statements.

There are no ‘right’ or ‘wrong’ answers. Your opinion is what is wanted.

For each statement, draw a circle around

1 if you **Strongly Disagree** with the statement
2 if you **Disagree** with the statement
3 if you **Are Not Sure** about the statement
4 if you **Agree** with the statement
5 if you **Strongly Agree** with the statement

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Practice Example

Suppose you were given the statement "I think learning science is fun." You would need to decide whether you ‘Strongly Disagree’, ‘Disagree’, ‘Not Sure’, ‘Agree’ or ‘Strongly Agree’ that learning science is fun. If you selected ‘Agree’ then you would circle the number 4 on your questionnaire.

		Strongly Disagree	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
1.	I think learning science is fun.	1	2	3	(4)	5

LEARNING GOAL ORIENTATION		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
In this science class …						
1.	One of my goals is to learn as much as I can.	1	2	3	4	5
2.	One of my goals is to learn new science contents.	1	2	3	4	5
3.	One of my goals is to master new science skills.	1	2	3	4	5
4.	It is important that I understand my work.	1	2	3	4	5
5.	It is important for me to learn the science content that is taught.	1	2	3	4	5
6.	It is important to me that I improve my science skills.	1	2	3	4	5
7.	It is important that I understand what is being taught to me.	1	2	3	4	5
8.	Understanding science ideas is important to me.	1	2	3	4	5
TASK VALUE		**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
In this science class …						
9.	What I learn can be used in my daily life.	1	2	3	4	5
10.	What I learn is interesting.	1	2	3	4	5
11.	What I learn is useful for me to know.	1	2	3	4	5
12.	What I learn is helpful to me.	1	2	3	4	5
13.	What I learn is relevant to me.	1	2	3	4	5
14.	What I learn is of practical value.	1	2	3	4	5
15.	What I learn satisfies my curiosity.	1	2	3	4	5
16.	What I learn encourages me to think.	1	2	3	4	5

SELF-EFFICACY		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
In this science class …						
17.	I can master the skills that are taught.	1	2	3	4	5
18.	I can figure out how to do difficult work.	1	2	3	4	5
19.	Even if the science work is hard, I can learn it.	1	2	3	4	5
20.	I can complete difficult work if I try.	1	2	3	4	5
21.	I will receive good grades.	1	2	3	4	5
22.	I can learn the work we do.	1	2	3	4	5
23.	I can understand the contents taught.	1	2	3	4	5
24.	I am good at this subject.	1	2	3	4	5
SELF-REGULATION		**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
In this science class …						
25.	Even when tasks are uninteresting, I keep working.	1	2	3	4	5
26.	I work hard even if I do not like what I am doing.	1	2	3	4	5
27.	I continue working even if there are better things to do.	1	2	3	4	5
28.	I concentrate so that I won't miss important points.	1	2	3	4	5
29.	I finish my work and assignments on time.	1	2	3	4	5
30.	I don't give up even when the work is difficult.	1	2	3	4	5
31.	I concentrate in class.	1	2	3	4	5
32.	I keep working until I finish what I am supposed to do.	1	2	3	4	5

