School of Education

Improving Student Motivation and Self-Regulation in Science and Mathematics Classes: Examining the Impact of the Learning Environment

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

May 2018

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.

Signature:

Yulia Burdakova

May, 2018

ACKNOWLEDGEMENTS

My PhD journey has been long and filled with both challenges and learning curves. I thank God for giving me the necessary strength, motivation and abilities to complete my PhD study and for the opportunity to look back and reflect on my journey.

The completion of a task of this magnitude has required the help of numerous people throughout my journey. I have been blessed with many individuals in my academic and professional life who have provided me with the enormous support that was required. I would like to take this opportunity to extend my thanks to them all.

My sincere gratitude goes to my former Line Manager, Head of Maths and Science, Mark Darrell, who familiarised me with the research programs and encouraged me in different ways throughout my journey.

To my supervisor, Associate Professor Jill Aldridge, I extend my thanks for your professional support, time and guidance. The patience and encouragement which you demonstrated over the many years of our collaboration are greatly appreciated. I also extend my gratitude to my co-supervisor, Professor Barry Fraser for his continuous support. Without the help and direction from both supervisors I would not have made it to this point.

I am grateful to Dr Katrina McChesney, a graduate of the Curtin University School of Education, who edited my thesis according to the Australian Standards for Editing Practice.

My sincere gratitude goes to the mathematics and science teachers who consented to participate in this research. These teachers opened their classroom doors to me, permitting me to observe their classes and to collect feedback data from the students. Finally, I am grateful to the many students who spent time filling out the questionnaires.

ABSTRACT

Motivation is a major factor that impels students to engage or not engage in tasks or activities. As such, motivation is widely recognised as being critical to effective learning (Marx & Walsh, 1988). Maehr and Braskamp (1986) focused on motivation from a counterbalancing perspective, in which socio-cultural factors such as teachers' and parents' expectations and task expectations counterbalance students' personal motivation. In line with this view of motivation, the current study drew on Bandura's social-cognitive theory which conceptualises students' learning in terms of the interconnections between personal influences, environmental factors and behaviours.

The study involved a multi-methods approach that was carried out over two phases. The first phase involved the collection of quantitative data from the classes of seven teachers (N=351 students in 19 classes), using two instruments: Constructivist-Oriented Learning Environment Survey (COLES), to assess students' perceptions of the learning environment; and Student Adaptive Learning Environment Survey (SALES), to assess their motivation and self-regulation. This data were used to, first, provide evidence to support the reliability and validity of the instruments when used with this sample and, second, to identify salient factors within the learning environments that could be enhanced by teachers to improve students' motivation in mathematics and science.

The second phase involved a critical instance case study teacher using student feedback about their learning environment as a means of reflection. During this phase, qualitative data were collected using observations and interviews from two classes taught by the critical instance case study teacher. Using the feedback to guide decisions about how to improve students' engagement, the teacher implemented changes over action research cycles. The qualitative data were analysed to identify 1) factors inhibiting and enhancing positive changes in the teachers' mathematics and science classes and 2) the effectiveness of interventions implemented by the teacher to improve motivation.

Purposive sampling was used to maximise the representativeness of the sample. This ensured that all of the selected classes included a range of academic abilities and were

co-educational. For the collection of quantitative data, the sample involved a total of 19 classes, taught by seven teachers. All of the classes were selected from years 7 to 10 which provided a sample of 351 students, of whom 195 were boys and 156 were girls. For the collection of qualitative information, a critical instance case study (in which a smaller sample of interest was drawn from the larger sample) involved one teacher and two of her mathematics and science classes. Both of the classes were mixed-ability and co-educational ($n = 56$ students).

Analysis of the quantitative data provided evidence to support the reliability and validity of the surveys. For both surveys the results supported the factor structures, the internal consistency reliability, ability to differentiate between classes and the discriminant validity.

The quantitative data were used to examine whether students' perception of the learning environment contribute to student motivation and which aspects of the learning environment were independent predictors of motivation. Simple correlation and multiple regression analyses were undertaken with the individual as the unit of analysis. The multiple regression analysis provided more parsimonious information than the simple correlation did about the relationships between correlated independent variables. The standardised regression weights (*ß*) indicated that task value was positively and significantly related to teacher support ($p< .01$), formative assessment ($p<.01$), and personal relevance ($p< .01$); self-efficacy was positively and significantly related to clarity of assessment ($p< .01$) and task orientation ($p< .01$); and self-regulation was positively and significantly related to teacher support ($p< .05$), task orientation ($p< .01$) and cooperation ($p< .05$).

To investigate whether the interventions implemented by the teacher during the action research cycles improved students' perceptions of the learning environment and self-reports of motivation and engagement, MANOVA was used. Because the multivariate test yielded significant results, using Wilks' lambda criterion, the univariate ANOVA was interpreted for each of the scales. The results indicated that the pre-post differences were statistically significant for three scales, these being formative assessment ($p< .05$, 0.25 standard deviations), task orientation ($p< .05$, 0.32 standard deviations) and differentiation ($p< .05$, 0.21 standard deviations). The effect sizes for these three scales ranged from .21 to .32. There were also statistically significant and positive pre–post differences for three of the four of the motivation scales with students reporting high scores for learning goal orientation ($p < .05$, 0.34 standard deviations), self-efficacy ($p < .05$, 0.43 standard deviations), and self-regulation ($p < .05$, 0.52 standard deviations).

The results of the study could have important applications for educational systems concerning how changes to malleable aspects of learning environment, including pedagogical strategies, might enhance students' motivation and self-regulation. As such, the findings provide a greater understanding of how student motivation could be enhanced through critical self-reflection based on student feedback and action research to bring about change in the learning environment.

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INTRODUCTION

1.1 Background to the Study

Over the last decade, increasing students' participation in science, technology, engineering, and mathematics (STEM) has increasingly become the focus of educational reforms (Education Council, 2015). Grants have been made available to educators to support the implementation of programmes focused on STEM education across the schooling sector, with improvement priorities including students' STEM ability, engagement, participation, and aspiration; STEM teacher capacity; and the quality of STEM teaching (Education Council, 2015).

Despite these initiatives, mathematics and science subjects continue to be perceived as difficult by the majority of school students, with many students struggling to motivate themselves or to understand why they need to learn difficult concepts (Burghes & Robinson, 2010). Further, past educational reviews have concluded that internationally curriculum and classroom practices often fail to motivate students to learn mathematics and science (Osborne & Dillon, 2008; Sjøberg & Schreiner, 2010; Tytler, 2007). These reviews have not, however, examined factors that could affect student motivation. A major aim of the present study, therefore, was to investigate factors within the learning environment that might influence students' motivation in mathematics and science learning.

This chapter introduces the study by describing the context in which the study took place (Section 1.2) and the conceptual framework of the study (Section 1.3). The chapter goes on to introduce the objectives of the study (Section 1.4) and provides an overview of the significance of the research (Section 1.5). Finally an overview of the thesis is provided in Section 1.6.

1.2 Context of the Study

This section provides background information about the context in which this study was conducted. First, Section 1.2.1 provides information about education in South

Australia, the state in which the study was carried out; and second, Section 1.2.2 provides information about the specific site at which the study was conducted;

1.2.1 Education in South Australia

To provide context for the study, this section provides information about Australian school curriculum in Section 1.2.1.1. The section then goes on to Section 1.2.1.1 which explains the structure of the state's education system. Finally, given that the focus of the research described in this thesis was in STEM classes, Section 1.2.1.3 provides information about STEM education in South Australia.

1.2.1.1 Curriculum in Australian Schools

Australia is made of seven states and territories, of which South Australia is one. Although Australia has a national curriculum that all states and territories are required to adhere to, each state and territory has its own education system. The Australian Curriculum, Assessment, and Reporting Authority (ACARA), established under Section Five of the Australian Curriculum, Assessment, and Reporting Authority Act (2008), is responsible for the development of the national curriculum, the administration of national assessments, and the associated reporting on schooling in Australia (ACARA, 2017).

The state [and territory] curriculum, assessment, and certification authority for South Australia, is responsible for determining how the national curriculum content and achievement standards are to be integrated into school courses. They also ensure that all public schools in South Australia provide the Australian curriculum to students.

The Australian curriculum includes the foundation / reception to year 10 school curriculum and year 11 and 12 school curriculum. The foundation / reception to Year 10 school curriculum is structured using three dimensions: disciplinary knowledge, skills, and understanding; general capabilities; and cross-curricular priorities. Each of these are described below.

Disciplinary knowledge, skills, and understanding are taught for each of the eight learning areas of the Australian Curriculum: English, Mathematics, Science, Health and Physical Education, Humanities and Social Sciences, The Arts, Technologies, and Languages. Of these learning areas, Humanities and Social Sciences, The Arts, Technologies, and Languages each include multiple subjects (for example, the Languages learning area includes Japanese or French as individual subjects; the Humanities and Social Sciences learning area includes geography, citizenship, or economics as individual subjects). For each learning area, the Australian curriculum provides content descriptions, achievement objectives, and specifications of the levels of knowledge and skill that students are expected to demonstrate by the end of each school year. Whereas the content statements specify the knowledge, understanding, and skills that are to be taught and learned, the achievement standards provided in the curriculum describe the depth of understanding, the extent of knowledge, and the level of complexity that are expected of students.

The general capabilities are incorporated within the Australian Curriculum learning content for each learning area and are aimed to prepare young Australians for everyday life and work in the twenty-first century (ACARA, 2017). The general capabilities include literacy, numeracy, information and communication technology capability, critical and creative thinking, personal and social capability, ethical understanding, and intercultural understanding. These capabilities are developed when knowledge and skills are applied in various situations (ACARA, 2017).

There are three cross-curriculum priorities in the Australian Curriculum: Aboriginal and Torres Strait Islander histories and cultures; Asia and Australia’s engagement with Asia; and sustainability. These priorities are designed to equip students with the tools and language to allow them better understand the world at various levels (ACARA, 2017). The cross-curriculum priorities aim to add depth and richness to student learning through content elaborations that are incorporated within the learning areas (ACARA, 2017).

1.2.1.2 Structure of the Education System in South Australia

The public education system in South Australia has a four-level structure consisting of early childhood education, primary school education, secondary school education, and tertiary education (Government of South Australia, 2017). In South Australia, as with the other states and territories, it is compulsory for children under the age of 17 to participate in schooling, training, or work for at least 25 hours per week (Government of South Australia, 2017). The Education Act of South Australia also states that it is the responsibility of parents and guardians to ensure that children between the ages of six and 16, who are in their care attend school.

There are two different types of school systems that operate in South Australia: public schools and private schools. Public schools are run by the government, and the funding of these schools is largely the responsibility of the state. Private schools, on the other hand, are run by private organisations (mainly churches) and, although they receive some government funds, funding is largely drawn from tuition fees. Public education in South Australia is free, whereas parents pay fees for private education. Given that my study was undertaken in a public school, the remainder of this section focuses on the public education system.

Early childhood education starts between the ages of three to five. This level of education is delivered in a range of settings, including childcare centres and pre-schools. Early education is not compulsory but is accessible to all Australian children.

Public primary schools in South Australia are all co-educational. These schools covering the period from reception to year 7, cater for students aged from five to 11 years. Children attending public primary schools usually attend a school near their home, although parents have the right to send their child to another school if it has places available. Some public primary schools are located on the same site as a high school, and others are located near a high school.

Public secondary schools usually enrol students between the ages of 13 and 18 years. Some public schools restrict their student numbers and give priority to children living within the allocated geographic zone around the school. Many public schools also run special interest programmes (for example, involving sport, music, languages or dance). These special interest schools run selection processes and offer placements based on students’ interests and talents.

Young people aged 17 and older may continue with tertiary study, participate in a community education programme, or start work. Tertiary education is provided by universities and by other higher education institutions such as Technical and Further Education institutes and Vocational Education and Training providers. Tertiary study allows young people to receive qualifications or advance their skills in areas of their choice.

1.2.1.3 STEM Education in South Australia

Between 2006 and 2011, the number of STEM positions in Australia grew 1.5 times faster than all other occupation groups (Australian Government, 2015). In order to support to emerging industries and the digital economy in South Australia, Department of Further Education, Employment, Science and Technology (DFEEST) has recognised the need to attract and develop a workforce with stronger skills in STEM (DFEEST, 2011). As a result, the Science, Technology, Engineering, and Mathematics (STEM) Skills Strategy for South Australia (DFEEST, 2011) was developed to attract more people into science, technology, engineering, and mathematics study at school and university and into related vocational training. The STEM Skills Strategy for South Australia seeks to create greater awareness of the study, training, and career opportunities available in STEM and focuses on how state government, in collaboration with the South Australian Department of Education, can promote the STEM disciplines to make them more appealing career paths.

At the time that this study was conducted, the South Australian Government had invested $250 million in STEM educational reform (Department of Education and Child Development, 2016), supporting STEM programmes in 139 public schools across the metropolitan area of the state (serving approximately 75,000 students). For example, a new $100 million school (opening in 2019) will have specialist STEM and health sciences programmes. The South Australian government, in partnership with the Department of Education and Child Development of South Australia (DECD), has also implemented initiatives that support improvements in STEM teaching and learning. These initiatives are intended to ensure that public education equips students with STEM knowledge and skills so that they will have the capacity to take their places in a changing, competitive, and interconnected global employment market.

Despite this interest in STEM and increased funding, the national curriculum still treats the STEM area as discrete subjects. That is, although science, mathematics, and technologies are separate learning areas within the Australian Curriculum, there is provision for these subjects to be integrated within the science, technology, engineering, and mathematics (STEM) framework. The Australian Curriculum addresses STEM through the learning areas of science, technologies, and mathematics, as well as through selected general capabilities: numeracy, information and communication technology capability, and critical and creative thinking. The engineering component of STEM is also addressed in technologies through the provision of a specific content description that focuses on engineering principles and systems. Finally, the Australian Curriculum provides opportunities for strengthening and enriching students' STEM knowledge, understanding, and skills through emphasising the connections between learning areas (ACARA, 2017). Different schools within each state are tackling the issue of integrating STEM in different and often innovative ways. As described below, the school at which the research took place sought to enhance the use of STEM by combining science and mathematics classes.

1.2.2 The Research Site

The site at which the present study was conducted, was a school located in a southern suburb of Adelaide (the capital of South Australia). The suburbs surrounding the school were positioned around 21 km south of the Adelaide city centre. At the time the study was conducted, nearly all of the students enrolled at the school lived in the local suburbs, which were situated along the coast, with minimal commercial or industrial activity. The school was opened in 1987 and moved from its original reception to year 10 configuration to a reception to year 12 configuration in 1996. As such, the school was one of only six reception to year 12 schools in the metropolitan area of Adelaide at the time my study took place. The enrolment of 1,280 students was organised into three levels: a junior school (catering for reception to years 6), a middle school (catering for years 7 to 9), and a senior school (catering for years 10 to 12).

In line with the STEM Skills Strategy outlined in Section 1.2.1.3 and the STEM education initiatives outlined in Section 1.1.1.3, the school has, since 2011, participated in the Australian government's Advanced Technology Project, which focuses on STEM and the integration of the mathematics, science, and technology learning areas. In accordance with the objectives of the South Australian Government and the Department of Education, the main aim of the Advanced Technology Project and other in-school STEM programmes was to improve students' experiences in learning science and mathematics as well as their motivation and engagement in STEM learning areas. It is important to note that, at the time that my study was conducted and in line with these STEM programmes, all mathematics and science teachers in Advanced Technology Project schools were teaching mathematics and science to the same classes as an integrated subject and were encouraged to include technology (such as iPads, data loggers, computer simulations, and graphing calculators) and STEM-integrated units (described below) in their teaching.

At the research school, students from years 6 to 11 were, at the time of this study, involved in various STEM activities ranging from STEM-integrated teaching and learning units to using iPads. The innovative units were varied and included ideas related to energy efficiency and sustainability; nanotechnology; the Science–Technology–Engineering Leveraging Relevance Project; robotics; and integrating science, technologies, engineering, and mathematics. The use of iPads in students' learning included programmes such as data loggers, graphical calculators, two- and three-dimensional computer simulations.

At the time of the study, the school was running a number of STEM engagement programs in cooperation with the University of Adelaide, the University of South Australia, and Flinders University. For example, the school ran STEM mentoring programmes; STEM career presentations; STEM university pathways presentations; and workshops on chemistry, nanotechnology, physics, biology, and genetics. Local industry representatives and university academics were, at the time of the study, regularly invited to speak about the importance of learning science and mathematics at middle and senior school assemblies. These guest speakers sought to raise students' awareness of the opportunities that existed in STEM areas and to boost students' motivation and engagement for learning STEM disciplines by sharing their own life stories and experiences in STEM.

At the time of this study, a co-curricular STEM Gifted and Talented Programme was also implemented at the school for students enrolled in years 7 to 10. This programme aimed to provide gifted and talented students with extensive and challenging experiences in STEM that would take students out of the comfort zones of their everyday school experiences and allow them to participate in mind-challenging activities beyond those provided in their regular school programme. The gifted and talented programme provided advanced conceptual opportunities for discovery learning and stimulated higher-order thinking skills.

To summarise, in order to support the increasing focus on STEM education and to provide students with opportunities to develop their skills in STEM areas, mathematics and science subjects in the research site were integrated and taught as one subject across years 7 to 10. Further, STEM-integrated units were included in the school's mathematics and science curriculum. The use of technology and the integration of mathematics, engineering, and science principles influenced class activities and assessment tasks.

1.3 Conceptual Framework

Whereas the previous section described the context in which the study took place, this section outlines the research paradigms that informed the present study and summarises how key features of these paradigms were reflected in the research. The study reported in this thesis involved multi-method research combined with the implementation of action research concepts. The multi-method approach included the use of both qualitative and quantitative methods in order to address different aspects of the research problem. Combining different research methods under the same investigation allowed to broaden the scope of the research and obtain a more comprehensive picture of the investigated concepts (Morse, 2003).

Given the multi-method nature of the study, it was necessary to draw more than one paradigm at different stages. Neither the interpretivist paradigm nor the positivist paradigm alone provided a sufficient foundation for the study. This section describes how the study commenced from a more objectivist stance, favouring a post-positivist paradigm (a positivist–deductive quantitative component of the study), and then shifted to an interpretivist stance at the qualitative component of the study. Finally this section describes the paradigm of praxis (Freire, 1986) that was used to underpin the action research component of the study.

The first phase of the study involved a quantitative component that drew on the positivist paradigm. The positivist paradigm, also known as the empirical paradigm, originated from logical positivism in philosophy and is based on a belief that knowledge is only authentic if it is observable and verifiable. In this paradigm, a hypothesis is generally formulated from theory first, and then data is collected in order to test the validity of the hypothesis in real situations. In the current study, it was hypothesised that students' perceptions of the learning environment could impact on their self-report of motivation and self-regulation. The positivist paradigm was considered appropriate for the current study because it would allow the use of quantitative instruments to assess a large number of students, thereby providing a large-scale overview of students' perceptions from which generalisations could be formed.

The qualitative component of the study drew on the interpretivist paradigm. The interpretivist paradigm is usually based on individual people's view of reality and assumes that reality is socially constructed (Anderson, 1998). The view of reality is considered and understood from the participants' perspectives. Interpretive research is generally descriptive and inductive and typically uses qualitative research methods (Creswell, 1998).

In addition to the positivist–deductive (quantitative) and interpretivist–inductive (qualitative) components of the present study, a praxis action research component was also included in the study. The paradigm of praxis has been used by educators to describe a cyclical process of experiential learning, involving both reflection and action that are directed at the structures to be transformed (Freire, 1986). Praxis is a self-reflective form of inquiry undertaken by participants in social or educational situations in an effort to improve their practices or their understanding of these practices (Carr & Kemmis, 1983; Kemmis & McTaggart, 1988). These was applied to the current study during the action research component.

1.4 Objectives of the Study

The overarching aim of the study reported in this thesis was two-fold. It sought first to investigate the impact of students' perception of the learning environment on self-reports of students' motivation and self-regulation in mathematics and science, and, second, to examine how student feedback could be used to change the learning environments with a view to improving students' motivation and self-regulation in mathematics and science classes. As such, it was hypothesised, first, that students' perceptions of the psychosocial learning environment would influence student motivation and self-regulation and, second, that teachers could use feedback based on students' perceptions of the learning environment to improve their motivation and self-regulation.

Two instruments were used to gather data related to students' perceptions of their learning environment and self-reports of motivation and self-regulatory beliefs. To ensure confidence in the results obtained in the study, it was necessary to provide evidence to support the reliability and validity of these instruments. Therefore, the first research objective was:

> To investigate the reliability and validity of the surveys assessing students' perceptions of the classroom learning environment and their motivational and self-regulatory beliefs when used in middle school mathematics and science classes in South Australia.