Appendix 5

Correlations between items for the SALES scales

Correlations between items for the SALES scales

	LG1	LG2	LG3	LG4	LG5	LG6	LG7	LG8	TV1	TV2	TV3	TV4	TV5	TV6	TV7	TV8	SE1	SE2	SE3	SE4	SE5	SE6	SE7	SE8	SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8
LG1	**1.000**	**.597**	**.576**	**.505**	**.519**	**.558**	**.545**	**.549**	.303	.389	.451	.440	.414	.360	.414	.478	.375	.329	.445	.445	.362	.429	.385	.357	.471	.461	.460	.503	.369	.483	.447	.400
LG2	**.597**	**1.000**	**.722**	**.535**	**.599**	**.628**	**.499**	**.622**	.310	.461	.498	.457	.482	.437	.426	.450	.408	.399	.464	.448	.396	.458	.463	.472	.437	.386	.430	.458	.347	.467	.433	.391
LG3	**.576**	**.722**	**1.000**	**.548**	**.589**	**.644**	**.539**	**.629**	.357	.440	.493	.480	.494	.444	.408	.482	.451	.421	.490	.417	.382	.443	.445	.457	.445	.392	.389	.429	.363	.470	.418	.392
LG4	**.505**	**.535**	**.548**	**1.000**	**.547**	**.540**	**.653**	**.461**	.262	.338	.399	.365	.339	.295	.315	.383	.297	.271	.355	.392	.254	.391	.338	.308	.353	.313	.345	.377	.371	.385	.354	.367
LG5	**.519**	**.599**	**.589**	**.547**	**1.000**	**.673**	**.588**	**.596**	.353	.412	.487	.485	.427	.421	.384	.422	.376	.331	.404	.417	.319	.458	.424	.387	.447	.385	.401	.440	.357	.459	.423	.400
LG6	**.558**	**.628**	**.644**	**.540**	**.673**	**1.000**	**.587**	**.661**	.414	.469	.521	.517	.500	.419	.454	.499	.375	.363	.440	.396	.371	.467	.402	.444	.459	.431	.460	.472	.378	.481	.422	.435
LG7	**.545**	**.499**	**.539**	**.653**	**.588**	**.587**	**1.000**	**.520**	.274	.369	.436	.433	.386	.364	.353	.430	.352	.325	.445	.371	.312	.441	.375	.355	.437	.371	.421	.445	.368	.427	.355	.415
LG8	**.549**	**.622**	**.629**	**.461**	**.596**	**.661**	**.520**	**1.000**	.436	.547	.570	.546	.561	.484	.493	.519	.434	.399	.467	.416	.445	.520	.485	.490	.456	.416	.453	.474	.370	.490	.453	.423
TV1	.303	.310	.357	.262	.353	.414	.274	.436	**1.000**	**.497**	**.632**	**.655**	**.565**	**.551**	**.540**	**.597**	.383	.344	.429	.388	.384	.403	.375	.380	.366	.364	.362	.326	.259	.379	.357	.321
TV2	.389	.461	.440	.338	.412	.469	.369	.547	**.497**	**1.000**	**.656**	**.609**	**.541**	**.522**	**.573**	**.633**	.414	.392	.478	.434	.373	.480	.496	.457	.409	.341	.401	.449	.253	.458	.448	.375
TV3	.451	.498	.493	.399	.487	.521	.436	.570	**.632**	**.656**	**1.000**	**.763**	**.624**	**.596**	**.539**	**.617**	.430	.407	.496	.456	.440	.487	.486	.464	.425	.401	.461	.450	.343	.499	.435	.402
TV4	.440	.457	.480	.365	.485	.517	.433	.546	**.655**	**.609**	**.763**	**1.000**	**.670**	**.635**	**.517**	**.612**	.414	.397	.474	.413	.414	.479	.476	.442	.439	.402	.440	.432	.378	.460	.409	.414
TV5	.414	.482	.494	.339	.427	.500	.386	.561	**.565**	**.541**	**.624**	**.670**	**1.000**	**.605**	**.502**	**.552**	.419	.404	.441	.401	.455	.453	.482	.429	.393	.377	.410	.421	.331	.449	.374	.322
TV6	.360	.437	.444	.295	.421	.419	.364	.484	**.551**	**.522**	**.596**	**.635**	**.605**	**1.000**	**.509**	**.551**	.437	.407	.486	.399	.391	.468	.504	.415	.425	.387	.398	.428	.334	.408	.369	.361
TV7	.414	.426	.408	.315	.384	.454	.353	.493	**.540**	**.573**	**.539**	**.517**	**.502**	**.509**	**1.000**	**.650**	.406	.385	.462	.411	.398	.482	.486	.450	.372	.351	.376	.391	.223	.426	.363	.314
TV8	.478	.450	.482	.383	.422	.499	.430	.519	**.597**	**.633**	**.617**	**.612**	**.552**	**.551**	**.650**	**1.000**	.445	.418	.502	.488	.422	.493	.512	.511	.481	.452	.450	.501	.355	.517	.496	.450
SE1	.375	.408	.451	.297	.376	.375	.352	.434	.383	.414	.430	.414	.419	.437	.406	.445	**1.000**	**.611**	**.569**	**.540**	**.556**	**.541**	**.564**	**.612**	.379	.407	.404	.457	.386	.477	.412	.413
SE2	.329	.399	.421	.271	.331	.363	.325	.399	.344	.392	.407	.397	.404	.407	.385	.418	**.611**	**1.000**	**.632**	**.555**	**.554**	**.545**	**.595**	**.596**	.388	.357	.347	.422	.390	.466	.426	.429
SE3	.445	.464	.490	.355	.404	.440	.445	.467	.429	.478	.496	.474	.441	.486	.462	.502	**.569**	**.632**	**1.000**	**.627**	**.594**	**.595**	**.612**	**.547**	.469	.443	.481	.493	.443	.549	.474	.477
SE4	.445	.448	.417	.392	.417	.396	.371	.416	.388	.434	.456	.413	.401	.399	.411	.488	**.540**	**.555**	**.627**	**1.000**	**.510**	**.586**	**.550**	**.547**	.419	.418	.414	.453	.436	.515	.459	.448
SE5	.362	.396	.382	.254	.319	.371	.312	.445	.384	.373	.440	.414	.455	.391	.398	.422	**.556**	**.554**	**.594**	**.510**	**1.000**	**.579**	**.542**	**.639**	.364	.388	.415	.453	.434	.498	.440	.387
SE6	.429	.458	.443	.391	.458	.467	.441	.520	.403	.480	.487	.479	.453	.468	.482	.493	**.541**	**.545**	**.595**	**.586**	**.579**	**1.000**	**.709**	**.577**	.413	.407	.479	.495	.432	.539	.495	.462
SE7	.385	.463	.445	.338	.424	.402	.375	.485	.375	.496	.486	.476	.482	.504	.486	.512	**.564**	**.595**	**.612**	**.550**	**.542**	**.709**	**1.000**	**.608**	.384	.375	.371	.435	.401	.485	.491	.414
SE8	.357	.472	.457	.308	.387	.444	.355	.490	.380	.457	.464	.442	.429	.415	.450	.511	**.612**	**.596**	**.547**	**.547**	**.639**	**.577**	**.608**	**1.000**	.412	.387	.437	.438	.386	.495	.472	.417
SR1	.471	.437	.445	.353	.447	.459	.437	.456	.366	.409	.425	.439	.393	.425	.372	.481	.379	.388	.469	.419	.364	.413	.384	.412	**1.000**	**.734**	**.668**	**.572**	**.516**	**.603**	**.573**	**.606**
SR2	.461	.386	.392	.313	.385	.431	.371	.416	.364	.341	.401	.402	.377	.387	.351	.452	.407	.357	.443	.418	.388	.407	.375	.387	**.734**	**1.000**	**.679**	**.560**	**.545**	**.566**	**.560**	**.568**
SR3	.460	.430	.389	.345	.401	.460	.421	.453	.362	.401	.461	.440	.410	.398	.376	.450	.404	.347	.481	.414	.415	.479	.371	.437	**.668**	**.679**	**1.000**	**.622**	**.493**	**.621**	**.578**	**.599**
SR4	.503	.458	.429	.377	.440	.472	.445	.474	.326	.449	.450	.432	.421	.428	.391	.501	.457	.422	.493	.453	.453	.495	.435	.438	**.572**	**.560**	**.622**	**1.000**	**.537**	**.622**	**.640**	**.618**
SR5	.369	.347	.363	.371	.357	.378	.368	.370	.259	.253	.343	.378	.331	.334	.223	.355	.386	.390	.443	.436	.434	.432	.401	.386	**.516**	**.545**	**.493**	**.537**	**1.000**	**.562**	**.485**	**.549**
SR6	.483	.467	.470	.385	.459	.481	.427	.490	.379	.458	.499	.460	.449	.408	.426	.517	.477	.466	.549	.515	.498	.539	.485	.495	**.603**	**.566**	**.621**	**.622**	**.562**	**1.000**	**.634**	**.641**
SR7	.447	.433	.418	.354	.423	.422	.355	.453	.357	.448	.435	.409	.374	.369	.363	.496	.412	.426	.474	.459	.440	.495	.491	.472	**.573**	**.560**	**.578**	**.640**	**.485**	**.634**	**1.000**	**.615**
SR8	.400	.391	.392	.367	.400	.435	.415	.423	.321	.375	.402	.414	.322	.361	.314	.450	.413	.429	.477	.448	.387	.462	.414	.417	**.606**	**.568**	**.599**	**.618**	**.549**	**.641**	**.615**	**1.000**