Once the reliability and validity of the surveys had been established, the study sought to identify the factors within the classroom environments that were likely to influence students' motivational and self-regulatory beliefs. Although past research has provided some evidence to suggest that the learning environment is related to a range of student affective outcomes (den Brok, Fisher, Rickards, & Bull, 2006; Velayutham, Aldridge, & Fraser, 2011, 2013) and that the learning environment can be a strong predictor of students' attitudes and self-efficacy beliefs (Dorman, 2001; Fraser, 2012, 2014; Walker, 2006), to the best of my knowledge, associations between the learning environment and student motivation and self-regulation in combined mathematics and science classes had not been examined prior to my study. As such, the next research objective sought to examine which learning environment constructs were most likely to impact students' motivation and self-regulation in mathematics and science classes. Therefore, the second research objective was:

> To examine which learning environment constructs are most likely to contribute towards students' motivation and self-regulation in mathematics and science.

Past research in the field of learning environments has provided strong support for the efficacy of using student feedback to guide improvements in teacher practice (Fraser & Fisher, 1982, 1986; McRobbie & Fraser, 1993; Telli, Cakiroglu, & den Brok, 2006; Velayutham et al., 2011, 2013). However, to date, few studies have examined whether student feedback can be used in this way in STEM classrooms specifically, and even fewer studies have focused on environment–outcome relationships. It was anticipated that the information, provided in response to the previous research objective, could help teachers to make decisions about where they might focus their energy in terms of making improvements to the learning environment. Drawing on these results, regarding the environment–motivational associations, alongside student feedback, one teacher used action research to develop strategies that it was hoped would lead to improvements in students' perceptions of the learning environment and their motivation and self-regulation. Therefore, the third research objective was:

> To examine the effectiveness of reflecting on and using student feedback to guide changes in the learning environments to improve students' motivation and self-regulation.

1.5 Significance of the Research

This section provides a brief overview of the significance of the research reported in this thesis. This information is expanded upon in Chapter 5.

First, the research reported in this thesis provided evidence to support the reliability and validity of two instruments when used in South Australian secondary schools. Together, the two instruments—one to assess students' perceptions of their learning environments and the other to assess students' motivational and self-regulation beliefs—offer an economical and efficient means for teachers to collect feedback that can be used for reflection and to help guide improvement in their teaching practices.

Second, the research presented in this thesis is significant to both researchers and practitioners because it identified salient psychosocial elements in the classroom learning environment that are likely to influence students' motivation and self-regulation in mathematics and science learning. This was achieved through investigating the links between various learning environment factors and students' motivational and self-regulatory beliefs.

Third, the present research is significant because it includes practical action research component which explores, in a smaller way, how the possibility of modifying the learning environment based on students' feedback, might be used to improve students' motivation. The data derived from the student surveys were used by a critical instance case study teacher as part of an action research process that involved reflective practices Although a number of studies have explored the relationships between learning environment constructs and various student learning outcomes (Dorman, 2001; Fraser, 2012; Schunk & Zimmerman, 2007; Urdan & Schoenfelder, 2006), this study sought to explore how changing malleable features of classroom environments (such as teaching strategies) might enhance student motivation.

1.6 Thesis Overview

The research that formed the foundation of this thesis is reported in five chapters. A background to the research including a description of the context was provided in Chapter 1. This chapter also introduced the research objectives and explained the theoretical framework that the research draws upon. Finally, Chapter 1 briefly discussed the significance of the research and presented an overview of the organisation of the thesis.

In Chapter 2, a review of past research relevant to the study reported in this thesis is presented. This chapter begins with a review of social cognitive theory, which underpins the research. This chapter goes on to review of research related to the field of learning environments, teacher action research, and motivation. Given that one of the objectives of the study was to validate two instruments that measure students' perceptions of their learning environments and students' motivation and self-regulation, the chapter reviews past research related to these areas and the instruments that have previously been developed to assess them.

Chapter 3 provides a description of the research methods used in the study and provides insight into related procedural aspects. This chapter describes the multi-method design and the action research process that were used to address the research objectives. Chapter 3 also provides details of the sample obtained for the study, the duration of the research, and the data collection methods.

The data analyses and results related to each research objective of this study are reported in Chapter 4. This chapter begins by reporting the evidence used to support the validity of the two instruments used to collect the quantitative data. The chapter goes onto report the results related to the analysis used to investigate learning environment–motivation associations. Chapter 4 then goes on to report the results of how the case study teacher used student perception data to reflect, plan, and implement changes in her classrooms, with the aim of improving her students' perceptions of the learning environment and their motivation and self-regulation.

Chapter 5 provides a summary and discussion of the results that were obtained in relation to the three research objectives. This chapter also considers the contributions made by this research as well as the key limitations of the study. Finally, Chapter 5 provides suggestions for future research related to learning environments and motivation as well as the suggestions for action research that utilises student feedback as the key driver for improvements in classroom environments and students' motivation and self-regulation.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Whereas the previous chapter provided an introduction to the thesis, this chapter provides a review of literature related to the research areas that are pertinent to the present study. The literature review starts by introducing social–cognitive theory and its relevance to the present study (Section 2.2). The next section (Section 2.3) provides an overview of research in the field of learning environments, including reviewing the history of research on learning environments and a selection of important instruments that have been designed to assess students' perceptions of learning environments. Section 2.5 then provides an overview of past studies related to action research. Research related to students' motivational beliefs and self-regulation is reviewed in Section 2.4. Finally, a summary of the chapter is provided in Section 2.6.

2.2 Social-Cognitive Theory

The fundamental concepts of the present study include the interconnections between personal influences (students' motivational beliefs), environmental factors (teaching strategies, classroom activities, relationships and other learning environment factors), and behaviours (self-regulation and engagement). Within the field of psychology, there are a range of learning theories that explain those interconnections. One of those theories, Bandura's social-cognitive theory, was drawn on for the purpose of this study and is expanded upon in this section.

Within the field of psychology, there are a range of learning theories that explain the processes of learning, motivation and development. One of those theories, Bandura's social-cognitive theory, was proposed in 1977. Bandura's social-cognitive theory is rooted in traditional learning theory concepts such as drives, cues, responses, and rewards (Miller & Dollard, 1941), but adds social learning concepts related to social learning. Bandura's (1977) theory introduces the principles of social motivation into traditional learning theories and also encompasses several further considerations:

observational learning (a form of social learning that occurs through observing the behaviour of others), vicarious experiences (a form of social learning that occurs through observing the experiences of others), and concepts of self-efficacy (that is, the strength of a person’s self-beliefs related to their ability to complete tasks or achieve desired goals; Bandura & Walters, 1963).

Social–cognitive theory conceptualises students’ learning in terms of the interconnections between personal influences (such as students’ thoughts or beliefs), environmental factors (such as classroom activities), and behaviours (such as self-regulation; Bandura, 1977). The primary focuses of social–cognitive theory are, first, the particular behavioural patterns obtained and sustained by people, and, second, the environmental factors influencing people’s behaviour.

Social–cognitive theory explains human behaviour in terms of reciprocal determinism. The model involves three sources of influence (personal determinants, environmental factors and behaviours). They are seen as being reciprocally connected and influencing each other (Bandura, 1977, 1986). Figure 2.1 provides a visual representation of reciprocal determinism defined by Bandura, 1977. As illustrated by the double-headed arrows, the sources of influences are bidirectional and interact with each other. It should be noted that reciprocal determinism does not mean either that the different sources of influence are of equal strength or that they occur simultaneously.

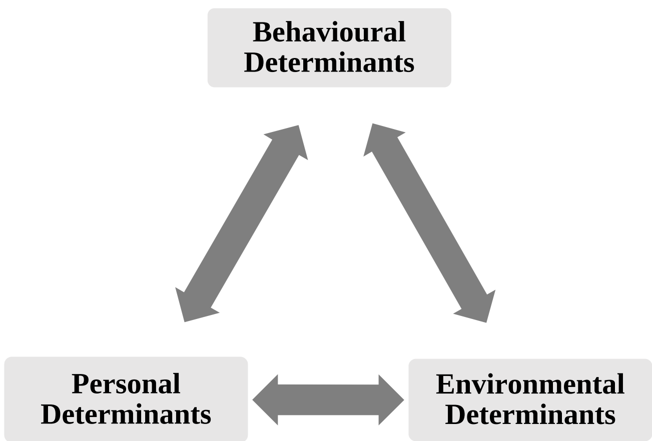

Figure 2.1. Reciprocal determinism in social–cognitive theory

The reciprocal interactions, between personal determinants (e.g., physical or biological characteristics, thoughts, emotions, values, beliefs, expectations, perceptions, and intentions) and behavioural determinants (e.g., actions and behavioural patterns), shows the relationship between what people feel, think, and believe and their behaviour. For example, a student with low self-efficacy beliefs (personal determinant) might refuse to participate in more challenging classroom activities (behavioural outcome). Conversely, receiving a low grade on a test or answering a teacher's question incorrectly (behavioural determinant) might negatively influence a student's confidence and self-efficacy beliefs (personal outcome).

The reciprocal interrelationships between personal determinants and environmental determinants suggests that personal determinants can affect people's social environments and vice versa. For example, people can prompt particular reactions from their social environment as a result of their age, race, or physical attractiveness even before they say or do anything. People can similarly evoke different reactions depending on their socially conferred roles and status. For example, a tall, young, male teacher might be more successful in calming his class down after an active physical exercise than an old, small-in-stature, female teacher. Social environments, in turn, can activate different emotions and cause different reactions in people (e.g., through modelling, instruction and social persuasion; Bandura, 1989). For example, if teachers, who are integral members of classroom environments, use interesting and engaging learning activities (environmental determinants), this may evoke positive emotions such as interest, enthusiasm, laughter, action and curiosity among students (personal outcome). Similarly, teachers' praise and encouragement (environmental determinants) can positively affect students' confidence and self-efficacy beliefs (personal outcome).

The reciprocal interaction between behavioural and environmental determinants is related to the influences between behavioural and environmental factors which acknowledges that people are both "products and producers" of their environment (Bandura, 1989, p. 4). For example, teachers can influence classroom environments (environmental determinant) through the teaching and learning activities that they select. Personal factors, such as students preferences and capabilities (personal determinant), can also influence the classroom learning environments (environmental outcome; Liao, Liu, & Loi, 2010). For example, in an advanced science class, the students' abilities (personal determinant) may determine which assessment tasks (environmental factor) are selected by the teacher. Environmental determinants, in turn, decide which actions and forms of behaviour are developed and activated. Raush (1965) found that through their actions, people are able to create and select their environments. For example, as a component of the environment, a teacher who approaches students in an intimidating way when persuading them to follow instructions could cause hostile behaviours from the students in response (behavioural outcome).

Past research indicates that it is important to consider students' behaviours through the lens of social–cognitive theory and to advance our understanding of classroom environment factors that could affect students' motivation and engagement (Schunk & Zimmerman, 2007). Past research also indicates that teachers who have the most influence over classroom learning environments, are able to create positive classroom environments (environmental factor) in which students may be more motivated (personal factor) and productive (behavioural factor; Urdan & Schoenfelder, 2006).

In the past, research related to the field of learning environments has used a social–cognitive theory in investigating the effects of the learning environment (as an environmental determinant) on students' motivational beliefs (personal determinant) and self-regulatory practices (behavioural determinant) in science learning (Velayutham et al., 2011, 2013). In the study reported in this thesis, social–cognitive theory was used to inform the analysis of data in determining which learning environment characteristics were likely to influence student behaviour. Social–cognitive theory also provided a basis for the development of teaching intervention strategies that were designed to elicit personal (motivational) and behavioural (self-regulation) changes among students.

2.3 Learning Environment Research

The present research also included an investigation of how learning environment factors directly and indirectly influence students' learning and affective outcomes;

including their motivation to learn. It was important, therefore, to review literature associated with the area of learning environment research.

The Glossary of Education Reform (2014) describes the learning environment as the range of varied physical locations, contexts and cultures in which students learn. The glossary states that the learning environment includes the culture of a class (e.g., its characteristics, ethos, and interactions) and the ways in which teachers facilitate learning (e.g., grouping desks; positioning visual learning materials; and utilising audio, video, and Information Technology resources). The Glossary of Education Reform specifies that the characteristics of a learning environment are determined by a number of factors including school policies and governance structures. The Glossary of Education Reform highlights the importance of learning environments due to their direct and indirect influence on students' learning; engagement in learning activities; motivation to learn; and sense of well-being, belonging, and personal safety.

According to Fraser (2012), learning environments are the places where learning occurs and generally includes two components: the social and the physical environments. According to Fraser (1998, 2012, 2014), the social environment consists of the teachers and students and the interactions between them, whereas the physical environment consists of the physical settings and materials (e.g., the physical arrangements of desks, chairs, and lighting).

Given these understandings of what learning environments are, the remainder of this section provides an overview of literature associated with the field of learning environment research. In Section 2.3.1, an outline of the history of learning environment research is provided. Section 2.3.2 then reviews ten important learning environment surveys that have been developed over the past 50 years.

2.3.1 History of the Field of Learning Environments

Learning environment research originated from social psychology. The first recorded research that involved learning environments was conducted by Thomas (1929) and involved classroom observations. The basis for contemporary learning environment research, however, is Lewin's (1935) theory, which suggests that behaviour can be described as the interaction between the individual and his or her environment.

Although Lewin (1935) recognised that both the individual and the environment influence people's behaviours, he did not explain the nature of this influence. This aspect was elucidated by Murray (1938, 1951) in his need-press model. The model proposed that the behaviour of an individual can be affected by their environment and its pressures (which may be conscious or unconscious, physiological or psychological, and hidden or openly expressed). These pressures were explained as the forces on an individual's behaviour. The forces could either endorse or impede the realisation of the needs. Murray (1951) classified those pressures as alpha press (referred to the *actual* environment) and beta press (referred to the *perceived* environment). This model was further extended by Stern, Stein, and Bloom (1956), who clarified that alpha press can be understood as a consensual group view of the environment, whereas beta press can be understood as a personal view. This early person-environment fit research was fundamental for educational environment studies and was expanded in the work of Moos (1974) and Walberg (1968).

Moos (1974) proposed a theory that concentrated mainly on personal perceptions of the environment. He divided the human environment into three different dimensions: relationship, system maintenance and change, and personal growth. The relationship dimension encompasses the nature and intensity of interpersonal relationships (e.g., a person's involvement in their environment, how individuals help each another, or whether there is a free exchange of ideas). In classroom settings, this dimension refers to the interactions between the teacher and the students and those between students. Moos (1974) suggested that the classroom environment plays a considerable role in influencing students' perceptions of the teacher and, as a result, influences how they perform in the subject.

In Moos' theoretical framework, the system maintenance and change dimension relates to the degree to which the environment is orderly, clear in expectations, controlled and responsive. This dimension includes order and organisation, clarity, control, and innovation. Whereas order and organisation are concerned with students' orderly behaviour and the organisation of classroom activities, the clarity component considers the clarity of classroom expectations and consequences for breaking class rules. The control component describes the extent to which the teacher enforces rules and expectations and the harshness of the consequences used. Finally, innovation considers the degree to which students contribute to planning classroom activities as well as the extent to which the teacher uses new strategies or promotes creative thinking among students.

The final dimension in Moos' (1974) framework, personal growth, encompasses students' personal development and self-enhancement (e.g., completing planned activities and staying on task). Moos' conceptual framework provided a platform for the development of new research instruments such as the Classroom Environment Scale (Trickett & Moos, 1973). The model could be used to assess various aspects of learning environments.

Walberg (1976) established that valid assessments could be made using students' perceptual data and that such data could be used in learning environment research. He proposed a model of educational productivity in which students' outcomes are influenced by the quantity and quality of instruction as well as the psychosocial environments of the school or class, the home, the peer group, and the mass media. Walberg also designed a new survey that examined students' perceptions of the social climate of secondary classrooms (Fraser, Walberg, Welch, & Hattie, 1987; Walberg & Anderson, 1968).

Research examining the interrelationships between students' perceptions of their learning environments and students' cognitive and affective learning outcomes (Fraser & Fisher, 1982; McRobbie & Fraser, 1993; Zandvliet & Fraser, 2004, 2005) is directly related to my study. These interrelationships have been explored in past studies involving science learning at different year levels (Fraser & Fisher, 1982; Fraser & Treagust, 1986; McRobbie & Fraser, 1993; Velayutham et al., 2011, 2013). Fraser (2012, 2014), in his reviews of past learning environment research, noted that a wide range of studies have been conducted throughout the world in different subjects (including mathematics, science, English, geography, computing), at different grade levels (including elementary, secondary, higher education), using multiple outcome measures (including achievement, attitude, self-efficacy), and using different learning environment questionnaires.

The relationships between learning environment factors and students' motivation and self-regulation (as factors contributing to students' learning outcomes) are especially relevant to the present study. Velayutham et al. (2011, 2013) suggested that sources of self-efficacy and motivation beliefs can be found within the psychosocial learning environment. If, for instance, students feel unfairly treated by their teacher, they may choose not to engage in classroom activities even if they possess high motivation and self-efficacy beliefs. Previous research that has explored the interrelationships between students' perceptions of classroom learning environments and their motivation, although limited, has provided some evidence to suggest that learning environment factors are likely to influence students' motivation and self-regulation (Fraser, 2012; Lorsbach & Jinks, 1999; Velayutham et al., 2011, 2013) as well as students' self-efficacy beliefs (Dorman, 2001; Dorman & Fraser, 2009; Velayutham et al., 2011, 2013). Past research related to the relationship between the learning environment and motivation is reviewed in Section 2.5.4.

According to previous research, students' perceptions of their learning environments affect students' motivation and engagement in classroom activities. The current study, therefore, assessed students' perceptions of their learning environment and examined whether improving students' perceptions of their learning environments could improve the students' motivation and self-efficacy beliefs. The next section (Section 2.3.2) reviews a selection of existing surveys for evaluating students' perceptions of aspects of their learning environments.

2.3.2 Instruments for Assessing the Classroom Environment

The present study also involved assessment of learning environment factors. Therefore, it was important to review the range of instruments available to ensure that the most suitable, efficient and economical tool for evaluation of learning environment constructs was selected.

There has been considerable progress in the field of learning environment research over the past 50 years in terms of the ways to conceptualise, assess, and examine the factors and effects associated with learning environments (Fraser, 2012, 2014). A wide variety of learning environment questionnaires have been designed for use in various settings. This section (Section 2.3.2) describes 10 historically important classroom learning environment surveys published over the past 50 years:

- The Learning Environment Inventory (LEI; Walberg & Anderson, 1968; see Section 2.3.2.1);
- The Classroom Environment Scale (CES; Trickett & Moos, 1973; see Section 2.3.2.2);
- The Individualised Classroom Environment Questionnaire (ICEQ; Rentoul and Fraser, 1979; see Section 2.3.2.3);
- The My Class Inventory (MCI; Fisher & Fraser, 1981; see Section 2.3.2.4);
- The College and University Classroom Environment Inventory (CUCEI; Fraser & Treagust, 1986; see Section 2.3.2.5);
- The Science Laboratory Environment Inventory (SLEI; Fraser, Giddings and McRobbie, 1995; see Section 2.3.2.6};
- The Questionnaire on Teacher Interaction (QTI; Wubbels, Creton and Hooymayers, 1992; see Section 2.3.2.7);
- The Constructivist Learning Environment Survey (CLES; Taylor, Fraser & Fisher, 1997; see Section 2.3.2.8);
- The What Is Happening In This Class? Questionnaire (WIHIC; Fisher and McRobbie. 1996; see Section 2.3.2.9); and
- The Constructivist-Oriented Learning Environment Survey (COLES; Aldridge, Fraser, Bell and Dorman, 2012; see Section 2.3.2.10).

2.3.2.1 Learning Environment Inventory (LEI)

The Learning Environment Inventory (LEI), was developed and validated as part of the Harvard Project Physics activities in the 1960s to assess students' perceptions of the social climate of secondary classrooms (Walberg & Anderson, 1968). The LEI was one of the first instruments in learning environment research that allowed valid assessment of students' perceptions (Fraser, 2014). The final version of the LEI consisted of 105 items (seven items per scale) assessing 15 dimensions (cohesiveness, friction, favouritism, cliqueness, satisfaction, apathy, speed, difficulty, competitiveness, diversity, formality, material environment, goal direction, disorganisation, and democracy) that were considered to be descriptive of typical classroom environments (Fraser, 2014). The items have four response alternatives, namely, strongly disagree, disagree, agree, or strongly agree. The scoring direction is reversed for approximately half of the items. A sample item from the cohesiveness scale is “All students know each other very well”; a sample item from the speed scale is “The pace of the class is rushed”.