Appendix 6

Cross-loading matrix of items with constructs for the SALES and WIHIC

Cross-loading matrix of items with constructs for the SALES and WIHIC

Item	Loadings										
	SC	TS	IVT	IGT	TO	CP	EQ	LG	TV	SE	SR
SC1	**0.710**	0.161	0.339	0.215	0.191	0.484	0.186	0.143	0.114	0.158	0.181
SC3	**0.789**	0.267	0.304	0.243	0.382	0.504	0.333	0.339	0.287	0.301	0.367
SC4	**0.708**	0.146	0.309	0.167	0.166	0.411	0.182	0.105	0.113	0.147	0.152
SC5	**0.793**	0.189	0.348	0.241	0.296	0.555	0.248	0.216	0.163	0.241	0.309
SC6	**0.781**	0.296	0.477	0.392	0.429	0.451	0.333	0.408	0.370	0.433	0.445
TS1	0.279	**0.782**	0.511	0.381	0.400	0.263	0.425	0.340	0.408	0.389	0.392
TS2	0.201	**0.819**	0.412	0.368	0.391	0.239	0.468	0.302	0.359	0.343	0.364
TS3	0.252	**0.850**	0.448	0.389	0.428	0.315	0.554	0.368	0.438	0.352	0.389
TS4	0.261	**0.799**	0.393	0.305	0.447	0.295	0.563	0.363	0.390	0.355	0.385
TS5	0.240	**0.837**	0.457	0.333	0.420	0.279	0.511	0.334	0.391	0.338	0.369
TS6	0.240	**0.846**	0.449	0.421	0.397	0.287	0.476	0.329	0.404	0.358	0.356
TS7	0.248	**0.761**	0.428	0.379	0.336	0.279	0.447	0.275	0.306	0.321	0.281
TS8	0.269	**0.809**	0.459	0.450	0.529	0.324	0.584	0.471	0.519	0.444	0.464
IVT1	0.429	0.407	**0.798**	0.484	0.368	0.355	0.331	0.351	0.318	0.410	0.359
IVT2	0.385	0.330	**0.774**	0.420	0.321	0.309	0.251	0.275	0.268	0.384	0.300
IVT3	0.308	0.513	**0.710**	0.465	0.424	0.252	0.422	0.334	0.366	0.392	0.358
IVT4	0.349	0.471	**0.832**	0.529	0.430	0.342	0.387	0.345	0.368	0.489	0.395
IVT5	0.290	0.418	**0.707**	0.435	0.421	0.263	0.304	0.296	0.288	0.344	0.355
IVT6	0.412	0.398	**0.776**	0.551	0.463	0.405	0.398	0.342	0.366	0.433	0.413
IVT7	0.423	0.381	**0.723**	0.563	0.445	0.455	0.351	0.353	0.384	0.422	0.428
IVT8	0.341	0.391	**0.729**	0.593	0.452	0.330	0.372	0.342	0.352	0.475	0.449
IGT1	0.339	0.378	0.572	**0.813**	0.466	0.300	0.350	0.361	0.426	0.479	0.479
IGT2	0.310	0.418	0.596	**0.779**	0.505	0.335	0.435	0.400	0.412	0.459	0.483
IGT3	0.291	0.403	0.561	**0.843**	0.479	0.331	0.359	0.348	0.410	0.428	0.482
IGT4	0.324	0.339	0.562	**0.797**	0.482	0.365	0.356	0.359	0.382	0.494	0.462
IGT5	0.277	0.350	0.554	**0.831**	0.457	0.311	0.302	0.305	0.397	0.455	0.448
IGT6	0.271	0.425	0.520	**0.824**	0.479	0.343	0.334	0.324	0.365	0.452	0.440
IGT7	0.264	0.385	0.517	**0.842**	0.487	0.357	0.363	0.326	0.406	0.440	0.483
IGT8	0.312	0.375	0.540	**0.836**	0.547	0.368	0.343	0.413	0.458	0.483	0.528
TO1	0.364	0.388	0.381	0.435	**0.774**	0.416	0.452	0.619	0.477	0.490	0.645
TO2	0.330	0.407	0.400	0.432	**0.774**	0.375	0.441	0.521	0.449	0.454	0.639
TO3	0.369	0.424	0.498	0.505	**0.792**	0.397	0.465	0.522	0.468	0.524	0.606
TO4	0.348	0.414	0.403	0.400	**0.763**	0.422	0.495	0.497	0.432	0.490	0.579
TO5	0.378	0.431	0.527	0.544	**0.839**	0.470	0.489	0.564	0.520	0.589	0.642
TO6	0.313	0.424	0.452	0.513	**0.818**	0.391	0.506	0.581	0.524	0.586	0.681
TO7	0.356	0.440	0.452	0.495	**0.827**	0.416	0.538	0.614	0.539	0.583	0.662
TO8	0.330	0.399	0.408	0.463	**0.785**	0.411	0.513	0.489	0.457	0.528	0.579
CP1	0.549	0.305	0.392	0.342	0.477	**0.809**	0.412	0.382	0.280	0.325	0.411
CP2	0.478	0.251	0.332	0.314	0.421	**0.791**	0.335	0.317	0.249	0.293	0.348
CP3	0.542	0.253	0.353	0.309	0.447	**0.828**	0.328	0.334	0.252	0.326	0.386
CP4	0.474	0.276	0.357	0.328	0.380	**0.817**	0.315	0.279	0.248	0.279	0.331
CP5	0.405	0.284	0.344	0.369	0.351	**0.736**	0.302	0.273	0.274	0.264	0.284
CP6	0.511	0.284	0.351	0.292	0.370	**0.835**	0.326	0.273	0.214	0.237	0.303
CP7	0.590	0.283	0.363	0.285	0.450	**0.848**	0.395	0.350	0.266	0.304	0.390
CP8	0.484	0.333	0.412	0.419	0.409	**0.781**	0.364	0.330	0.294	0.365	0.371