The LEI has been widely utilised to explore the links between students’ perceptions of their learning environment and their outcomes (Hirata & Sako, 1998; Hofstein, Gluzman, Ben-Zvi, & Samuel, 1979; Power & Tisher, 1979; Walberg, 1968a, 1968b). Despite its wide use, however, the instrument’s factorial validity was never established. The LEI was not used in the present study because it was considered to be too large (105 items) and, therefore, its administration would be too time-consuming. In addition, the language used in the instrument was considered to be too difficult for high school students and relevant to more traditional classrooms.

2.3.2.2 Classroom Environment Scale (CES)

As described in Section 2.3.1, Rudolf Moos (1974) proposed that aspects of the classroom environment can influence students' learning outcomes. In his research, which involved perceptual measures of nine different human environments including hospitals and correctional institutions, Moos developed a historically important learning environment instrument, the Classroom Environment Scale (CES; Trickett & Moos, 1973). The CES was one of the first instruments that allowed measurement of respondents’ perceptions of their ideally liked or preferred environments.

The CES consists of nine scales: involvement, affiliation, teacher support, task orientation, competition, order and organisation, rule clarity, teacher control, and innovation. Each scale includes 10 items that are responded to using a true–false response format. A sample item from the teacher support scale is “The teacher takes a personal interest in the students”; a sample item from the rule clarity scale is “There is a clear set of rules for students to follow.” The scoring is reversed for almost half of the items. The validity and reliability of the CES have been widely tested by past researchers (Fisher & Fraser, 1983; Keyser & Barling, 1981; Moos & Moos, 1978).

The CES was not selected for the present study because it was considered to be designed for the more teacher-centred classrooms of the past than for today’s student-centred environments. Another shortcoming of the CES is its two-point true–false response scale, which is considered to be not an accurate assessment of students’ perceptions.

2.3.2.3 Individualised Classroom Environment Questionnaire (ICEQ)

The Individualised Classroom Environment Questionnaire (ICEQ) was designed by Rentoul and Fraser (1979) to examine learning environment constructs associated with individualised and inquiry-based education settings. This instrument was one of the first surveys that were designed to evaluate the learning environment in more student-centred classrooms (Fraser, 1979). The ICEQ was also the first instrument to incorporate an Investigation scale as an important component of the contemporary inquiry-based approach in science education (Fraser, 2014).

The ICEQ assesses dimensions that differentiate between individualised and traditional classrooms. The ICEQ consists of 50 items, with 10 items in each of five scales: personalisation, participation, independence, investigation, and differentiation. The items are responded to using a five-point frequency scale of almost never, seldom, sometimes, often, and very often. Sample items are “The teacher considers students’ feelings” for the personalisation scale and “Different students use different books, equipment and materials” for the differentiation scale. The validity and reliability of the ICEQ have been previously established (Ashgar & Fraser, 1995; Fraser, Pearse, & Azmi, 1982).

Although some of the ICEQ scales and dimensions (particularly Differentiation) were considered to be relevant to the present study, the ICEQ was specifically designed for inquiry-based science learning. Therefore, the decision was made not to use the ICEQ in the present study, which involved the investigation of learning environments in science and mathematics classes.

2.3.2.4 My Class Inventory (MCI)

The My Class Inventory (MCI) was modified from the LEI (see Section 2.3.2.1) for use with primary school students and then used in other studies (Fisher & Fraser, 1981; Fraser, Anderson, & Walberg, 1982; Fraser & O’Brien, 1985). The final version of the MCI has 35 items within five scales: cohesiveness, friction, satisfaction, difficulty, and competitiveness. Each item is responded to using a two-point yes–no format. Sample items include “Children are always fighting with each other” for the friction scale and “Children seem to like the class” for the satisfaction scale. The MCI has been widely validated and used successfully in several countries, including: Brunei Darussalam (Majeed, Fraser, & Aldridge, 2002), the United States of America (Scott Houston, Fraser, & Ledbetter, 2008; Sink & Spencer, 2005), and Singapore (Goh, Young, & Fraser, 1995).

The MCI was not chosen for the present study as it had originally been designed for primary school students.

2.3.2.5 College and University Classroom Environment Inventory (CUCEI)

The College and University Classroom Environment Inventory (CUCEI) was designed by Fraser and Treagust (1986) to evaluate learning environment constructs in tutorial classes at the tertiary educational level. To develop the CUCEI, salient factors from three past surveys—the LEI, CES, and ICEQ—were examined to allow the use of the new questionnaire in tertiary educational settings. The CUCEI includes seven scales: personalisation, involvement, student cohesiveness, satisfaction, task orientation, innovation, and individualisation. Sample items include “Activities in this class are clearly and carefully planned” for the task orientation scale and “Teaching approaches allow students to proceed at their own pace” for the individualisation scale. The response format involves a four-point Likert scale ranging from “strongly agree” to “strongly disagree”.

In Australia, Yarrow, Millwater, and Fraser (1997) validated the CUCEI and used it to assess preservice primary teachers' perceptions of their university classroom environment. Yarrow et al. (1997) administered the CUCEI to obtain the teachers' perceptions of their actual and preferred classroom environments; they then re-administered the CUCEI 10 weeks later to measure any changes in the actual classroom environment. The results demonstrated that the CUCEI can be used to guide improvements in teaching.

Later, the CUCEI was modified by Nair and Fisher (2000), who replaced the involvement and satisfaction scales with a cooperation scale and an equity scale. Nair and Fisher (2000) also changed the four-point response format to a five-point frequency rating scale of almost never, seldom, sometimes, often, and almost always. Finally, the items related to each scale were grouped together in blocks.

The CUCEI was designed for use in the tertiary education, and its validity and reliability were not well-established despite the survey having been used by past researchers (Fraser, 1991; Joiner, Malone, & Haimes, 2002; Nair & Fisher, 2000; Yarrow et al., 1997; Fraser, Williamson, & Tobin, 1987). As such, this survey was not used in the present research.

2.3.2.6 Science Laboratory Environment Inventory (SLEI)

The Science Laboratory Environment Inventory (SLEI) was designed by Fraser, Giddings, and McRobbie (1995) to evaluate the unique setting of practical science classes. The questionnaire consists of five scales: student cohesiveness, open-endedness, integration, rule clarity, and material environment. Each scale consists of seven items. The response format includes a five-point frequency scale ranging from almost never to very often. Sample items are "I use the theory from my regular science class sessions during laboratory activities" for the integration scale and "We know the results that we are supposed to get before we commence a laboratory activity" for the open-endedness scale.

When the SLEI was first field tested and validated, the sample involved 5,447 students from six countries: Australia, Canada, England, Israel, Nigeria, and the USA (Fraser et al., 1995). Further evidence to support the reliability and validity of the SLEI has been provided in a number of past studies in Australia (Fisher, Henderson, & Fraser, 1997) and Singapore (Quek, Wong, & Fraser, 2005; Wong & Fraser, 1996).

Another study was undertaken in Miami, Florida, to evaluate the use of anthropometric[1] activities in terms of student outcomes and the classroom environment (Lightburn & Fraser, 2007). This study involved 761 biology students in 25 classes in a suburban public high school. Data analysis supported the internal consistency reliability and the factorial validity of the SLEI. However, this instrument was not selected for the current research because of its narrow focus on science laboratories.

2.3.2.7 Questionnaire on Teacher Interaction (QTI)

The Questionnaire on Teacher Interaction (QTI) was designed by Wubbels, Creton, and Hooymayers (1992) in the Netherlands. The QTI was specifically developed to assess students' and teachers' perceptions of interpersonal teacher behaviour (Wubbels & Levy, 1993). The theoretical model of proximity and influence proposed by Leary (1957) was used by Wubbels & Levy (1993) to develop the QTI. Wubbels & Levy (1993) specified Cooperation–opposition (as elements of proximity) and dominance–submission (as elements of influence) as survey dimensions and represented them in a coordinate system by eight scales: leadership, understanding, helping/friendly, uncertain, dissatisfied, admonishing, strict behaviour, and student responsibility/freedom. The response format for the QTI involves a five-point frequency scale ranging from never to always. Sample items include "This teacher explains things clearly" for the leadership scale and "This teacher is impatient" for the admonishing scale.

The QTI has been used and widely validated at different year levels and in different countries including: the USA (Wubbels & Levy, 1993); Australia (Fisher, Henderson, & Fraser, 1995; Henderson, Fisher, & Fraser, 2000); Singapore (Goh & Fraser, 1998; Quek et al., 2005); Turkey (Telli et al., 2006); Korea (Kim, Fisher, & Fraser, 2000;

[1] Adjective for noun "Antropometry" - the study of human body measurements especially on a comparative basis (Merriam-Webster, 2017)

Lee, Fraser, & Fisher, 2003); Brunei Darussalam (Scott & Fisher, 2004); and Indonesia (Fraser, Aldridge, & Soerjaningsih, 2010).

The QTI was not used in the present study because it has a narrow focus (only assessing student perceptions of interpersonal teacher behaviour), which excludes other dimensions of the classroom environment.

2.3.2.8 Constructivist Learning Environment Survey (CLES)

The development of the constructivist, more student-centred approach in science education in the 1990s motivated the development of the Constructivist Learning Environment Survey (CLES; Taylor et al., 1997). This survey marked the development of a new in the field of learning environment research way of arranging surveys with the items forming individual scales being grouped together in blocks. The CLES was designed to evaluate the degree to which a specific learning environment is consistent with constructivist epistemology, to support teachers in reflections on their epistemological beliefs, and to alter teachers' instructional strategies (Taylor et al., 1997).

The CLES includes five scales: personal relevance, uncertainty, critical voice, shared control, and student negotiation. Each scale consists of six items. The response format involves a five-point frequency scale ranging from almost never to almost always. Sample items are "I learn that science has changed over time" for the uncertainty scale and "It's okay for me to express my opinions" for the critical voice scale.

The CLES has undergone modifications and been reduced to a 20-item survey (Aldridge, Fraser, Taylor, & Chen, 2000). The modified version has been validated in a range of studies in the USA (Johnson & McClure, 2004; Nix, Fraser, & Ledbetter, 2005); South Africa (Aldridge, Fraser, & Sebela, 2004); Korea (Kim et al., 2000); Taiwan and Australia (Aldridge et al., 2000); and Singapore (Koh & Fraser, 2014). The original CLES was also modified, translated into Spanish, and validated in a study involving 739 primary school science students in Miami, Florida (Peiro & Fraser, 2009).

In Singapore, Koh and Fraser (2014) used the CLES to assess the effectiveness of the Mixed Mode Delivery (MMD) model, which was aimed at improving students' motivation and engagement. The sample consisted of 2,216 secondary school students taught by preservice teachers in an MMD group and 991 students in a control group. When the MMD and control groups were compared in terms of the gaps between the actual and preferred classroom environments, the study showed that the MMD had positive effects on students' both actual and preferred perceptions of their learning environments.

Although constructivism is considered to be an important component of mathematics and science classrooms, this was not the focus of the present study.

2.3.2.9 What Is Happening In This Class? (WIHIC) Questionnaire

The What Is Happening In This Class? (WIHIC) questionnaire was designed by Fraser, Fisher, and McRobbie (1996). There are two versions of the WIHIC: a group form and a personal form. The group form assesses the perceptions of a whole class regarding the learning environment, whereas the personal form evaluates students' individual perceptions of the learning environment. The original questionnaire consists of 90 items in nine scales. The WIHIC has undergone modifications that have reduced the questionnaire to 56 items in seven scales: student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity (Aldridge, Fraser, & Huang, 1999). Sample items are "I give my opinions during class discussions" for the involvement scale and "I receive the same encouragement from the teacher as other students do" for the equity scale.

The WIHIC is the most widely used of all of the 10 learning environment instruments reviewed in this chapter (Fraser, 2014). It has been translated into numerous languages and cross-validated in many countries, including Australia (Dorman, Fisher, & Waldrip, 2006); Canada (Zandvliet & Fraser, 2005); the USA (den Brok, Fisher, Rickards, & Bull, 2006); Indonesia (Fraser, Aldridge, & Adolphe, 2010; Wahyudi & Treagust, 2006); New Zealand (Saunders & Fisher, 2006); Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008); Turkey (Telli et al., 2006); the United Arab Emirates (Afari, Aldridge, Fraser, & Khine, 2013; MacLeod & Fraser, 2010); and the

United States of America (Allen & Fraser, 2007; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008; Zaragoza & Fraser, 2017).

The WIHIC has many advantages, including its strong reliability and validity and its applicability to the research reported in this thesis. Despite these advantages, the survey was not used in the present study because a more recent survey, which included the dimensions of the WIHIC was available that included constructs related to assessment practices. It was the newer survey, The Constructivist-Oriented Learning Environment Survey (COLES) that was selected (described in the next section).

2.3.2.10 Constructivist Oriented Learning Environment Survey (COLES)

The COLES scales were drawn from a range of previously developed and validated instruments, including the WIHIC (Fraser et al., 1996), ICEQ (Rentoul & Fraser, 1979), and the CLES (Taylor et al., 1997). The COLES included two new important scales to assess current assessment practices, namely, Formative assessment and Clarity of assessment criteria.

The COLES consists of 11 scales that can be broadly clustered into three groups: relationships (including the student cohesiveness, teacher support, equity, and young adult ethos scales); assessment (including the clarity of assessment criteria and formative assessment scales); and delivery (including the task orientation, differentiation, personal relevance, involvement, and cooperation scales). Sample items include “The extent to which students know, help and are supportive of one another” for the student cohesiveness scale and “The extent to which students feel that the assessment tasks given to them make a positive contribution to their learning” for the formative assessment scale.

The validity and reliability of the COLES, as well as its relevance to teacher action research, were established in a study conducted by Bell and Aldridge in 2014. Therefore, this instrument was considered to be suitable for use in the present study. A more detailed description of the COLES is provided in Chapter 3, and evidence to support the reliability of the survey when used in South Australia is provided in Chapter 4.

The next section (Section 2.5) provides an overview of the history of action research, its main components, and its applications in education. Action research was relevant to the present study because action research techniques could be utilised in efforts to improve aspects of the learning environment and students' motivational beliefs.

2.4 Motivation

Whereas the previous section reviewed instruments for assessing classroom environments, this section (Section 2.4) reviews literature related to motivation, a fundamental concept that builds theoretical foundation of the present study. This section begins by providing a theoretical overview of the concept of motivation (Section 2.4.1). The section then outlines prominent motivational constructs that were of relevance to this study (Section 2.4.2). Next, Section 0 reviews past research on self-regulation. Section 2.4.4 examines research related to the interrelations between motivation and aspects of the learning environment. Finally, Section 2.4.5 goes on to review six of the most prominent and widely-used surveys assessing student motivational beliefs.

2.4.1 Motivational Theories

Given that the study reported in this thesis assessed students' motivational beliefs, it was considered important to review research on existing motivational theories. It is recognised that both motivation and engagement are important for effective learning (Marx & Walsh, 1988). Although the two terms "motivation" and "engagement" are often used interchangeably, these concepts have been distinguished by Russell, Ainley, and Frydenberg (2005, p. 1), who state that "Motivation is about energy and direction, the reasons for behaviour, why we do what we do. Engagement describes energy in action, the connection between person and activity."

Motivation has been defined as people's "motive related to performance on tasks involving standards of excellence" (Eccles, Wigfield, & Schiefele, 1998, p. 1017). In other words, motivation is what impels people to either engage or not engage in tasks or activities. Although researchers such as McClelland (1978) have focused on personality as the cause of motivation, motivation has also been considered from a counterbalancing perspective by Maehr and Braskamp (1986). The counter-balancing perspective suggests that socio-cultural factors, such as teachers' and parents' expectations or task expectations, counterbalance students' personal motivations. It states that social and task expectations apply to all class members as everyone is expected to meet the established expectations. From this perspective, Maehr and Braskamp (1986) conclude that an individual is likely to perform in ways that are expected by significant others and that display their motivational orientations such as persistence, direction, or making the right choices.

The main challenge for teachers nowadays, as indicated by Theobald (2006), is to create a classroom environment that inspires and motivates students to study. Schunk (1985) stated that motivation can be explained as the internal state stimulating and directing goal-oriented behaviour. Past research shows that students' motivation is a key element in enhancing students' critical thinking, conceptual learning, and learning outcomes (Al Zubaidi, Aldridge, & Khine, 2016; Boekaerts, 2010; Dumont, Istance &Benavides, 2010; Kuyper, van der Werf, & Lubbers, 2000; Lee & Brophy, 1996; Pintrich, Marx, & Boyle, 1993; Wolters, 1999). With respect to students' motivation in science learning, past research has investigated the reasons why students endeavour to learn science; how intensively they strive; and what feelings, emotions, and beliefs they have in this process (Glynn, Taasoobshirazi, & Brickman, 2009). Past studies have indicated that motivation is an important element in students' successful engagement in learning and have suggested that motivated students participate more actively in learning activities and put more time and effort into their work in order to improve their academic achievement (Pajares, 2001, 2002, 2003; Pajares & Schunk, 2001). On the other hand, students who lack motivation display signs of disengagement, passiveness or even depression and anxiety when present in class. They do not put effort into their work, give up easily, withdraw from learning activities and can have behavioural problems at school (Neo & Neo, 2009).

2.4.2 Motivational Constructs

Three motivational constructs that have been regularly researched over the past two decades are learning goal orientation, task value, and self-efficacy, each of which is essential for motivated and self-regulated learning (Velayutham et al., 2011, 2013;

Zimmerman, 2002). According to Zimmerman (2002, 2008), these three constructs (learning goal orientation, task value, and self-efficacy) are also critical components of self-regulated learning. Given the relevance of these constructs to the study reported in this thesis, they are reviewed below.

2.4.2.1 Learning Goal Orientation

To provide an understanding of students' behavioural patterns related to their motivation and engagement in learning, the constructivist perspective of achievement goal theory suggested by Kaplan and Maehr (2007) and Pintrich (2000) are reviewed in this section. This theory is considered to be one of the most important models of motivation in education (Kaplan & Maehr, 2007; Wigfield & Cambria, 2010). Ames (1992) identified the following two key concepts within achievement goal theory (see also and Wigfield & Cambria, 2010):

- The *performance goal orientation*, described as a student's determination to demonstrate knowledge, understanding, and skills to other participants involved in the learning process (for example, students might question: "Am I doing this task better than my friend?" or "Does completing this task make me look smarter than others?"); and
- The *learning goal orientation*, described as a student's determination to increase their knowledge, understanding and skills (for example, students might question: "How will I do this task?" or "What will I learn?").

Whereas some research has suggested that a performance goal orientation can be a useful contributor to students' motivation and engagement (Wigfield & Cambria, 2010), other researchers have proposed that a performance goal orientation can be destructive, especially if students lack confidence and feel that they are not sufficiently competent to successfully complete the required tasks (Kaplan & Maehr, 2007). Elliot and McGregor (1999 divided this concept into two separate categories: the *performance-approach* orientation and the *performance-avoidance* orientation. They defined a performance-approach orientation as an orientation toward achieving success, whereas they defined a performance-avoidance orientation as an orientation toward avoiding failure. Elliot and McGreger (1999) discovered that a performance-approach goal orientation is associated with purpose, positive influence, and higher academic achievements. However, in other research, a performance-approach goal orientation has been associated with negative results including low retention of knowledge, anxiety, and disruptive behaviour (Midgeley, Kaplan, & Middleton, 2001). A performance-avoidance goal orientation has been found to be associated with low efficiency, anxiety issues, a refusal to ask clarifying questions, self-handicapping, and low academic achievement (Urdan, Ryan, Anderman, & Gheen, 2002).

Studies have also found that a learning goal orientation can impact on various learning outcomes and achievements (Brookhart, Walsh, & Zientarski, 2006; Kaplan & Maehr, 2007). Past correlational studies have provided strong evidence that a learning goal orientation is positively correlated with: effective coping strategies (Elliott & Dweck, 1988); persistence, problem-solving strategies, achievement (Bereby-Meyer & Kaplan, 2005); positive attitudes towards others (Kaplan, 2004); students' selection of subjects (Cury, Elliot, Da Fonseca, & Moller, 2006; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000); effort (Elliot, McGregor, & Gable, 1999); retention of knowledge (Elliot & McGregor, 1999); self-efficacy (Kaplan & Maehr, 1999); positive emotions (Roeser, Midgley, & Urdan, 1996) and well-being (Dykman, 1998).