	SC	TS	IVT	IGT	TO	CP	EQ	LG	TV	SE	SR
EQ1	0.315	0.588	0.426	0.376	0.502	0.387	**0.827**	0.417	0.411	0.411	0.441
EQ2	0.258	0.548	0.363	0.317	0.489	0.337	**0.825**	0.401	0.400	0.370	0.437
EQ3	0.290	0.512	0.411	0.361	0.503	0.388	**0.847**	0.370	0.368	0.404	0.414
EQ4	0.303	0.506	0.321	0.331	0.519	0.390	**0.854**	0.408	0.376	0.391	0.437
EQ5	0.301	0.567	0.410	0.389	0.528	0.350	**0.871**	0.436	0.431	0.424	0.423
EQ6	0.331	0.490	0.406	0.373	0.524	0.373	**0.852**	0.440	0.424	0.386	0.398
EQ7	0.313	0.517	0.437	0.410	0.548	0.342	**0.836**	0.421	0.432	0.493	0.465
EQ8	0.379	0.488	0.396	0.363	0.517	0.371	**0.842**	0.423	0.415	0.413	0.420
LG1	0.281	0.343	0.337	0.357	0.576	0.294	0.346	**0.769**	0.514	0.494	0.564
LG2	0.261	0.375	0.384	0.369	0.546	0.307	0.353	**0.808**	0.555	0.553	0.526
LG3	0.308	0.373	0.400	0.389	0.521	0.299	0.375	**0.814**	0.567	0.553	0.514
LG4	0.316	0.304	0.297	0.267	0.514	0.339	0.436	**0.715**	0.426	0.412	0.437
LG5	0.318	0.357	0.341	0.308	0.555	0.329	0.411	**0.808**	0.534	0.492	0.517
LG6	0.313	0.351	0.348	0.347	0.581	0.328	0.408	**0.839**	0.597	0.515	0.553
LG7	0.335	0.279	0.297	0.290	0.517	0.342	0.378	**0.773**	0.482	0.471	0.502
LG8	0.273	0.372	0.370	0.411	0.577	0.290	0.413	**0.801**	0.654	0.577	0.554
TV1	0.218	0.334	0.307	0.344	0.401	0.198	0.322	0.430	**0.749**	0.487	0.433
TV2	0.273	0.409	0.364	0.404	0.494	0.255	0.400	0.543	**0.794**	0.557	0.505
TV3	0.279	0.413	0.368	0.410	0.522	0.276	0.428	0.611	**0.856**	0.578	0.538
TV4	0.278	0.405	0.367	0.407	0.509	0.264	0.388	0.590	**0.859**	0.554	0.524
TV5	0.253	0.395	0.375	0.401	0.461	0.248	0.354	0.572	**0.791**	0.549	0.481
TV6	0.251	0.380	0.348	0.396	0.465	0.266	0.364	0.511	**0.770**	0.553	0.485
TV7	0.236	0.401	0.361	0.369	0.452	0.252	0.406	0.515	**0.741**	0.549	0.454
TV8	0.293	0.453	0.385	0.430	0.554	0.294	0.408	0.580	**0.806**	0.598	0.586
SE1	0.333	0.338	0.452	0.442	0.495	0.318	0.354	0.486	0.526	**0.782**	0.517
SE2	0.304	0.319	0.446	0.441	0.464	0.244	0.321	0.449	0.496	**0.795**	0.497
SE3	0.355	0.367	0.415	0.472	0.559	0.317	0.405	0.555	0.592	**0.803**	0.593
SE4	0.327	0.358	0.440	0.416	0.545	0.344	0.362	0.522	0.534	**0.775**	0.548
SE5	0.217	0.325	0.412	0.408	0.507	0.237	0.372	0.451	0.514	**0.763**	0.517
SE6	0.335	0.394	0.447	0.470	0.583	0.327	0.457	0.571	0.589	**0.813**	0.577
SE7	0.322	0.406	0.451	0.466	0.536	0.293	0.415	0.525	0.601	**0.817**	0.518
SE8	0.282	0.351	0.483	0.457	0.543	0.297	0.407	0.518	0.559	**0.806**	0.536
SR1	0.347	0.401	0.382	0.466	0.629	0.356	0.440	0.555	0.522	0.509	**0.827**
SR2	0.329	0.383	0.391	0.461	0.601	0.334	0.378	0.500	0.484	0.502	**0.809**
SR3	0.346	0.356	0.400	0.459	0.644	0.360	0.385	0.532	0.520	0.529	**0.831**
SR4	0.360	0.386	0.435	0.466	0.655	0.357	0.420	0.570	0.537	0.575	**0.812**
SR6	0.376	0.404	0.480	0.517	0.686	0.389	0.440	0.580	0.568	0.634	**0.825**
SR7	0.365	0.383	0.408	0.462	0.660	0.361	0.457	0.524	0.513	0.578	**0.806**
SR8	0.384	0.365	0.415	0.491	0.646	0.372	0.390	0.509	0.468	0.544	**0.812**