Ames (1992) stated that a learning goal orientation is influenced more by learning environment factors than by students' intrinsic qualities. Anderman and Young (1994) also indicated that learning environment factors, such as teaching strategies and instructions, impact students' goal orientation. They stated that, in mathematics and science classes, goal orientation concepts imply that alterations in goal orientation strategies could increase or impede students' motivation and participation in classroom activities. According to Wigfield and Cambria (2010, p. 7), "goal orientations are more a product of context rather than the person".

2.4.2.2 Task Value

As stated by Eccles and Wigfield (2002) in their expectancy–value theory, task value plays an essential role in students' performance and choices related to their achievements. Eccles and Wigfield (2002) proposed four major facets that contribute to task value: namely, attainment value (task importance), intrinsic value (the enjoyment gained from doing the task), utility value (the usefulness of the task), and, finally, cost value (what needs to be given up to complete the task).

Intrinsic value has been described in previous studies as the first element of task value to develop in a person (Wigfield, Tonks, & Klauda, 2009). It has also been shown that the attainment value of a task is related to individuals' sense of self, which normally emerges at elementary school, whereas the utility value of a task develops across the school years. In other study, Wigfield and Cambria (2010) measured early secondary school students' task values and merged the attainment, intrinsic, and utility values into a single task value scale. Their research supported the hypothesis that there is an association between the task value held by students and their cognitive and affective learning outcomes. Wigfield and Cambria (2010) also proposed that students' perceived task value predicts students' motivation and engagement in learning.

Past research has also indicated that task value is likely to affect students' selection of academic courses (Simpkins, Davis-Kean, & Eccles, 2006), students' determination (Denissen, Zarrett, & Eccles, 2007) and their learning outcomes (Pekrun, 2009). There is also strong evidence within past research to suggest that students' task value can be affected by their classroom and school environments—in particular, by the contextual organisation of these environments, such as the types of learning activities and reward systems (Wigfield, Eccles, & Rodriguez, 1998).

2.4.2.3 Self-Efficacy

In 1977, Bandura proposed that students' beliefs about their ability to achieve goals have a strong impact on their behaviour. Bandura (1977) purports that self-efficacy beliefs are likely to determine people's feelings, thoughts, motivations, and behaviours. He proposed that self-efficacy starts to develop in early childhood, as children face different experiences, challenges, and situations, and continues to form throughout the whole life course as people accumulate knowledge, skills, and understanding. It was also suggested that key sources of self-efficacy include mastery experiences (when success or failure in performing a challenging task strengthens or weakens people's self-efficacy beliefs), social modelling (when observing others' success or failure impacts on people's sense of self-efficacy), and social persuasion (when people are persuaded to believe that they can be successful in achieving a goal).

Bandura (1993, 1997) also explained that self-efficacy can affect students' approaches to challenging tasks: Students who possess strong self-efficacy beliefs are likely to view such tasks as challenges that need to be mastered, whereas people with low self-efficacy are likely to try to avoid challenging tasks and think that such tasks are beyond their capabilities. According to Bandura (1997), students with stronger self-efficacy beliefs are more interested in, engaged in, and committed to learning activities and also make better progress after negative outcomes or failures. People with weaker self-efficacy beliefs, on the other hand, are likely to focus on personal failures and quickly lose confidence in their abilities (Bandura, 1997).

Britner and Pajares (2006, p. 486), in their research on science learning, found that children with stronger self-efficacy beliefs were inclined 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." Past research provides strong evidence that self-efficacy can be considered to be a potent predictor of students' choices, expended effort, and persistence (Bandura, 1997; Britner & Pajares, 2001; Zeldin & Pajares, 2000).

Past research has also discovered strong associations exist between students' self-efficacy beliefs and their positive cognitive and affective outcomes. Lyman, Prentice-Dunn, Wilson, and Bonfilio (1984) reported positive correlations between self-efficacy and persistence; Multon, Brown, and Lent (1991) and Schunk (1984, 1985) described links between self-efficacy and academic performance; Walker, Greene and Mansell (2006) reported associations between self-efficacy and cognitive engagement; Schunk and Hanson (1985) reported positive correlations between self-efficacy and academic motivation; and, finally, Urdan (1997) reported links between self-efficacy and a learning goal orientation.

2.4.3 Self-Regulation

An important component of the study reported in this thesis is self-regulation. This section, therefore, reviews research related to self-regulation beliefs and their interconnections with students' outcomes and perceptions of the learning environment.

Schunk and Zimmerman (2007) have proposed that self-regulation is the self-directive progression by which students modify their capabilities into academic expertise. They have shown that there is a link between students' self-regulation and their levels of efficacy and intrinsic interest in their learning. Schunk and Zimmerman (2007) found that the process of self-regulation itself can be a source of motivation—even for more challenging tasks that students might not otherwise perceive as motivating. Past studies have provided strong evidence to suggest that self-regulation is a prominent element of positive learning outcomes (Hindman, Skibbe, Miller, & Zimmerman, 2010) and have suggested that a strong interrelation exists between self-regulation and high academic performance (Matthews, Cameron Ponitz, & Morrison, 2009; Montroy, Bowles, Skibbe, & Foster, 2014).

As stated by Boekaerts and Cascallar (2006), the critical construct of self-regulation can be seen as students' aptitude for directing their cognitive, motivational, and affective processes to achieve desired outcomes. Overall, past research suggests that students who achieve higher academic results are likely to demonstrate greater engagement and self-regulation in the learning process (Blair & Razza, 2007; Duncan et al., 2007; Matthews et al., 2009).

Boekaerts and Cascallar (2006) also suggested that there may be links between learning environment factors and students' self-regulation in learning. They stated that both motivation and self-regulation can be triggered by learning environment factors. Behavioural self-regulation was explained as students' choice of appropriate behaviours in response to the demands of the learning environment, such as participation in a specific learning activity, paying attention, or staying on task despite environmental distractions (Ponitz et al., 2008). Sudents' motivational beliefs are found to be strongly correlated with their self-regulation in learning, which means that students with higher motivation beliefs are more engaged in self-regulated learning (Pintrich, 2003; Schunk & Zimmerman, 2007; Wolters, 1999).

Past research has also shown that there is a strong relationship between students' perceptions of task value and their self-regulation in learning (Pintrich & De Groot, 1990; Schunk, Pintrich, & Meece, 2008; Simpkins et al., 2006; Wolters, Yu, & Pintrich, 1996). Such studies suggest that students who perceive their learning activities as being relevant and interesting demonstrated increased motivation and cognitive engagement in learning activities than those who did not feel that learning activities were relevant or interesting.

Furthermore, past research has indicated that there is a strong correlation between students' self-efficacy beliefs and their self-regulation (Pajares, 2002; Zimmerman, 2000). Finally, past research has revealed that students who perceive their classrooms to be goal-oriented (e.g., students feel that the teacher emphasises learning goals) are more likely to use their self-regulation to direct their learning (Ames & Archer, 1988; Kaplan & Midgley, 1999; Newman, 1998; Ryan, Gheen, & Midgley, 1998; Urdan & Midgley, 2003).

2.4.4 Environment-Motivation Associations

Given that one of the focal points of the research reported in this thesis was the examination of environment-motivation associations, past research related to the impact of the learning context on student motivation and self-regulation is reviewed here. Past research has suggested strong and consistent associations between the learning environment and a range of student cognitive and affective learning outcomes (see reviews of literature by Fraser, 2012, 2014).

Lorsbach and Jinks in their review of self-efficacy theory and learning environment research (1999) suggested that the concept of self-efficacy is strongly associated with perceptions of the learning environment and is an essential constituent of all three of dimensions of human environments defined by Moos (1974), namely Relationship Dimension, Personal Development Dimension and System Maintenance and System Change Dimension. In terms of the Relation Dimension, self-efficacy is dependent on the character of personal relationships and is perceived mainly by comparisons personal knowledge and skills to other students. Self-efficacy is also related to Personal Development Dimensions as it can be explained as a personal evaluation of capability and development. Finally, in terms of the System Maintenance and System Change Dimension, it was proposed that self-efficacy is dependent upon goals, incentives, and expectations created and maintained in the social environment which allows for more accurate evaluations of ability.

Research has provided strong evidence to suggest that there is a positive relationship between classroom learning environment and students' sense of academic self-efficacy (Alkharusi, 2009; Dorman, 2001; Dorman, Fisher, & Waldrip, 2006; Dorman & Fraser, 2009). A recent study, conducted by Daemi, Tahriri and Zafarghandi (2017), examined the relationship between classroom environment and learners' academic self-efficacy using a sample of 200 advanced English as Foreign Language learners. The results also provided a strong evidence that there was a statistically significant correlation between classroom environment factors and students' self-efficacy with the strongest correlation between task orientation and self-efficacy and between student cohesiveness and self-efficacy.

This review of past studies showed that there was a limited evidence in previous research on the influence of psychosocial learning environment on student motivation and self-regulation. A study by Velayutham et al. (2011, 2013), using a sample of 1360 students, reported that learning environment factors strongly influence self-efficacy, learning goal orientation and task value as key motivational constructs. Also, the same study provided strong evidence on the influence of psychosocial learning environment on students' self-regulation in science learning. Further. A study by Al Zubaidi et al. (2016), involving a sample of 994 university students also reported statistically significant learning environment – motivation associations. Opolot-Okurut (2010) in his study, involving a sample of 81 students, also reported associations between students' perceptions of their mathematics classroom learning environment and their motivation such as effectance, involvement and seeking of challenge. The relationship between students' motivation and their learning environment at university level in South Africa was the focus of another study (Müller & Louw, 2004) which proposed that learning environment constructs, such as teachers' interest, relevance of contents, quality of instruction, transparency and fit of requirements, affect students' motivation. Also, Baeten, Dochy and Struyven (2013) provided evidence that there is an effect of different learning environments on students' motivation conducted their study (a sample of first-year student teachers, *N*= 1,098, studying a child development course).

The research reported above, when considered in terms of Bandura's social-cognitive theory, suggests that the context in which learning takes place, or classroom environment, is likely to affect students' motivational and self-regulatory beliefs. It was hypothesised, therefore, that students' perceptions of the psychosocial learning environment would influence student motivation and self-regulation.

2.4.5 Instruments for Assessing Students' Motivational Beliefs

A notable feature of research in educational psychology over the past 40 years has been the development of research instruments that assess students' motivational and/or self-regulatory beliefs. Surveys that evaluate students' motivation and/or self-regulation in learning include:

- Patterns of Adaptive Learning Survey (PALS; Midgley, Maehr, Hicks, Roeser, Urdan, & Anderman, 1996; see Section 2.4.5.1);
- Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991; see Section 2.4.5.2);
- Multidimensional Motivation Instrument (MMI; Uguroglu, Schiller, & Walberg, 1981; see Section 2.4.5.3);
- Science Motivation Questionnaire (SMQ; Glynn et al., 2009; see Section 2.4.5.4);
- Students' Motivation Towards Science Learning Questionnaire (SMTSL; Tuan, Chin & Shieh, 2005; see Section 2.4.5.5); and
- Students' Adaptive Learning Engagement in Science (SALES; Velayutham et. al, 2011, 2013; see Section 2.4.5.6).

2.4.5.1 Patterns of Adaptive Learning Survey (PALS)

The Patterns of Adaptive Learning Survey (PALS) was designed by Midgley et al. (1996) to examine students' motivational beliefs. The PALS has four scales: mastery goal orientation, performance approach goal orientation, performance avoid goal orientation, and academic efficacy. Each scale comprises four or five items; the items are responded to using a five-point Likert scale. Sample items from the mastery goal orientation scale include "I like class work that I'll learn from even if I make a lot of mistakes" and "An important reason why I do my class work is because I like to learn new things".

Close scrutiny of the items in the PALS indicated that the instrument might not be suitable for the present study. First, the survey was designed to assess students' general motivational beliefs rather than their motivation orientation towards mathematics and science learning. Second, task value was considered to be a significant factor in students' motivational beliefs, but the PALS survey does not assess this construct. Although some scales of the PALS were considered to be relevant to the present study (for example, mastery goal orientation and academic efficacy), given the disadvantages listed above, the decision was made not to use this survey in the current study.

2.4.5.2 Motivated Strategies for Learning Questionnaire (MSLQ)

The Motivated Strategies for Learning Questionnaire (MSLQ) was designed by Pintrich et al. (1991) and consists of seven scales, namely, intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning, performance, and text anxiety. The survey includes between four and eight items in each scale; the items use a seven-point response scale ranging from "not at all true of me" to "very true of me". Sample items include "In a class like this, I prefer course material that really challenges me so I can learn new things" and "If I study in appropriate ways, then I will be able to learn the material in this course".

Although some scales of the MSLQ were considered to be relevant to the current research program (for example, task value and self-efficacy), the survey has a number of disadvantages. First, like the PALS (reviewed in Section 2.4.5.1), the MSLQ was developed to assess students' general motivational beliefs rather than their beliefs in mathematics and science learning specifically. Second, because the MSLQ was constructed to assess university students' motivational beliefs, the language used was considered to be difficult, which is not suitable for secondary students, who may find it challenging to understand. It was decided, therefore, not to use the MSLQ in the present study.

2.4.5.3 Multidimensional Motivation Instrument (MMI)

The Multidimensional Motivation Instrument (MMI) was designed by Uguroglu et al. (1981) to assess students' general motivational beliefs. It comprises six scales, namely, academic self-concept, achievement motivation, social self-concept, locus of control, emotional self-concept, and physical self-concept. There are 23 items overall, with between one and seven items per scale. The items are responded to using a five-point Likert scale. Sample items include "At home, once I start a new project I usually finish it" (for the achievement motivation scale) and "When I do something well, it is because I worked hard" (for the locus of control scale).

This questionnaire was administered by Tuan et al. (2005) to 115 school students in grades 3 to 8. The aim of that study was to operationalise and field test a motivation survey utilising multidimensional measures. The MMI questionnaire was not used in the present study as the survey was developed and used for primary school students. Also, the survey was also designed to assess general motivational beliefs rather than motivational beliefs in mathematics and science learning specifically.

2.4.5.4 Science Motivation Questionnaire (SMQ)

The Science Motivation Questionnaire (SMQ) was designed by Glynn et al. (2009) to measure students' motivation in science learning for university students. Initially, the SMQ consisted of six motivational constructs that could be related to science learning, namely, intrinsic motivation, extrinsic motivation, personal relevance, assessment anxiety, self-determination, and self-efficacy. The survey underwent refinements and exploratory factor analysis that led to the original questionnaire being reduced to only five scales: intrinsic motivation and personal development, self-efficacy and assessment anxiety, self-determination, career motivation, and grade motivation. The final version of the SMQ consists of 30 items that are responded to using a five-point Likert scale. A sample item is “The science I learn is more important to me than the grade I receive” (from the personal relevance scale).

Although some of the scales of the SMQ (such as personal relevance and self-efficacy) were relevant to the present study, as the range of scales included in the survey was considered to be too narrow. Further, the SMQ was developed for university students, therefore, the complex language used in the survey was considered difficult for junior and middle high students. Finally, as noted by Glynn et al. (2009), some of the items of the SMQ may require modification to represent the various motivational components more successfully.

2.4.5.5 Students’ Motivation Towards Science Learning (SMTSL)

The Students’ Motivation Towards Science Learning (SMTSL) survey, developed by Tuan et al. (2005), includes six motivational constructs: self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation. The SMTSL has 35 items that are responded to using a five-point Likert scale (ranging from “strongly disagree” to “strongly agree”). Sample items are “Whether the science content is difficult or easy, I am sure that I can understand it” and “I am not confident about understanding difficult science concepts” (both from the self-efficacy scale).

Although the self-efficacy and performance goal scales of the SMTSL appeared to be relevant to the present study, close scrutiny of this instrument indicated that the active learning strategies and learning environment stimulation scales were not directly related to motivation. Another disadvantage of the SMTSL is that some of its items consist of long sentences and complex words that secondary school students may find difficult to understand.

2.4.5.6 *Students' Adaptive Learning Engagement in Science (SALES)*

The lack of economical instruments suitable for assessing secondary students' motivational beliefs and self-regulation in science learning prompted the development of another survey, the Students' Adaptive Learning Engagement in Science (SALES), which was designed and validated by Velayutham et al. (2011, 2013). The SALES consists of 32 items, with eight items in each of four scales: learning goal orientation, task value, self-efficacy, and self-regulation. The items are responded to using a five-point Likert scale ranging from "strongly disagree" to "strongly agree".

All of the scales of the SALES are theoretically inclusive and relevant to the present study. It was considered that the SALES was able to provide the researcher and the teachers participating in the present study with useful data related to critical characteristics of students' motivation in mathematics and science classes. This instrument, described in more detail in Chapter 3 of this thesis, was used in the present study to assess students' motivational beliefs and self-regulation.

2.5 Action Research

A fundamental components of the present study was the use of action research as a means of improving the classroom learning environment and students' motivational beliefs. According to Ferrance (2000) in her series, "Themes in Education", action research in education is explained as a process in which participants methodically and thoroughly examine their own practice, using the techniques of research. Ferrance (2000) noted that Stephen Corey, a teacher at the Teachers' College at Columbia University, was among the first to successfully use action research in the field of education. Corey (cited in Ferrance, 2000, p. 7) stated that action research would bring about change because "teachers were involved in both the research and the application of the data that they gathered; he further noted that action research is more likely to improve teachers' classroom practices than reading about what others have learnt."

The general term "action research" can be traced back to Kurt Lewin (1946) who introduced a definition of action research in his study, "Action Research and Minority Problems." Lewin explained action research as a form of research that serves to compare the conditions and impacts of different forms of social action. He also defined action research as a type of research resulting in a social action and that uses a spiral of steps consisting of cycles of planning, action, and investigating the effects of the action.

Over time, the definition of action research has taken on different forms. For at least 20 years, action research has been seen as a source of teachers' and leaders' professional development, given that action research can lead educators to focus more on their actions than they may have done before (Bell & Aldridge, 2014; Grundy, 1995; Lankshear & Knobel, 2004). This view of action research is especially relevant to the present study as the study involves practical action research as a source of professional development.

Teacher action research involves a cycle of assessment, action, and re-assessment Schön (1983). Schön (1987) extended his 1983 explanation of action research by stating that it facilitates an understanding of student perceptions of one's teaching practices. Creswell (2005) explained practical action research as a form of teacher professional development and described the main components that contributed to practical action research:

- Teachers assume the roles of researchers to make decisions about examining their teaching practice as part of their professional development.
- Teachers commit to ongoing professional development, which is an essential commitment for any teacher who chooses to get involved in action research.
- Teachers are willing to reflect on their practices with the aim of improving these practices.
- Teachers reflect on their practices systematically rather than randomly, examining issues in their classrooms.
- Teachers assume the roles of researchers, select focus areas, collect student perceptual data, and then analyse and interpret the data in order to develop an intervention plan.

Carr and Kemmis (1983) state that it is valuable for teachers' professional growth for teachers to be involved in action research about their teaching strategies and skills. Action research can be a powerful professional development tool that enables teachers to collect relevant evidence to guide improvements in their teaching practice (Hubbard & Power, 2003). Previous research also indicates that teacher action research gives teachers a greater sense of effectiveness and a greater readiness to find solutions to different issues within their classrooms (Holly, Arhar, & Kasten, 2005). Teacher action research is conducted by researchers and teachers in their own classrooms and can involve the collection of both qualitative and quantitative data, along with reflection on these data and subsequent action (Bryman 2008; Creswell 2005).

As explained by Carr and Kemmis (1983), action research involves a cycle of critical, self-critical, and reflective processes. Through those processes teachers learn more details about their own classroom environments and about their teaching practices. An important element of teacher action research is the reflection stage. During the reflection stage a teacher has an opportunity to reflect on his or her teaching practices and to seek a solution to an issue that needs to be addressed (Fullan, 1999). Student perception data have been used in many previous studies to investigate learning environment factors and to test whether teachers are able to utilise this information to actively reflect on their practices and to alter their classrooms (Aldridge & Fraser, 2008; Aldridge et al., 2012; Borko, 2004; Lankshear & Knobel, 2004). The research reported in this thesis used student perception data to assess classroom environment factors to reflect upon and to guide improvements to the classroom environment. The findings of the research described in this thesis demonstrated the importance of teacher reflection for changing their practices and its effectiveness in supporting the implementation of new teaching strategies and practices.

Creswell (2005) has suggested that reflection is one of the most prominent components of action research. One of the earliest definitions of reflection in the context of teacher action research was provided by John Dewey (1933, p. 9), who defined reflection as "action based on the active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it." Dewey also noted that "thinking is the accurate and deliberate institution of connections between what is done and its consequences" (Dewey, 1981, p. 505). Schön (1983, 1987) further elaborated the importance of teacher reflection during action research and introduced the terms “reflection-in-action” and “reflection-on-action” in his work.

2.6 Chapter Summary

The research reported in this thesis focused on learning environments and interactions between learning environment factors and students’ motivational and self-efficacy beliefs and self-regulation. It was decided, therefore, to use social–cognitive theory as a theoretical foundation, as those interactions are modelled in that theory (Bandura, 1977, 1986, 1997). Social cognitive theory considers students’ learning in terms of the interconnections between personal influences (such as students’ thoughts or beliefs), environmental factors (such as the classroom), and behaviours (such as self-regulation; Bandura, 1986). Social–cognitive theory purports that environmental factors can affect a person’s behaviour, allowing not only understanding of how people obtain and sustain certain behavioural patterns but also a basis for intervention strategies aimed at behavioural change (Bandura, 1977).

Learning environment research is reported to have its roots in the work of Lewin’s (1935), who suggested that behaviour can be described as the interaction between the individual and his or her environments. Lewin (1935) recognised that both the individual and the environment influence people’s behaviours. The nature of this influence was further elucidated by Murray (1938, 1951) in his need-press model, which proposed that the behaviour of an individual can be affected by their environment and its pressures (the forces on an individual’s behaviour which could either endorse or impede the realisation of the needs). Murray (1951) classified those pressures as alpha press, which referred to the *actual* environment, and beta press, which referred to the *perceived* environment. This model was further extended by Stern, Stein, and Bloom (1956), who clarified that alpha press can be understood as a consensual group view of the environment, whereas beta press can be understood as a personal view. This early research was fundamental for educational environment studies and was expanded in the work of Moos (1974) and Walberg (1968) when, in independent studies they both developed the first learning environment questionnaires.

Since then, considerable progress in the field of learning environment research in terms of the ways to conceptualise, assess, and examine the factors and effects associated with learning environments. This work has resulted in the proliferation of economical, valid, and widely-applicable instruments that allow for the evaluation of learning environment factors using student and teacher perceptual data (Fraser, 2012, 2014). This chapter reviewed 10 instruments for assessing learning environments.

Theobald (2006) suggested that, to establish a learning environment that inspires and motivates students to study, is not an easy task for teachers. Motivation is a term used in educational settings and research to describe the force or energy that impels people to either engage or not engage in tasks or activities (Russell, Ainley, & Frydenberg, 2005). The three components of motivation that were used in my study were learning goal orientation, task value, and self-efficacy. All of these components are essential to students' self-regulation. Students with higher self-efficacy beliefs and learning goal orientations engage in classroom activities with a greater determination to learn, understand, and master new knowledge and skills. Tasks value impacts on student perceptions of learning activities. Tasks valued by students are perceived better in terms of interest, importance and utility. Past research on motivation has led to researchers developing and validating a range of tools that aim to assess students' motivational and self-efficacy beliefs. This chapter reviewed six significant instruments in this field.

Past research has provided strong evidence that students' perceptions of their learning environments can influence a variety of student outcomes (Fraser & Fisher, 1982; McRobbie & Fraser, 1993; Zandvliet & Fraser, 2004, 2005). However, many of the student outcomes in previous studies have been restricted to either cognitive or affective outcomes. The study reported in this thesis aimed to fill a gap in past research by investigating the impacts of learning environment factors on students' motivation and self-regulation in mathematics and science learning. Given that the present study aimed to investigate links between learning environments and student motivation, this chapter reviewed literature related to those relationships. Al Zubaidi et al. (2016), Opolot-Okurut (2010) and Velayutham et al. (2011, 2013) have suggested that the sources of self-efficacy and motivation beliefs can be attributed to the psychosocial learning environment. As such, the present study aimed to further investigate the links between learning environments and students' motivation in order to inform researchers and practitioners about key components of the psychosocial learning environment that could improve students' motivation and self-regulation in mathematics and science learning.

Given that one of the objectives of the present study was to examine strategies that can be used to improve learning environments in mathematics and science classes, action research concepts and methods were reviewed in this chapter. The term "action research" originated with Kurt Lewin (1946), who defined it as comparative research on the conditions and effects of different forms of social action. Carr and Kemmis (1983) described action research as a cycle of critical, self-critical, and reflective processes through which teachers can discover students' perceptions of their classroom environments (including teaching practices). Creswell (2005) discusses action research as a form of teacher professional development and identifies the main components that contribute to practical action research: namely, teachers assuming the roles of researchers; teachers committing to ongoing professional development; teachers systematically reflecting on their practices with the aim of improving their practices; and teachers collecting, analysing, and interpreting student perceptual data in order to develop intervention strategies. This study extended past studies related to action research by focusing specifically on aspects of the learning environment that were likely to improve students' motivation.

Whilst this chapter reviewed literature related to the study reported in this thesis, the following chapter describes the research methods used.

Chapter 3

RESEARCH METHODS

3.1 Introduction

This chapter describes the research methods used in the present study. The chapter begins by presenting the research design in Section 3.2 and reiterating the research objectives (introduced in Chapter 1) in Section 3.3. The selection of the samples involved in the study is described in Section 3.4. Section 3.5 describes the data collection including details of the instruments and the data-collection processes used. The action research methods used in the previous study are outlined in Section 3.6. The procedures used to analyse the data at each stage are described in Section 3.7. Section 3.8 then outlines the ethical considerations made throughout the research. Finally, a chapter summary is provided in Section 3.9.

3.2 Research Design

It was decided that the present research should utilise a mixed-method design that would take advantage of both quantitative and qualitative methods to better explore the research questions. Past research has suggested that it may not always be sufficient to use either just quantitative or just qualitative research methods because of the increasing multifariousness of research problems in the social sciences (Creswell & Clark, 2007). The use of quantitative and qualitative methods as components within the same study is argued to both enrich the research scope and results (Caruth, 2013; Green, 2012) and broaden the scope of the research (Morse, 2003, p. 189). Using a mixed-method research design can be used to triangulate data collected from both quantitative and qualitative components of the study (Creamer, 2017). Caruth (2013) proposes that there are four benefits for using a mixed-method research design. First, it combines quantitative and qualitative methods to develop the best possible approach to addressing the research problem. Second, the mixed-method design generates data that allows a deeper understanding of the research problem. Third, it allows the researcher to increase confidence in drawing conclusions from its findings. Finally, it is incorporates the strengths from one research model to counterbalance methodological weaknesses from the other in order to increase reliability. Overall, mixed methods can help to better understand and describe the complexities related to teaching and learning and is becoming more popular in the field of social sciences, in particular education (Ponce, 2014).

In the present study, the data collected, using both qualitative and quantitative research methods, were complementary and led to a more coherent and comprehensive picture. The design used in the present study was similar to the design pioneered by Campbell and Fisk (1959), which included multi-method research, with different methods being used for data collection within a single project of research. This design was used extensively in learning environment research over the past decades (Fraser, 2012, 2014).

The research was carried out in two phases. In the first phase, a large-scale administration of surveys provided data that allowed for the examination of the reliability and validity of those surveys. This quantitative overview was also used to examine which of the learning environment constructs contributed towards students' motivation and self-regulation in mathematics and science. Additionally, these quantitative data were used for the critical instance case study to examine pre–post changes to students' perceptions of the learning environment and their motivational beliefs, as well as to evaluate the effectiveness of the teaching strategies that were implemented in attempts to change the classroom environments to improve students' motivation and self-regulation.

In the second phase, qualitative data were collected to investigate the strategies that the critical instance case study teacher implemented. The data included information about what she reflected on, planned, and implemented in order to improve her classroom learning environments. An important element of the current research was the incorporation of the principles of action research (described in more detail in Section 44 of 0 and in Section 0 of this chapter). Kemmis and McTaggart (1988) described action research as a spiral or cycle of planning, action, monitoring, and reflection. Further, Ger (1997) states that the cycle starts with exploration of real issues that are identified within a group of individuals in order to find the solutions for these practical problems existing in the specific area. Creswell (2008) also proposes that action research incorporates a focus on the identified practical issue, researcher's experiences, coordinated effort, sharing of the outcomes, active changes, an arrangement of activity. As indicated by Miller (2003), action research is a dynamic process that includes change of practices, setting objectives and finding methods to implement the changes. Action research was considered to be appropriate for the current research because of its key features, as outlined above.

The multi-method design used in the present study can be represented by the formula QUAN + qual (Cresswell, 2005). This formula indicates that the research design involved the collection of both quantitative and qualitative data, with the quantitative data being dominant (Morse, 2003). The diagrammatic overview of the research design presented in Figure 3.1 Research design shows the ways in which the quantitative and qualitative investigations were mixed. This mixing encompassed the utilisation of quantitative and qualitative data, gathered during the beginning stages of the research, as the driver for teacher action research in the last stages of the research programme. Mixing of methods also occurred at the data analysis stage, during which the quantitative and qualitative data complemented each other, allowing for better exploration of the research problem, and formed a complete picture of the phenomena being investigated, with the final aim to report the meta-inferences of the research programme.

Neither the interpretive paradigm nor the positivist paradigm was considered to be a sufficient foundation for the present study because the study involved a multi-method approach that included the implementation of action research. The study commenced from a more objectivist stance, favouring a positivist paradigm (a positivist–deductive quantitative component of the study), and then shifted to an interpretivist stance at the qualitative component of the study, and moved to paradigm of praxis (Freire, 1986) during the action research component of the study.

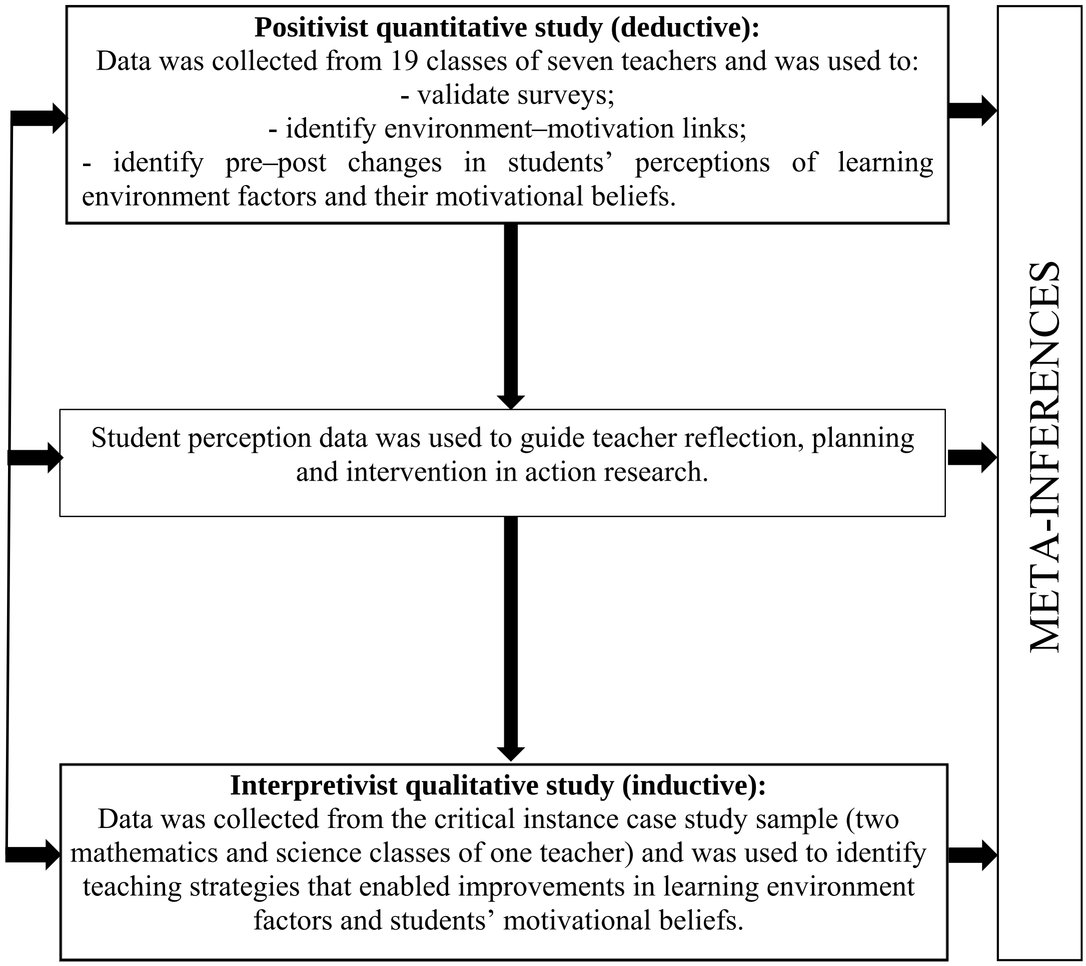

Figure 3.1 Research design

3.3 Research Objectives

As stated in Chapter 1, the overarching aim of this research was to identify learning environment factors that influence students' motivation and engagement in mathematics and science classes. The research objectives were introduced in Section 1.4 of Chapter 1 and are reiterated here:

Research Objective 1.

> To investigate the reliability and validity of the surveys assessing students' perceptions of the classroom learning environment and their motivational and self-regulatory beliefs when used in middle school mathematics and science classes in South Australia.

Research Objective 2.

> To examine which learning environment constructs are most likely to contribute towards students' motivation and self-regulation in mathematics and science.

Research Objective 3.

> To examine the effectiveness of reflecting on and using student feedback to guide changes in the learning environments to improve students' motivation and self-regulation.

3.4 Sample

The selection of participants for the present study involved, in the first instance, purposeful sampling to allow the researcher to decide which teachers and classes would be included in the data collection to ensure a representative sample of teachers who were willing to participate in the study. The research was carried out at one public co-educational school (pre-school to year 12) located in a southern suburb of Adelaide, South Australia. The site was selected for the study as it was a workplace of the researcher, thereby allowing access to the sample and ability to collect the data. The school is a large, mixed-ability, co-educational government school with an enrolment of approximately 1,500 students. As such, the school was considered to be representative of a wide range of metropolitan public schools populated with students from low to average socio-economic backgrounds. The school had access to a range of facilities including a resource centre, computer classrooms, well-equipped science laboratories, interactive white boards, projectors, data loggers, and class sets of graphing calculators and iPads.

As described in Section 3.2, the research reported in this thesis used two phases during which data were collected and analysed over one semester. The samples for both phases were drawn from the same school. This section describes the samples for each phase of the study.

3.4.1 Sample for Phase 1

The sample for phase one involved the classes of seven mathematics and science teachers who consented to participate in the study. All of the teachers had completed their bachelor's degrees in education and had attended a number of professional development programmes throughout the year (on topics such as quality learning, assessment improvement, and numeracy improvement). The seven teachers all taught both mathematics and science as one integrated subject to their assigned classes and were encouraged to include technology in their teaching (e.g. iPads, data loggers, computer simulations, graphing calculators, etc.). Of the seven teachers involved in the study, three were female and four were male. Two of the teachers were early career teachers, and the other five teachers had many years of teaching experience in a number of public schools.

The surveys were administered to students from all of the classes taught by each of seven participating teachers. This provided a sample of 394 students, of whom 351 students provided complete and usable data. The classes included 19 year 7 to 10 mathematics and science classes, each of which was taught by one of the seven teachers. Of the 351 students, 195 were boys and 156 were girls. A breakdown of this sample in terms of year level, number of classes, and student gender is presented in Table 3-1.

Table 3-1 Overview of the sample for Phase 1.

Year Level	Students	Classes	Male	Female
Year 7	76	5	42	34
Year 8	108	8	60	48
Year 9	66	2	36	30
Year 10	101	4	57	44
Total	351	19	195	156

Given the nature of the school, and that classes were not streamed according to ability, this provided a sample of students that included a range of genders, abilities, literacy and numeracy levels, and socio-economic backgrounds.

3.4.2 Sample for Phase 2

The second phase of the study involved the collection of data from one critical instance case study teacher and her two classes. The critical instance case study teacher was one of the seven teachers involved at stage 1. The teacher was purposefully selected because of her willingness to be involved in this component of the study. Therefore, this teacher was monitored more closely than the other teachers through interviews and classroom observations. This teacher was also given more opportunities to discuss her activities and approaches with the researcher and other colleagues during the action research.

The critical instance teacher was a female teacher who had a bachelor's degree in science education and approximately ten years of teaching experience in secondary school mathematics and science. This teacher was one of the leading teachers in the numeracy and STEM projects at the school. The critical instance case study teacher selected two of her classes to be involved in the study: one Year 8 mathematics and science class and one Year 10 mathematics and science class. Only students who consented to participate were involved in the study. This provided a sample of 36 students in the Year 8 class and 20 students in the Year 10 class, providing a total of 56 students, all of whom consented to participate in the study. Of these students, 26 were girls and 30 were boys. The data collected from this case study sample was used to investigate the third research objective which included an action research component.

3.5 Instruments

This section describes the collection of the data during each phase of the research. During the first phase of the study, two instruments were used to collect quantitative data: the Constructivist-Oriented Learning Environment Survey (COLES; described in Section 3.5.1; scales provided in Appendix A) and the Student Adaptive Learning Environment Survey (SALES; described in Section 3.5.2; scales provided in Appendix B). During the second phase of the study, in addition to quantitative data, data collected using the COLES and the SALES (described below), qualitative information was also gathered using classroom observations (Section 0) and work samples (Section 3.5.4). Each of these data collection strategies is described below.

3.5.1 Constructivist-Oriented Learning Environment Survey (COLES)

The Constructivist-Oriented Learning Environment Survey (COLES) was developed and validated by Aldridge, Fraser, Bell, and Dorman (2012) to provide a range of data that could be used to assist teachers in changing their classroom environments and existing strategies through reflection on students' feedback. As described in Chapter 2, the COLES scales were drawn from a range of previously developed and validated questionnaires, including the What Is Happening In this Class? (Fraser et al., 1996), the Individualised Classroom Environment Questionnaire (Rentoul & Fraser, 1979), and the Constructivist Learning Environment Survey (Taylor et al., 1997). Given that no existing instrument assessed characteristics related to assessment practices in the classroom, two further scales examining formative assessment and assessment clarity were developed by Aldridge et al. (2012). The validity and reliability of the COLES was established by Aldridge et al. (2012) making it a sensible choice for the present study.

In total, the COLES consists of 11 scales that are clustered into three groups: relationships (which includes the student cohesiveness, teacher support, equity, and young adult ethos scales); assessment (which includes the clarity of assessment criteria and formative assessment scales); and delivery (which includes the task orientation, differentiation, personal relevance, involvement, and cooperation scales). A short description and a sample item for each scale are provided in Each of the scales has six items, with the exception of one (young adult ethos), which had seven items, providing a total of 67 items. Students were required to respond to the items using a five-point frequency scale of almost always, often, sometimes, seldom, and almost never. Each item asks for two responses, to allow students to provide information about the learning environment that is present in the classroom (the actual environment) as well as information about the learning environment that they would prefer. To accomplish this, the instrument utilises a side-by-side response format in which students respond to each item with respect to both their actual and preferred formats (Aldridge et al., 2012). Figure 3.2 provides an example of the side-by-side response format used in the COLES. A full copy of the COLES is provided in Appendix A.

Table 3-2.

Each of the scales has six items, with the exception of one (young adult ethos), which had seven items, providing a total of 67 items. Students were required to respond to the items using a five-point frequency scale of almost always, often, sometimes, seldom, and almost never. Each item asks for two responses, to allow students to provide information about the learning environment that is present in the classroom (the actual environment) as well as information about the learning environment that they would prefer. To accomplish this, the instrument utilises a side-by-side response format in which students respond to each item with respect to both their actual and preferred formats (Aldridge et al., 2012). Figure 3.2 provides an example of the side-by-side response format used in the COLES. A full copy of the COLES is provided in Appendix A.

Table 3-2. Description and sample item for each COLES scale[2]

	Scale	Description	Sample item
		The extent to which …	
RELATIONSHIPS	Student cohesiveness	… students know, help, and are supportive of one another.	Members of this class are my friends.
	Teacher support	… the teacher helps, befriends, trusts, and is interested in students.	The teacher moves around the class to talk with me.
	Equity	… students are treated equally by the teacher.	I get the same amount of help from the teacher as do other students.
	Young adult ethos	… teachers give students responsibility and treat them as young adults.	I am given the opportunity to be independent.
ASSESSMENT	Formative assessment	… students feel that the assessment tasks given to them make a positive contribution to their learning.	Assessment tasks help me to monitor my learning.
	Assessment clarity	… the assessment criteria are explicit so that the basis for judgments is clear and public.	I understand how the teacher judges my work.