Appendix 7

Cross-loading matrix of items with constructs for the SALES

Cross-loading matrix of items with constructs for the SALES

Item	Loadings			
	LG	TV	SE	SR
LG1	**0.741**	0.522	0.472	0.543
LG2	**0.764**	0.552	0.534	0.497
LG3	**0.773**	0.553	0.531	0.493
LG4	**0.689**	0.435	0.428	0.435
LG5	**0.773**	0.505	0.476	0.492
LG6	**0.810**	0.592	0.493	0.501
LG7	**0.747**	0.459	0.446	0.468
LG8	**0.769**	0.638	0.549	0.515
TV1	0.420	**0.701**	0.469	0.432
TV2	0.546	**0.765**	0.527	0.504
TV3	0.577	**0.824**	0.560	0.538
TV4	0.574	**0.829**	0.529	0.509
TV5	0.545	**0.765**	0.531	0.472
TV6	0.534	**0.755**	0.528	0.473
TV7	0.521	**0.704**	0.524	0.453
TV8	0.563	**0.781**	0.586	0.567
SE1	0.471	0.493	**0.761**	0.478
SE2	0.429	0.456	**0.761**	0.464
SE3	0.545	0.577	**0.770**	0.572
SE4	0.502	0.514	**0.732**	0.515
SE5	0.413	0.483	**0.737**	0.475
SE6	0.546	0.558	**0.755**	0.545
SE7	0.511	0.568	**0.783**	0.485
SE8	0.505	0.543	**0.788**	0.497
SR1	0.532	0.532	0.492	**0.808**
SR2	0.475	0.482	0.458	**0.780**
SR3	0.492	0.512	0.478	**0.801**
SR4	0.547	0.527	0.533	**0.775**
SR5	0.454	0.395	0.488	**0.568**
SR6	0.537	0.556	0.598	**0.798**
SR7	0.499	0.504	0.545	**0.775**
SR8	0.478	0.466	0.512	**0.780**