[2] Copied with permission of the author

DELIVERY	Involvement	… students have attentive interest, participate in discussions, ask questions, and share ideas.	I explain my ideas to other students.
	Task orientation	… it is important to complete activities planned and to stay on the subject matter.	I pay attention during this class.
	Personal relevance	… the subject is relevant to students' everyday out-of-school experiences.	I relate what I learn in this class to my life outside of school.
	Cooperation	… students cooperate with one another on learning tasks.	When I work in groups in this class, there is teamwork.
	Differentiation	… teachers cater for students differently on the basis of ability, rates of learning, and interests.	I am able to work at the speed which suits my ability.

		ACTUAL					PREFERRED				
	Equity	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
14	I get the same amount of help from the teacher as do other students.	1	2	3	4	5	1	2	3	4	5

Figure 3.2 Side-by-side response format for actual and preferred responses used in the COLES[3]

3.5.2 Student Adaptive Learning Engagement (SALES) Survey

The Student Adaptive Learning Engagement Survey (SALES) was developed and validated by Velayutham et al. (2011). The development of the survey sought to ensure the content validity basing each scale on a sound theoretical framework and an extensive review of literature. Further, a detailed and systematic approach to writing the individual items within each scale helped to maximise the scale's face and content validity (Velayutham et al., 2011). The validity and reliability of the SALES, was established using a sample of 1,360 students in 78 high school science classes in Western Australia, making it a sound choice for the present study.

The original SALES was designed for use in science classes and, as such, the items referred specifically to science (for example, one item read "In this science class, what I learnt can be used in my daily life"). To make the items usable in the integrated science and mathematics classes involved in the present study, the wording of each item was changed to remove reference to science. For example, the item, "In this science class, even if the science work is hard I can learn it" was changed to "In this class, even if the work is hard, I can learn it". With the exception of these changes, all other wording remained the same. In total, the SALES is comprised of 32 items with eight items in each of the four scales of learning goal orientation, task value, self-efficacy, and self-regulation. **Error! Reference source not found.** Table 3-3 provides,

[3] Copied with permission of the author

for each SALES scale, a description and a sample item. For each item, the respondents were asked to indicate the extent to which they disagreed or agreed with each statement by using a Likert scale consisting of strongly disagree, disagree, not sure, agree, and strongly agree. A full copy of the SALES is available in Appendix B.

Table 3-3 Description and sample item for each modified SALES scale[4]

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

3.5.3 Classroom Observations

Classroom observations were carried out in the two classes selected by the critical instance case study teacher over a one-semester period, during which the action research was carried out (see Section 3.6). Twelve observations overall were carried out in the participating teacher's classrooms, four at the prior to the action research cycles, four during the intervention stage and four at the end of the action research. Each observation lasted approximately 90 minutes, the duration of one double lesson. These classroom observations focused largely on:

- The learning environment factors identified by the teacher during her reflection on student feedback the teaching strategies used by the teacher;

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- Students' reactions to the interventions planned and implemented by the teacher; and
- Students' behaviours as indicators of their motivation and engagement.

The observations were also used to provide feedback to the teacher. A copy of the researcher's notes was provided to the teacher after each observation to assist her in reflecting on her teaching and developing or fine-tuning teaching interventions in the course of the action research.

Being aware that the presence of the researcher in the classroom could influence both student and teacher behaviours, the researcher took the stance of a non-participant observer and attempted to minimise the impact of the visits. To this end, the researcher sat at the back of the classroom, away from the students; the researcher did not intervene in either discussions within the classroom or the learning activities.

During the classroom observations, the researcher focused on and, using field notes, recorded the interactions between students as well as on the interactions between students and the teacher. Also, the focus of the researcher was on the learning activities used throughout the lesson and the instances of engaged behaviours.

3.5.4 Interviews

Both in-depth interviews and informal reflection discussions were conducted throughout the action research cycles. In-depth interviews were conducted with the critical instance case study teacher at each observation to clarify what had been observed. Reflection discussions were used as a form of interviews to allow identification of the types of teaching methods that teachers would use to improve students' motivation in the next stage of the action research. However, the present study reports only the results obtained from the critical instance case study teacher. These in-depth interviews involved a semi-structured format, allowing me the freedom to explore the strategies and activities that the teacher had implemented in her classes (Kvale, 1996; Schensul, Schensul & LeCompte, 1999). Informal discussions with the critical instance case study teacher occurred every day. These interviews were recorded using a digital recorder and discussions were recorded using field notes. The sample interview questions are presented in Appendix C.

All of the participating teachers were also encouraged to discuss strategies with each other during teacher faculty meetings. However, the critical instance case study teacher showed greater enthusiasm compared to the other participating teachers for discussing and then implementing new strategies that could prompt positive changes in learning environment factors and student motivation and engagement.

3.6 Action Research

The action research component consisted of four stages that were carried out over one semester. The four stages of the action research are presented diagrammatically in Figure 3.3 and described in this section.

During stage one, baseline data was collected. First, the two surveys (described in Sections 3.5.1 and 3.5.2) were administered to all of the students in the two classes of the critical instance case study teacher: one to assess their perceptions of the learning environment and another to assess their motivational beliefs. Administration was carried out by the researcher to ensure that there was consistency in the data collection and that students understood how to respond to the survey. It was explained to the students that the surveys were voluntary and that they were not a test. They were informed that their teacher was interested in students' opinions about what was happening in the classroom. It was also stated that fair, honest, and considered feedback was expected. Students were told that their individual responses to the surveys were confidential and that the teacher would only be provided with overall class results.

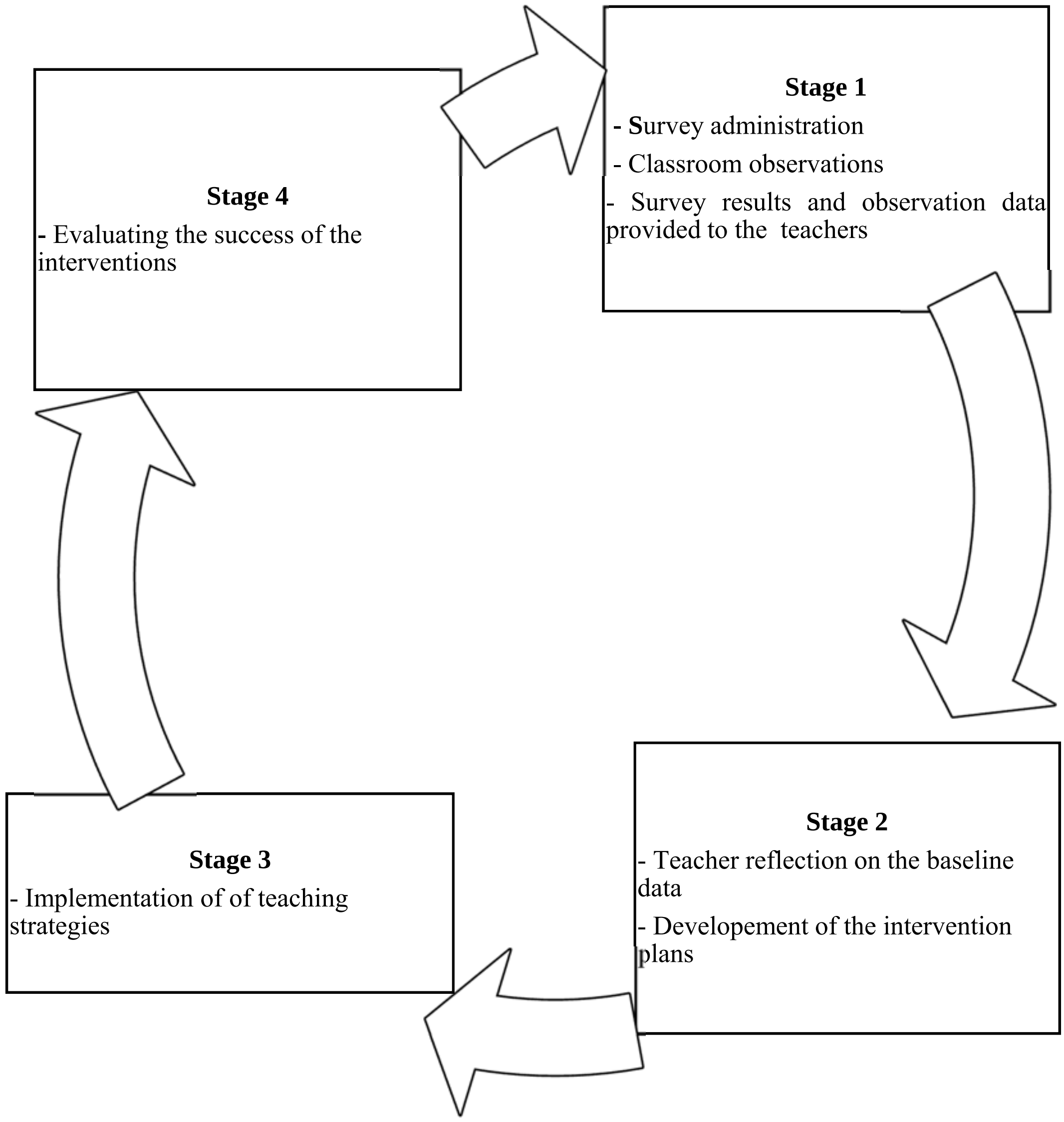

Figure 3.3 Stages used in the action research

During stage one, feedback based on the pre-test data collected using the two surveys was provided to the critical instance case study teacher. This feedback was in the form of a feedback package that included the means, medians, and standard deviation for each scale and individual items (see Chapter 4 for details). The information included in the package (based on students' responses) was used by the teacher for the purpose of reflection.

During stage two, the feedback from the surveys as well as the findings from the classroom observations were discussed with the teacher. During those discussions, the teacher reflected on the data to guide the development of the strategies that would be implemented in the next stage. Intervention plans were developed by the teacher in the course of the discussions and reflection meetings. During this stage the critical instance case study teacher focused on developing ideas for change and possible courses of action for the intervention stage. Examples of intervention plans (Teacher Plan for Action) are presented in Appendix D.

Stage three of the action research cycle was the intervention stage. It involved the teacher implementing her intervention strategies aimed at improving students' perceptions of learning environments and their motivational beliefs. This stage involved cycles of reflection in action and on action. In addition, the cycle involved observations by the researcher as the interventions were being implemented. Post-observation discussions were also used as a source of reflection for the teacher.

During stage four of the action research, data were collected from the classes of the critical case study teacher through classroom observations, informal discussions and in-depth teacher interviews. Also, the two instruments, used in the first stage, were re-administered to the same classes and students. Student post-test feedback package was provided to the critical instance case study teacher to determine the extent to which her interventions had been successful and to inform the planning of further improvement strategies. These data were used to examine the improvements and analyse the teaching strategies that had been used in the case study teacher's attempts to improve students' perceptions of learning environment factors and their motivation in science and mathematics learning.

3.7 Data Analysis

This section describes how the data were analysed to address each of the research objectives. In all cases, SPSS Version 23 software (IBM Corp., 2017) was used to perform the quantitative analysis for the present study. First, Section 3.7.1, describes the analysis used to provide evidence to support the reliability and validity of the two surveys. Second, Section 3.7.2 describes the analysis used to examine the relationships between students' perceptions of the learning environment and self-reports of motivation and self-regulation. Third, Section 3.7.3 outlines the analysis used to examine pre-post changes in learning environment, motivation and self-regulation. Finally, Section 3.7.4 describes how the qualitative data were analysed to examine the efficacy of teaching interventions.

3.7.1 Evidence to Support Reliability and Validity of the Surveys

To address the first research objective, the quantitative data (N=351) were used to investigate the factor structure, internal consistency reliability, discriminant validity, and ability to differentiate between classes separately for both surveys (COLES and SALES). Factor analysis was used to assess the extent to which each item in a specific scale was similar to the other items in the same scale. Principal axis factor analysis with oblique rotation was used to examine the factor structure of each instrument. Oblique rotation was used as the factors in both surveys (learning environment and adaptive learning engagement) were likely to overlap (Brown, 2006; Costello & Osborne, 2005). Following the suggestions of Field (2005), Stevens (1992), and Thompson (2004), the two criteria utilised for retaining any item were that the item needed to have a factor loading of at least 0.40 on its a priori scale and less than 0.40 on any of the other scales.

Scale reliability estimates, using the Cronbach alpha reliability coefficient as an index of scales' internal consistency, were used to examine the internal consistency for each scale of the COLES and the SALES (Field, 2005). According to Cohen, Manion, and Morrison (2000), the Cronbach alpha coefficient for a satisfactory scale should be 0.70 or higher.

Discriminant validity examined whether the scales in each instrument differed from each other. To provide evidence to support the discriminant validity of the COLES and SALES, the component correlation matrix, obtained from oblique rotation, was used. Factor correlations above .80 may suggest an overlap of concepts and indicate poor discriminant validity (Brown, 2006).

Finally, to examine whether the scales included in the two surveys were able to differentiate between groups that the scales should theoretically be able to differentiate between, a one-way analysis of variance (ANOVA) was conducted. Because, theoretically, students in the same class should perceive the learning environments in similar ways, but differently to students in other classes, class membership was used as the independent variable, was used for each scale.

3.7.2 Environment–Motivation Associations

To examine relationships between the students' perception of learning environments and their self-report of motivation, simple correlation and multiple regression analyses were utilised. Simple correlation analysis was used to provide information about the bivariate associations between each of the COLES and SALES scales. Multiple correlation analysis was used for three reasons: to provide a more comprehensive image of the combined effect of correlated environment magnitudes on motivational beliefs; to reduce the Type 1 error rate associated with the simple correlation analysis (Stevens, 1992, 2002); and to identify which scales were making the largest contributions to explaining the variance in students' motivational beliefs. The regression weights were interpreted as describing the impact of a particular learning environment factor on student motivation when all other environment factors were mutually controlled. Both the simple correlation and the multiple regression analysis were performed for the student unit of analysis.

3.7.3 Pre–Post Changes in Learning Environment and Motivation

To investigate the effectiveness of using student feedback to develop and implement strategies that would improve students' motivational beliefs, the data collected from the students in the classes of critical instance case study teacher was used to examine the pre–post changes. As a first step, descriptive analysis, based on students' responses to the COLES and the SALES scales, included the average item mean and average item standard deviation for each scale for both the pre-test and the post-test. These values were used to identify whether there were pre–post improvements in students' perceptions of the learning environment or in their motivational or self-efficacy beliefs.

Multivariate analysis of variance (MANOVA) with respective measures was used to determine whether the pre–post changes in student scores were statistically significant. The testing occasion (pre-test or post-test) was used as the independent variable and the scales of the COLES and SALES were used as the dependent variables. Because the MANOVA yielded statistically significant results using Wilks' lambda criterion, the univariate ANOVA results were analysed for the dependent variables.

Effect sizes were also calculated (as recommended by Thompson, 2004) to estimate the magnitude of the differences between students' scores in the pre-test and the post-test. To calculate the effect sizes, using the means and standard deviations of two groups (pre-test and post-test), the following formula was used:

$$\text{Cohen's } d = (M_1 - M_2) / SD_{\text{pooled}}$$

$$\text{where } SD_{\text{pooled}} = \sqrt{[(SD_1^2 + SD_2^2) / 2]}$$

3.7.4 Qualitative Data Analysis

Qualitative data analysis is the method used to explain data in order to address the research objectives (Merriam, 2009). Therefore, the qualitative data analysis conducted in the present study included organisation and interpretation what was seen, heard, and read by the researcher in relation to the classroom observations and interviews. In accordance with past research suggestions (Merriam, 2009), analysis of the qualitative data was conducted throughout the research and started at the stage of data collection. Analysis of the qualitative data involved finding themes, patterns, and meanings in order to address the research objectives.

3.7.4.1 Analysis of Interviews and Observation Data

To analyse the qualitative data collected from the critical instance case study teacher and her classes during the action research cycles, grounded theory methods, as proposed by Strauss and Corbin (1994), were used. The results then were utilised to develop interventions based on the student perception data in a bid to improve learning environments and self-reported motivation. Key themes related to teaching practices were derived from the interviews and classroom observations; these themes were examined to address the third research objective related to the effectiveness of the use of student feedback to guide changes to learning environments and impact on students' motivation and self-regulation. The analysis approach was largely inductive, with findings resulted from the collected data, unlike the methods when the data being gathered to test a hypothesis (Taylor & Bogdan, 1984; Bell & Aldridge, 2014).

3.7.4.2 Use of Narratives

To capture and relay the genuine experiences of the critical case study teacher and her students through writing impressionistic tales, a narrative methodology was used. Namely, Van Maanen's (1994) impressionist tales of the field were utilised that produces the "inescapable problem of representation" (Denzin & Lincoln, 2005, p. 19). The impressionist tales were written as third-person narratives from the researcher's point of view. They were interlinked with direct quotes from the interviews and observation field notes. The narratives were used to provide more comprehensive general explanations that emerged from the quantitative component of the research programme; these narratives served to illustrate the findings related to the last research question.

Because the qualitative part of the present study involved interpretative research, introduced in Section 1.3, its findings were required to be interpreted (Creswell, 2008). This approach allowed the researcher to step back and construct two impressionistic narratives (one about a pre-test regular lesson and another about a lesson after the interventions were implemented) to represent the classrooms. The narratives involved extracting common themes and can be considered representative of a number of lessons. Importantly, the interpretative research includes interpretation of the collected data, so the researcher explained the findings, related to the qualitative data, using interpretative commentaries (Geelan, 1997; Lincoln and Guba, 1985). These commentaries followed by the narratives were used to provide an explanation of the differences and similarities of regular mathematics and science lessons and those that included the intervention strategies based on student feedback and aimed at improving students' perceptions of the learning environment factors and their motivational beliefs.

3.7.4.3 Ensuring the Trustworthiness of the Data

To improve the validity of the qualitative component of the study, the following strategies were employed:

- Using different sources of qualitative data (students and teachers);
- Using different methods of data collection (interviews, classroom observations and discussions);
- Using different methods of data analysis (grounded theory, interpretivist narratives, and interpretative commentaries);
- Gathering data over a period of time (one semester) at the same research site (the same school, teachers, students, and classes).

According to Merriam (2009), the use of the above strategies enhances the validity of qualitative research findings by providing a more holistic and credible explanation and understanding of the concepts being researched.

3.8 Ethical Considerations

Both prior to the start of the research and during the research programme, there were a number of ethical issues that required consideration. Ethical considerations are detailed below in terms of ethics approval (Section 3.8.1); privacy and confidentiality (Section 3.8.2); and other ethical considerations (Section 3.8.3).

3.8.1 Ethical Approval

All human research in Australia is required to comply with the National Statement on Ethical Conduct in Research (National Health and Human Research council, 2007), which focuses on the values of respect, research merit and integrity, justice, and beneficence. Prior to the commencement of the research, ethical approval was sought from Curtin University and the Department of Education and Child Development of South Australia, as detailed below.

Ethical approved was obtained from Curtin University (approval number SMEC 18–12). All of the specified Curtin University guidelines were followed. A copy of the ethics clearance approval letter can be found in Appendix E.

Because the research reported in this thesis involved a government secondary school in South Australia, the researcher also was required to seek ethics approval from the Department of Education and Child Development (DECD). The DECD approval process, which had to be followed prior to the research commencement, involved several stages as detailed in Figure 3.4.

Figure 3.4 DECD ethical approval stages.

After review, ethical approval was granted by the DECD; the DECD Ethics Approval letter can be found in Appendix F. Subsequently, approval was sought and obtained from the principal at the school in which the data were collected. Finally, appropriate consent was sought from individuals (the participating teachers and students).

All participants (students and teachers) were provided with verbal and written information related to the research programme, including a general overview of the research and their involvement in the study. The information sheets stated that participation in the research was voluntary and it was explained that participants could withdraw at any time. Information was given to students and parents, through the participating teachers, before each survey administration. Signed student and parent consent forms were obtained prior to commencing data collection, and students were free to choose not to participate or to withdraw at any time. Copies of the information sheets and consent forms for the students, teachers, and principal can be found in Appendices G, H, and I, respectively.

3.8.2 Privacy and Confidentiality

All students and teachers who were involved in the research were made aware that the information collected would be kept anonymous and that their individual responses would be unavailable to anyone other than my Curtin University doctoral supervisor and myself. To protect the identity of the participants, codes were used to replace the names of participants in both the surveys and the interview data. Once all of the data were collected and analysed, these codes were detached from the key information to ensure the anonymity.

The profiles that were generated for each class, were shared only with the teacher. To ensure that both teachers and students could not be easily recognised, teachers and students were allocated with random numbers, known only to the supervisors and the researcher and, once the data were analysed, these numbers were detached from student data prior to archiving. A system of individual codes was maintained for all quantitative data to enable the researcher and supervisors to re-identify an individual's data and destroy it if participation was withdrawn.

To comply with the audit trail (as described by Lincoln & Guba, 1985), all qualitative data were stored in both hard copy and electronic format. Interview recordings were transcribed, and filed. Field notes and other documents were also coded and filed. Codes were referenced and filed so that they could be easily retrieved and cross-referenced if required. Pseudonyms were used in written narratives to protect individual identities.

3.8.3 Other Ethical Considerations

The researcher was also aware that the amount of time required for the action research and for students to complete the surveys could affect the student learning. To overcome this, the researcher purposefully selected her own workplace as the participating school, allowing the researcher to cooperate closely with the participating teachers and students during the research process. Thus, the researcher was able to ensure that adequate time was allowed for students to respond to the surveys. The negative impact on students' learning was minimised by negotiating a suitable timetable for the survey administration and classroom observations over the semester.

The teacher profiles, generated using student responses to the surveys, were intended to provide a means of reflection that would allow teachers to identify aspects of the learning environment that could be improved. The researcher was aware that, in some instances, teachers might feel negatively affected by the feedback given to them. To minimise this, a degree of sensitivity was exercised by the researcher, with additional time and support being provided to the teachers together with face-to-face conversations and meetings that were run to avoid group discussions of the students' feedback.

3.9 Chapter Summary

The research was conducted over one semester in mixed-ability mathematics and science classes drawn from one metropolitan school in South Australia. The study adopted a multi-method approach with the research programme being comprised of two investigations: namely, a quantitative (positivist deductive), a qualitative (interpretivist inductive) investigation and action research.

The two samples, used for data collection, were different for the two phases. For the first phase of the study, a sample involving 351 was drawn from 19 classes taught by seven teachers. In the second phase a case study sample, involving 56 students in two classes taught by one teacher was used to investigate the last research objective.

Evidence for the validity and reliability of the two instruments (COLES and SALES) were provided by examining the factor structure, internal consistency reliability, discriminant validity, and ability to differentiate between classes (Research Objective 1). To examine relationships between the learning environment factors and students' motivation and self-regulation, simple correlation and multiple regression analyses were used (Research Objective 2). To examine the effectiveness of use of student feedback, qualitative data were gathered using classroom observations and interviews. These data were analysed using techniques related to grounded theory methods (Strauss & Corbin, 1994) and Van Manen's (1994) impressionist tales of the field. To better articulate the data analysis, interpretative commentaries were written for the qualitative data (Geelan, 1997; Lincoln and Guba, 1985). It was predicted that these commentaries would provide more detailed description of the ways in which the case study teacher used the feedback regarding students' perceptions as part of her improvement efforts.

To ensure that the information gathered in the course of the present study was trustworthy, different methods of data collection and data analysis were utilised. Also, the data was collected over a period of time at the same research site. According to Merriam, 2009, these factors improve the validity of the qualitative research findings and provide a more holistic and credible explanation and understanding of the concepts being researched.

There were a number of ethical considerations made throughout the present research. First, the researcher ensured that appropriate ethical approvals were obtained from Curtin University and the DECD. Appropriate permission and consent were then sought from participants and measures were taken to guarantee the confidentiality and anonymity of participants. Other ethical considerations were related to the administration of the two instruments: specifically, ways to ensure limiting survey fatigue and impact on students' learning. It was also considered important to consider ways to minimise the potentially negative impact that the student perception data could have on individual teachers.

To finalise, this chapter explained and justified the design of the study. It also provided details concerning the sample and methods of data collection. Additionally, the chapter described which methods of data analysis were utilised in the present study. It also considered ethical issues and explained how confidentiality and anonymity of the participants was ensured in the course of the research. The next chapter, Chapter 4, will report the results of the present study.

Chapter 4

DATA ANALYSIS AND RESULTS

4.1 Introduction

Whereas the previous chapter described the research methods used for the study reported in this thesis, this chapter reports the results of the study. The chapter starts by reporting evidence related to the reliability and validity of the instruments used in the study (Section 4.2). In the subsequent section (Section 4.3), results pertaining to environment–motivation associations are reported to identify the learning environment constructs that contribute to students' motivation in mathematics and science. Results related to the use of student feedback to improve the learning environment are then reported in Section 4.4. Section 4.5 then provides an analysis of the effectiveness of the intervention strategies. Finally, in Section 4.6, a summary of the chapter is provided.

4.2 Validity and Reliability of the Instruments

As highlighted in the previous chapter, two instruments were selected for use in this study to collect the quantitative data: the Constructivist-Oriented Learning Environment Survey (COLES; Aldridge et al., 2012; Bell & Aldridge, 2014) and the Student Adaptive Learning Engagement Survey (SALES; Veyalutham et al., 2011, 2013). The COLES was used to assess students' perceptions of the learning environment, whereas the SALES was utilised to examine key determinants of students' motivation and self-regulation.

Given that neither of these instruments had been used previously in South Australia, the first research objective was to provide evidence to support the reliability and validity of each instrument when used with high school students in South Australia. Doing so was important in order to provide confidence in the results of the ensuing objectives and for the teacher, who would use the data to reflect on her teaching practices during the action research.

Findings related to the reliability and validity of the instruments are reported separately. Results for the COLES are reported in Section 4.2.1, and results for the SALES are reported in Section 4.2.2.

4.2.1 Reliability and Validity of the COLES

This section describes the criterion-related validity of the COLES. The evidence in this section is reported in terms of the factor structure (Section 4.2.1.1), internal consistency reliability (Section 4.2.1.2), ability to differentiate between classes (Section 4.2.1.3), and discriminant validity (Section 4.2.1.4) of the instrument.

4.2.1.1 Factor Structure

Factor analysis was used to examine the internal structure of the original 67-item, 11-scale COLES when used with high school students in South Australia. The convergent validity of an instrument can be defined as a measure of the strength of the relationships between the items that are predicted to represent a single latent construct or concept (Brown, 2006).

Principal axis factor analysis with oblique rotation was used to examine the factor structure of the survey; this analysis was conducted separately for the pre-test and post-test versions of the survey, as reported in Chapter 3. The criteria for retaining any item was that the item's factor loading had to be at least .40 on its own scale and less than .40 on the other scales (Field, 2005; Stevens, 1992; Thompson, 2004). The factor loadings, eigenvalues, and percentages of variance explained for the pre-test and post-test using the actual version of the COLES are reported in Table 4-1.

For the pre-test, 62 of the 67 items had factor loadings of at least .40 on their a priori scale and loadings of less than 0.40 on the other 10 scales. The exceptions were items 15 and 17 from the equity scale, item 46 from the task orientation scale, item 60 from the cooperation scale, and item 62 from the differentiation scale.

For the post-test, 64 out of 67 items had factor loadings of at least .40 on their a priori scales and less than .40 on the other 10 scales. The exceptions were item 36 from the clarity of assessment scale, item 46 from the task orientation scale, and item 62 from the differentiation scale.

The bottom of Table 4-1 reports the percentage of the total variance that was accounted for by the different scales. For the pre-test, these percentages ranged from 1.74% to 38.34%, with the total variance explained being 69.47%. For the post-test, the percentages explained by the individual scales ranged from 1.79% to 38.82%, with the total variance explained being 70.80%. The bottom of Table 4-1 also reports the eigenvalues for different scales, which ranged from 1.17 to 25.69 for the pre-test and from 1.20 to 26.01 for the post-test.

4.2.1.2 Internal Consistency Reliability

The internal consistency reliability of each scale of the COLES was estimated using Cronbach's alpha coefficient. The alpha values were calculated for two units of analysis, the individual and the class mean. These estimates are reported Table 4-2 for the pre-test and post-test administrations of the COLES.

With the individual as the unit of analysis, the scale reliability for the 11 scales ranged from .76 to .92 for the pre-test and from .82 to .92 for the post-test. The reliability estimates were generally higher when the class mean was used as the unit of analysis, ranging from .84 to .98 for the pre-test and from .85 to .98 for the post-test. According to Cohen, Manion, and Morrison (2000), the alpha coefficient for a satisfactory scale should be 0.70 or higher. Therefore, these alpha reliability estimates support the internal consistency of all scales of the COLES for both the pre-test and the post-test.

Table 4-1 Factor loadings for the COLES for the pre-test and post-test data

	Factor Loadings																					
Item no.	Student cohesiveness		Teacher support		Equity		Young adult ethos		Formative assessment		Clarity of assessment		Involvement		Task orientation		Personal relevance		Cooperation		Differentiation	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	.61	.61																				
2	.42	.47																				
3	.73	.74																				
4	.40	.47																				
5	.48	.45																				
6	.60	.62																				
7			.59	.65																		
8			.76	.63																		
9			.68	.71																		
10			.66	.72																		
11			.71	.60																		
12			.60	.75																		
13					.48	.66																
14					.46	.74																
15					–	.72																
16					.49	.76																
17					–	.64																
18					.50	.73																
19							.51	.60														
20							.62	.61														
21							.56	.71														
22							.61	.66														
23							.47	.64														
24							.69	.54														
25							.54	.62														

	Factor Loadings																					
Item no.	Student cohesiveness		Teacher support		Equity		Young adult ethos		Formative assessment		Clarity of assessment		Involvement		Task orientation		Personal relevance		Cooperation		Differentiation	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
26									.45	.54												
27									.59	.70												
28									.65	.63												
29									.68	.60												
30									.72	.73												
31									.73	.75												
32											.42	.42										
33											.43	.43										
34											.40	.49										
35											.41	.55										
36											.64	–										
37											.45	.52										
38													.55	.53								
39													.79	.67								
40													.60	.57								
41													.74	.67								
42													.65	.61								
43													.51	.57								
44															.41	.59						
45															.43	.44						
46															–	–						
47															.40	.51						
48															.53	.63						
49															.44	.49						
50																	.71	.60				
51																	.78	.87				
52																	.62	.71				
53																	.60	.89				
54																	.64	.64				

	Factor Loadings																					
Item no.	Student cohesiveness		Teacher support		Equity		Young adult ethos		Formative assessment		Clarity of assessment		Involvement		Task orientation		Personal relevance		Cooperation		Differentiation	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
55																	.41	.40				
56																			.71	.59		
57																			.72	.69		
58																			.68	.68		
59																			.52	.75		
60																			–	.44		
61																			.41	.44		
62																					–	–
63																					.41	.40
64																					.72	.64
65																					.67	.73
66																					.42	.64
67																					.67	.66
% Variance	2.54	2.17	6.59	3.06	1.74	2.55	2.62	1.79	38.34	3.23	2.15	38.82	4.26	3.61	1.83	1.97	2.06	5.38	3.92	5.99	3.43	2.23
Eigen-value	1.70	1.45	4.41	2.05	1.17	1.71	1.76	1.20	25.69	2.16	1.44	26.01	2.85	2.42	1.22	1.32	1.38	3.60	2.62	4.02	2.30	1.49

Factor loadings smaller than .40 have been omitted.
Pre–post test sample size: *N* = 351 students from 19 classes.
Principal axis factoring; rotation method: Oblimin with Kaiser normalisation.

Table 4-2 Internal consistency reliability (Cronbach's alpha coefficient) and ability to differentiate between classrooms (ANOVA results) for two units of analysis for the COLES

Scale	Unit of analysis	Alpha reliability		ANOVA (eta^2)	
		Pre-test	Post-test	Pre-test	Post-test
Student cohesiveness	Individual	.80	.83	.16**	.07
	Class mean	.92	.85	-	-
Teacher support	Individual	.91	.92	.27**	.28**
	Class mean	.97	.98	-	-
Equity	Individual	.92	.92	.20**	.17**
	Class mean	.98	.98	-	-
Young adult ethos	Individual	.90	.90	.14**	.10**
	Class mean	.95	.96	-	-
Formative assessment	Individual	.90	.91	.19**	.16**
	Class mean	.97	.97	-	-
Clarity of assessment	Individual	.89	.90	.18**	.21**
	Class mean	.97	.97	-	-
Involvement	Individual	.89	.91	.16**	.15**
	Class mean	.96	.96	-	-
Task orientation	Individual	.87	.88	.08*	.08*
	Class mean	.91	.90	-	-
Personal relevance	Individual	.91	.92	.18**	.16**
	Class mean	.97	.97	-	-
Cooperation	Individual	.83	.82	.16**	.13**
	Class mean	.89	.97	-	-
Differentiation	Individual	.76	.83	.15**	.14**
	Class mean	.84	.88	-	-

** $p < .01$; *$p < .05$.
N = 351 students from 19 classes for both the pre-test and the post-test.

4.2.1.3 Ability to Differentiate between Classes

Concurrent validity relates to whether a construct is able to differentiate between those groups that it was expected to differentiate between. In the present study, whereas students within a particular classroom may be expected to perceive the learning environment in a similar way, the class mean would be expected to vary between classrooms. As such, in order to assess concurrent validity, a one-way analysis of variance ANOVA, with class membership as the independent variable, was used. The proportion of variance accounted for by class membership for each scale was calculated using the eta^2 statistic (the ratio of 'between' to 'total' sums of squares).

The results, reported in Table 4-2, show that all of the eta^2 values were statistically significant for the pre-test, indicating that all of the scales of the COLES were able to differentiate between classes as expected. For the post-test, all of the scales were able to differentiate between classes except for the student cohesiveness scale. It is possible that, for this scale, students' perceptions of cohesiveness were influenced more strongly by their peer relations than by what took place in the secondary mathematics and science classrooms. Overall, the statistically significant eta^2 results suggested that the scales of the COLES were able to differentiate between classes, thus supporting the concurrent validity of the scales.

4.2.1.4 Discriminant Validity

Discriminant validity refers to the degree to which a scale is unique in the dimension which it assesses; that is, the construct is not included in the other scales of the instrument. Trochim and Donnelly (2008) suggest that discriminant validity is achieved when the correlations between a particular item and the other items in the same construct are higher than the correlations between items from different constructs.

A component correlation matrix, obtained from oblique rotation, was generated for the COLES scales. Although Field (2005) has suggested that there should be a moderate relationship between factors, according to Brown (2006), factor correlations above .80 suggest an overlap of concepts and may indicate poor discriminant validity. The factor correlation matrix for both the pretest and posttest data (reported in Table 4-3) indicates that the highest correlation reported between factors was .48; this value met the requirement of discriminant validity defined by Brown (2006).

Table 4-3. Component correlation matrix for the scales of the COLES

Scale	Factor correlations										
	SC	TS	E	YAE	FA	CA	I	TO	PR	C	D
Student cohesiveness (SC)	–	.41	.32	.27	.18	.41	.21	.35	.42	.30	.29
Teacher Support (TS)	.14	–	.28	-.22	.12	.48	.27	.27	.18	.16	.35
Equity (E)	.24	.21	–	.26	.23	.25	.25	.27	.33	.15	.18
Young adult ethos (YAE)	.21	.29	.28	–	.25	.21	.23	.18	.25	.25	.19
Formative assessment (FA)	.34	.23	.43	.26	–	.13	.13	.13	.34	.05	.16
Clarity of assessment (CA)	.26	.24	.26	.29	.39	–	.25	.27	.28	.29	.33
Involvement (I)	.23	.25	.25	.34	.28	.48	–	.20	.07	.20	.14
Task orientation (TO)	.17	.28	.37	.30	.27	.26	.15	–	.29	.26	.17
Personal relevance (PR)	.10	.33	.28	.31	.22	.32	.32	.31	–	.25	.17
Cooperation (C)	.24	.07	.29	.22	.29	.25	.27	.13	.15	–	.14
Differentiation (D)	.30	.21	.41	.17	.42	.36	.33	.18	.30	.40	–

Pre-test correlations are shown above the diagonal and post-test correlations are shown below the diagonal.
N = 351 students from 19 classes for both the pre-test and post-test.

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4.2.2 Validity and Reliability of the SALES

To provide evidence to support the reliability and validity of the SALES, the factor structure (Section 4.2.2.1), internal consistency reliability (Section 4.2.2.2), ability to distinguish between classes (Section 4.2.2.3), and discriminant validity (Section 4.2.2.4) of the survey were examined.

4.2.2.1 Factor Structure

To provide evidence to support the convergent validity of the SALES, principal axis factor analysis with oblique rotation was used to examine the four-scale a priori structure of the SALES. The two criteria used for retaining any item were that the item must have a factor loading of at least .40 on its own scale but not on any other scales.

Table 4-4 presents the factor loadings, eigenvalues, and percentages of variance explained for the four scales of the SALES.

For both the pre-test and the post-test, all 32 items of the SALES had factor loadings of at least .40 on their a priori scale and on no other scale. The bottom of

Table 4-4 shows the percentage of variance accounted for by the different scales. For the pre-test, these percentages ranged from 4.16% to 47.55%, with the total being 64.90%. For the post-test, these percentages ranged from 5.03% to 44.93%, with the total being 63.90%. The bottom of

Table 4-4 also shows that the eigenvalues for the different scales ranged from 1.33 to 15.21 for the pre-test and from 1.61 to 14.38 for the post-test.

Table 4-4 Factor loadings for the SALES

Item no.	Factor loadings							
	Learning goal orientation		Task value		Self-efficacy		Self-regulation	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	.68	.68						
2	.60	.63						
3	.67	.70						
4	.83	.75						
5	.77	.77						
6	.73	.73						
7	.68	.76						
8	.51	.69						
9			.78	.76				
10			.57	.66				
11			.59	.75				
12			.75	.77				
13			.74	.75				
14			.77	.69				
15			.64	.68				
16			.45	.63				
17					.70	.76		
18					.82	.92		
19					.75	.68		
20					.70	.76		
21					.65	.68		
22					.64	.75		
23					.81	.69		
24					.76	.65		
25							.83	.75
26							.80	.72
27							.75	.75
28							.74	.75
29							.42	.53
30							.44	.63
31							.67	.74
32							.73	.77
Eigenvalue	2.41	2.55	1.81	1.92	15.21	14.38	1.33	1.61
% Variance	7.52	7.95	5.66	5.99	47.55	44.93	4.16	5.03

Factor loadings smaller than .40 have been omitted.
N = 351 students from 19 classes.

4.2.2.2 *Internal Consistency Reliability*

As a further measure of convergent validity, the internal consistency of each scale of the SALES was calculated using Cronbach's alpha coefficient for two units of analysis, the individual student and the class mean. The results, reported in Table 4-5, show that the scale reliability estimates were consistently high. Using the individual as the unit of analysis, with the scale reliability estimates ranging from .89 to .93 for the pre-test and from .95 to .98 for the post-test. Using the class mean as the unit of analysis, the scale reliabilities ranged from .90 to .92 for the pre-test and from .92 to .96 for the post-test.

Table 4-5 Internal consistency reliability (Cronbach's alpha coefficient) and ability to differentiate between classrooms (ANOVA results) for two units of analysis for the SALES

Scale	Unit of analysis	Alpha reliability		ANOVA (eta^2)	
		Pre-test	Post-test	Pre-test	Post-test
Learning goal orientation	Individual	.89	.95	.14**	.11*
	Class mean	.90	.92	-	-
Task value	Individual	.91	.98	.36**	.32**
	Class mean	.91	.97	-	-
Self-efficacy	Individual	.93	.97	.14**	.11*
	Class mean	.92	.95	-	-
Self-regulation	Individual	.93	.97	.19**	.19**
	Class mean	.92	.96	-	-

The eta^2 statistic (which is the ratio of 'between' to 'total' sums of squares) represents the proportion of variance explained by class membership.
N = 351 students from 19 classes.

4.2.2.3 *Ability to Differentiate Between Classes*

ANOVA with class membership as the independent variable was used to determine the extent to which each scale of the SALES was able to differentiate between the motivation of students in different classes. The resulting eta^2 statistics provided information about the amount of variance attributable to class membership for each scale.

The results, reported in Table 4-5, indicate that the eta^2 values were statistically significant for all four SALES scales for both the pre-test and the post-test. These results suggest that all of the scales of the SALES were able to differentiate between classes, supporting the concurrent validity of the scales.

4.2.2.4 Discriminant Validity

To examine the discriminant validity of the scales of the SALES, a component correlation matrix, obtained from oblique rotation, was generated. The results, reported in Table 4-6, suggest that there was limited overlap between the scales of the SALES as there was no correlation value greater than .80. As such, the correlations reported in Table 4-6 indicate that the scales of the SALES assess unique dimensions.