Appendix 8

Cross-loading matrix of items with constructs for gender subgroups

Cross-loading matrix of items with constructs for male sub-group

Item	Loadings			
	LG	TV	SE	SR
LG1	**0.790**	0.586	0.487	0.562
LG2	**0.795**	0.591	0.542	0.550
LG3	**0.819**	0.600	0.596	0.551
LG4	**0.689**	0.459	0.407	0.465
LG5	**0.789**	0.575	0.521	0.524
LG6	**0.820**	0.648	0.548	0.549
LG7	**0.761**	0.502	0.470	0.490
LG8	**0.791**	0.660	0.554	0.559
TV1	0.433	**0.710**	0.467	0.427
TV2	0.588	**0.761**	0.525	0.520
TV3	0.627	**0.834**	0.580	0.582
TV4	0.628	**0.844**	0.561	0.547
TV5	0.556	**0.751**	0.507	0.498
TV6	0.551	**0.765**	0.532	0.524
TV7	0.565	**0.723**	0.534	0.487
TV8	0.616	**0.787**	0.603	0.604
SE1	0.502	0.508	**0.782**	0.503
SE2	0.460	0.463	**0.764**	0.490
SE3	0.571	0.592	**0.789**	0.592
SE4	0.548	0.540	**0.745**	0.531
SE5	0.394	0.474	**0.708**	0.496
SE6	0.579	0.587	**0.779**	0.557
SE7	0.541	0.569	**0.801**	0.477
SE8	0.510	0.550	**0.795**	0.520
SR1	0.563	0.559	0.510	**0.818**
SR2	0.507	0.503	0.446	**0.780**
SR3	0.524	0.561	0.470	**0.802**
SR4	0.571	0.563	0.564	**0.798**
SR5	0.479	0.491	0.542	**0.653**
SR6	0.606	0.613	0.633	**0.806**
SR7	0.509	0.533	0.524	**0.784**
SR8	0.457	0.461	0.488	**0.773**

Cross-loading matrix of items with constructs for female sub-group

Item	Loadings			
	LG	TV	SE	SR
LG1	**0.675**	0.450	0.478	0.510
LG2	**0.738**	0.491	0.519	0.441
LG3	**0.722**	0.492	0.464	0.428
LG4	**0.690**	0.415	0.477	0.427
LG5	**0.745**	0.416	0.423	0.458
LG6	**0.792**	0.518	0.432	0.457
LG7	**0.736**	0.419	0.445	0.447
LG8	**0.740**	0.606	0.538	0.466
TV1	0.398	**0.696**	0.465	0.450
TV2	0.498	**0.765**	0.530	0.476
TV3	0.506	**0.807**	0.519	0.487
TV4	0.499	**0.812**	0.477	0.488
TV5	0.531	**0.785**	0.559	0.452
TV6	0.515	**0.747**	0.522	0.421
TV7	0.463	**0.673**	0.505	0.399
TV8	0.497	**0.763**	0.571	0.521
SE1	0.442	0.464	**0.731**	0.481
SE2	0.406	0.434	**0.751**	0.474
SE3	0.524	0.558	**0.740**	0.574
SE4	0.450	0.473	**0.705**	0.529
SE5	0.441	0.480	**0.763**	0.488
SE6	0.507	0.522	**0.734**	0.543
SE7	0.480	0.560	**0.768**	0.523
SE8	0.512	0.524	**0.772**	0.507
SR1	0.493	0.503	0.484	**0.772**
SR2	0.434	0.464	0.486	**0.764**
SR3	0.452	0.459	0.500	**0.789**
SR4	0.517	0.487	0.513	**0.732**
SR5	0.413	0.291	0.448	**0.651**
SR6	0.447	0.481	0.556	**0.785**
SR7	0.487	0.475	0.588	**0.759**
SR8	0.509	0.476	0.556	**0.797**