Table 4-6. Factor correlation matrix for the scales of the SALES

Scale	LGO	TV	SE	SR
Learning goal orientation (LGO)	–	0.47	0.43	0.59
Task value (TV)	0.44	–	0.51	0.43
Self-efficacy (SE)	0.52	0.45	–	0.49
Self-regulation (SR)	0.57	0.40	0.51	–

Pre-test correlations are shown above the diagonal and post-test correlations are shown below the diagonal.
N = 351 students from 19 classes of seven teachers for both the pre-test and post-test.

4.3 Environment–Motivation Associations

To examine whether students' perceptions of their learning environment was related to self-reports of motivation and self-regulation, simple correlation and multiple regression analyses were undertaken (with the individual as the unit of analysis). Analysis involved using the 11 COLES scales as the independent variables and the four SALES scales as the dependent variables.

Multiple regression analysis was used to provide more parsimonious information than the simple correlation did about the relationships between correlated independent variables and reduced the risk of a high Type I error rate, which is often linked with simple correlation analysis (Stevens, 1992, 2002). Beta values (β), which are the standardised regression weights, were used to identify which classroom environment scales contributed the most to the variance in motivational scales.

This section reports the findings of these analyses in terms of the impact of student perception of the learning environment on students' learning goal orientation (Section 4.3.1); task value (Section 4.3.2); self-efficacy (Section 4.3.3); and self-regulation (Section 4.3.4).

4.3.1 Learning Goal Orientation

The results of the simple correlation analysis, reported in Table 4-7, indicate that all 11 scales of the COLES were statistically significantly ($p < .01$) and positively related to students' responses to the learning goal orientation scale. The strengths of these statistically significant correlations ranged between .10 and .25.

The multiple correlation (R) value between the 11 COLES scales and students' learning goal orientation, reported at the bottom of Table 4-7, was .32 and was statistically significant ($p < .01$). To identify which classroom environment scales contributed to the variance in the learning goal orientation scores, the standardised regression weights (β) were examined. Four of the 11 learning environment scales were positively, statistically significantly ($p < .05$), and independently related to learning goal orientation: student cohesiveness, teacher support, task orientation, and personal relevance.

4.3.2 Task Value

The simple correlation analysis, reported in Table 4-7, shows that all 11 of the learning environment scales were statistically significantly ($p < .01$) and positively related to students responses to the task value scale. The correlations ranged from .12 to .34.

Table 4-7 Simple correlation and multiple regression analyses for the associations between students' perceptions of the learning environment and their motivation in science learning

Scale	Learning goal orientation		Task value		Self-efficacy		Self-regulation	
	r	β	*r*	β	*r*	β	*r*	β
Student cohesiveness	.19**	.12*	.15**	.03	.11**	.04	.19**	.03
Teacher support	.24**	.14*	.35**	.24**	.22**	.10	.28**	.14*
Equity	.18**	.01	.23**	.07	.15**	.07	.20**	.09
Young adult ethos	.17**	.10	.26**	.08	.17**	.06	.28**	.03
Formative assessment	.20**	.01	.34**	.13*	.22**	.01	.27**	.02
Clarity of assessment	.25**	.09	.34**	.05	.30**	.17**	.34**	.11
Involvement	.15**	.08	.23**	.08	.24**	.07	.20**	.08
Task orientation	.26**	.16*	.32**	.09	.28**	.16**	.39**	.28**
Personal relevance	.26**	.18**	.40**	.27**	.27**	.07	.32**	.09
Cooperation	.10**	.08	.12**	–.15*	.10**	–.13*	.13**	.12*
Differentiation	.15**	.04	.27**	.06	.23**	.07	.27**	.10
Multiple correlation (*R*)		.32**		.48**		.37**		.45**

**p* < .05; ***p* < .01
N = 351 students in 19 classes
Results are based on the individual as the unit of analysis.

The multiple correlation (R) for task value was .48 and was statistically significant ($p < .01$). The standardised regression weights (β; examined to identify which learning environment scales contributed to the variance in task value), reported in Table 4-7, show that four of the 11 learning environment scales were statistically significantly and independently related to task value: teacher support, formative assessment, personal relevance, and cooperation. All of the statistically significant correlations were positive, except that the cooperation scale was negatively and statistically significantly related to task value.

4.3.3 Self-Efficacy

The simple correlation analysis, reported in Table 4-7, shows that all 11 of the learning environment scales were statistically significantly ($p < .01$) and positively related to students' responses to the self-efficacy scale. The correlations ranged from .10 to .30.

The multiple correlation (R) was .37 and was statistically significant ($p < .01$). The standardised regression weights (β; examined to identify which learning environment scales contributed to the variance in the self-efficacy scores), reported in Table 4-7, show that three of the 11 learning environment scales were statistically significantly and independently related to self-efficacy: clarity of assessment, cooperation and task orientation. Two of the three statistically significant relationships were positive, the exception being for the cooperation scale, which was negatively related to self-efficacy.

4.3.4 Self-Regulation

The results of the simple correlation analysis, reported in Table 4-7, show that all 11 scales of the COLES were statistically significantly ($p < .01$) and positively related to students responses to the self-regulation scale. These statistically significant correlations ranged between .13 and .39.

The multiple correlation (R) for the 11 scales of the COLES, reported in Table 4-7, was .45 and was statistically significant ($p < .01$). To identify which classroom environment scales contributed to the variance in the self-regulation scores, the standardised regression weights (β) were examined (see Table 4-7). Three of the 11 classroom environment scales were positively, independently, and statistically significantly ($p < .05$) related to self-regulation, namely, teacher support, task orientation, and cooperation.

Thus far, the current chapter has reported the results for phase one of the study. Results related to the reliability and validity of the instruments used in the present study were reported in Section 4.2, and results pertaining to environment–motivation associations were reported in Section 4.3. The next section (Section 4.4) reports the findings related to the second phase of the study.

4.4 Using Student Perception Data to Guide Changes in Teaching Strategies to Improve Learning Environment Perceptions and Motivation

This section (Section 4.4) focuses on the critical instance case study teacher's efforts to use student feedback (as part of an action research approach) to make changes to the learning environments in a bid to improve her students' motivational and self-regulatory beliefs. This section is complemented by Section 4.5, which provides an analysis of the effectiveness of the intervention strategies used by the critical instance teacher.

To investigate how the critical instance case study teacher used the student feedback (derived from the COLES and the SALES) to guide her classroom strategies, the teacher as well as the students in her year 8 and 10 mathematics and science classes ($N = 56$) participated in interviews and classroom observations, as described in Chapter 3. At all stages of the action research process, this teacher was provided with opportunities to discuss with the researcher her approach and the types of strategies that she would use. The baseline data, collected prior to the commencement of the action research, involved observations and survey data. The observation data was used to construct a narrative to describe the setting prior to the intervention (provided in Section 4.4.1). This narrative is followed by an interpretative commentary used to distil the salient points. The section goes on to describe the student feedback (baseline data collected using the COLES and SALES) and how the teacher used this as the basis for reflection (Section 4.4.2). The section then goes on to describe the teacher's plan to improve the learning environment based on the feedback from students and observation data, and how the strategies were implemented (Section 4.4.3).

4.4.1 Stage 1: Classroom Observations - Setting the Scene

In this section, a first-person narrative, based on information gathered by the researcher during classroom observations and interviews with the critical instance teacher before the intervention, is used to set the scene. This section also includes an interpretative commentary on the narrative and a summary of the feedback that was provided to the teacher based on the student responses to the COLES and SALES pre-tests (Section 4.4.2).

This section provides a narrative that reflects the researcher's observations in a year 8 science class taught by the critical instance case study teacher. The purposes of the narrative are, first, to provide contextual information to help the reader to better understand the setting and, second, to help to explain the possible reasons for students' responses to two surveys administered prior to the action research.

My observation was going to take place in a regular year 8 science class taught by Maria, a mathematics and science teacher with over 10 years of teaching experience. Maria was enthusiastic about being involved in the action research and had decided to engage both of her classes (a year 8 integrated mathematics and science class and a year 10 integrated mathematics and science class). I was particularly interested to see what the learning environment was like and the strategies Maria used to motivate her students and the students' behaviours and reactions to these strategies, particularly with respect to their motivation.

It was a typical morning in school life. I arrived a couple of minutes before the bell. I greeted Maria, asked for her permission to enter and observe the lesson, took my seat at the back of the class, and started my observations. Most of the students had arrived just before or with the bell, but a few stragglers came in just after the bell. Although Maria was doing some last minute preparation for the lesson (such as setting her laptop, projector, and a power point presentation), she still found time to greet her students on their arrival and to talk to them individually. As the bell went, Maria asked her students to take their seats and take out their writing equipment and books. Most of the students, however, ignored Maria and continued to talk with each other, apparently oblivious to this instruction. Maria then raised her voice and repeated the instructions. The students gradually responded to Maria's request, took their seats, and started to take their equipment out of their bags.

The students were sitting in five groups with four to six students in each. The desks were arranged so that the students in each group were facing each other. This group setting was the norm at this school, with all other mathematics and science classrooms (except for the chemistry and physics laboratory rooms) and was arranged in the same way.

Once Maria had the attention of most of the students, she began her lesson in a strong and steady voice: "Today, class, we are going to learn about energy." Attracting the students' attention to the screen with a PowerPoint presentation related to energy, Maria pointed to the first slide, which had a series of short questions related to what energy is, where it is found, the things that it does, and how it is used. The teacher invited students to read the questions, and then she read them aloud to the class. Maria then asked the students to discuss the questions in their groups.

The students began to talk. From my vantage point, it was clear that only one of the five groups was maintaining a discussion related to the questions posed on the slide. Students in the remaining groups were talking but appeared off-topic and started to become noisy. Sensing this, Maria invited students from each group to call out the answers; however, only one group actively participated and the teacher was getting very little response from the any of the other four groups. In a bid to get the students from the other groups involved, she began to call on students by name and to ask questions of them individually. However, Maria still did not get any reasonable responses, with some of the students providing answers that were clearly incorrect. For example, one of the students called out: "Energy comes from energy drinks" and another responded: "You have a lot of energy when you go to [the] gym." While Maria continued asking questions, the noise level from other students started to rise as they engaged in conversations with their peers. One boy started to tap his desk with a pen. Maria reacted by warning him that if he continued to make the noise, he would get a detention. Another boy started to sing "La-la-la" and put his head on the table, clearly paying no attention to what was happening in class.

Maria continued to ask questions of individuals for another five minutes—during which the noise level increased—until she told the class to calm down and to attend to the next slide. The second slide summed up the answers to the questions posed on the first slide. There was a minute of silence as the students read the slide. Maria then started to list the key topics that they would be looking at during the term on the board. As she wrote with her back to the class, the students started to chat and giggle. Ignoring the giggling, Maria turned back to face the class and asked them to open their workbooks and copy what she had written on the board as well as the answers from the screen.

It was clear that the students were not enthusiastic about copying from the board. As they opened their books, there were comments such as "Oh no, again." Some students crossed their arms and made no move to start writing. Others shook their heads and were clearly reluctant to make a start. As time went on, many of the students started to copy the notes from the board;

there was a small group of students, however, who refused to cooperate at all. Seeing these students, Maria approached them and warned them that if they didn't follow her instructions, they would be given detentions or removed from class. The students cooperated and started to copy from the board.

Maria moved between the groups as all of the students were copying the information down. The students from the group that had been actively involved in the earlier discussion quickly finished copying down the answers and started to talk together. The rest of the class seemed to be in no rush to complete copying the work, and many were observed talking with each other. In one of the groups, a student was holding up his mobile telephone, showing something to the other members of the group. He quickly put the telephone down as Maria moved towards the group and started to write down the notes but, once the teacher moved away, the students began to talk again. This pattern of behaviour was observed amongst all of the groups in the class. As Maria approached, they would become quiet and start to copy from the board, but then, as she moved away, they would resume their conversations.

After five minutes, Maria called the class to quiet down and attend to the next slide. This slide showed definitions of different forms of energy (such as sound, heat, electrical, chemical, and nuclear) and had accompanying pictures to illustrate each one. Maria read the definitions out to the class, explained the pictures, and gave more examples of where the different forms of energy could be found. After explaining each form of energy, Maria wrote the list of different forms of energy on the board. She then asked the students to copy down the definitions and examples. Again, the noise level started to rise as students were told to copy from the screen, with only one of the groups doing as they had been told. The students in the other groups were conversing with each other, and some were distracted by their mobile telephones: playing games, browsing the internet, or texting. Again, the students only made efforts to copy from the board when Maria approached their group.

After five minutes, Maria called the students' attention again and moved to the next slide (which contained pictures and diagrams to explain how energy could be transferred). Once Maria had been through the slide, she again asked the students to copy down the examples and to draw the diagrams. Again, the students in all but one of the groups chatted to each other, giggled, and looked at their mobiles when the teacher's attention was shifted to other students. From my vantage point, I could hear students asking questions to the teacher such as, "Why do we need that?" "When and where will we use that?" and "Will we ever use this?" There were also comments including: "I don't need it in my life!" "I don't care" and "I will never use it anyway".

Maria ignored those questions and comments, raised her voice, and reminded students that they needed to copy the notes from the screen. Even though Maria moved between the groups, reminding them to focus on their work, I noticed that many of the students continued to go off task and begin to socialise as soon as she moved away.

After 10 minutes, Maria asked the class to be quiet and waited for silence so that she could explain the worksheet that she was about to give them. She showed the students the worksheet, which had pictures and boxes with words describing different forms of energy. She explained that they would need to match the pictures to the forms of energy that they represented. Once this had been explained, Maria distributed the worksheet to the students. The students did not look enthusiastic about completing the worksheet, with most of them having conversations with other members of their group or using their mobile telephones. I got up from my place at the side of the classroom to find out what was in the worksheet and what the students were doing with their mobiles. I found that some students were playing games on their telephones, and others were texting or browsing the internet. A number of students were wearing earphones and, presumably, were listening to music. As Maria walked around to help students, she took no notice of the headphones and ignored the students who were using their mobiles or talking to others.

Maria stopped to help a group and when she approached them, the group members told her that they did not understand what to do. Maria took a chair, sat with them, and went through the worksheet. As she worked with this group, the noise level from the remainder of the class increased. Maria stood up and cautioned the class about their inconsiderate behaviour, warning them that they would receive detention if they continued to talk and disrupt the class.

After Maria had finished helping this group, she stood and called for the students' attention, telling them that it was now time to hand in their completed worksheets. Maria walked around the class, collecting the worksheets from the students; once they had all been collected, the teacher attracted the students' attention. I noted that the teacher did not look at the completed worksheets and did not provide any feedback to the students. Once Maria had attracted the students' attention, she immediately instructed the students as to their next activity. She told the students that they would be required to discuss, in their groups, what they had learned during the lesson. She advised that each group should appoint a leader who would deliver the groups' findings. From the expressions on the students' faces, it was evident that they were not keen on this idea. Only the group of the most engaged students decided quickly who would be the leader. As the students in this group discussed the lesson, the group leader recorded dot points to summarise what they said.

In the other groups, there was much discussion about who would take the role of the leader, with no one wanting the job. The noise level elevated as students began to argue about who would take the role. From where I was sitting, I could hear the students arguing and saw some physical pushing. This situation went on for a couple of minutes before Maria declared that she would pick the group leaders herself. The students calmed down and Maria called the names of the students who would be leaders for each group. The leaders then started to consult with their groups so that they could deliver the group findings.

Once the groups had their points together, the group leaders took turns to present their group's points. During each presentation, the level of noise increased, and Maria was required to constantly remind the students to be quiet and listen.

Once all of the presentations had been made, Maria introduced the next worksheet, which included several different components. She informed the students that they would need to read the theoretical information provided on the sheet first and then go through the worked examples; only then should the students attempt the questions listed on the worksheet. Maria informed the students that this would be the final activity and that, if they did not complete the worksheet, they would have to do it for homework. She reminded them that the more they completed in class, the less they would need to do at home. This prompted students to be quiet and to listen to the instructions, which Maria repeated again.

Once the worksheets were distributed, I noticed that all of the students started to read the worksheet. The worksheet consisted of theory, formulae, worked examples, multiple choice questions, fill-in-the-gap exercises, and word problems. Maria instructed the students that at least all of the multiple-choice and half of the fill-in-the gap questions had to be completed before recess, and she stated that those who did not finish this much of the worksheet in time would have to stay in at recess to do so. I noticed that all of the students immediately took their pens and started to work. Approximately fifteen minutes later, students started to call out: "Finished, Miss!" Shortly afterwards, the bell went. At the sound of the bell, the students started to put away their equipment and proceeded to show the completed worksheet to Maria, who was standing at the door. I thanked Maria for the opportunity given to me to observe her class as she rushed out to her assigned yard duty.

Throughout the classroom observations, I looked for patterns in order to create a more complete picture of what I had observed. The narrative, provided in Section 4.4.1, draws on my observations of different lessons taught by Maria to illustrate various points; as an impressionistic tale, the narrative provides a description of a science classroom that was somewhat typical of both of the classes that I observed prior to the intervention. In these lessons, a number of patterns of behaviour displayed by the students indicated that, overall, they lacked motivation and were not generally engaged in their learning.

One of the most striking patterns revealed during the pre-intervention classroom observations was the students' lack of interest in the classroom activities and tasks provided by Maria. This lack of interest was manifested through the constant attempts, made by the majority of the students, to avoid completing the assigned tasks. The observations strongly suggested that the learning activities, provided by the teacher, were not perceived by the students to be interesting.

The second pattern that emerged from the observations was that many of the classroom activities appeared to be aimed at students with lower ability levels. The activities did not include opportunities for higher-order thinking or creativity and did not cater for more advanced students' needs. It was also observed that, for the few students who did complete their work in a timely manner, there was a lack of anything further to do; this appeared to contribute to the overall noise levels that were observed.

The third pattern was that the classroom setting, with groups of four to six students, favoured continuous group work and did not provide opportunities for individual students to work alone. It appeared that this group setting encouraged students within each group to distract each other, and possibly contributed to the number of off-task conversations that were observed.

The fourth pattern that emerged across all of the pre-intervention observations was the students' inappropriate or unnecessary use of mobile telephones and headphones. Some students were observed using their headphones to listen to music, whereas others were observed using their telephones to send text messages, browse the internet, or play games; all of these activities appeared to distract the students from learning tasks or activities. The observations also indicated that Maria (the teacher) did not notice her students using their mobile telephones.

The fifth pattern that emerged from the classroom observations was that classroom activities were not timed by the teacher. In the lessons that were observed, the students were not given time restrictions for any of the assigned activities and tasks, and this often led to behaviours that appeared to stop students getting on with their work. For example, when the first group discussion occurred at the beginning of a lesson, the teacher did not provide a time limit. For all activities, the students were not given a time restriction.

The sixth pattern that emerged during the course of the classroom observations was a lack of clear instructions or goals when Maria assigned classroom activities. The observations indicated that, on many occasions, the students were not clear about what was expected of them. The students also had a limited idea of their progress in their learning because of the limited feedback from the teacher as well as the absence of any self- or peer-assessment opportunities.

The identification of these six patterns made it reasonable to infer that the motivation and engagement of the students in this class were inhibited as the classroom activities were not connected to their everyday life. This lack of connection to the students' lives is evident in the observation narrative when students start asking questions such as "Why do we need it?" and "Where and when are we going to use it?"

In addition, the pre-intervention observations showed that the failure of Maria's attempts to motivate and engage her students may have been caused by various factors including students being seated in big groups and being frequently distracted by their peers; the teacher allowing the use of mobile telephones; the teacher allocating more time for the activities than students might have required; and the teacher not setting clear expectations for the tasks or activities.

4.4.2 Stage 2: Reflection and Focus - Examining Student Perception Feedback

Student feedback related to their perception of actual and preferred learning environment was provided for Maria's year 8 mathematics and science class (see Figure 4.1) and for her year 10 mathematics and science class (see Figure 4.2). Students' perceptions of the actual learning environment were indicated by the light grey segments of the figures and their preferred or ideal learning environment was indicated by the dark grey segments.

Maria spent time examining these profiles and worked with the researcher, who had observed Maria's lessons, to interpret the data in light of the classroom context. Maria expressed concerns about the gaps between the actual and preferred environments that were reported by students for four scales: differentiation, personal relevance, formative assessment, and task orientation. She noted that the largest gaps between the actual and preferred scores, for both classes, were for the differentiation and task orientation scales.

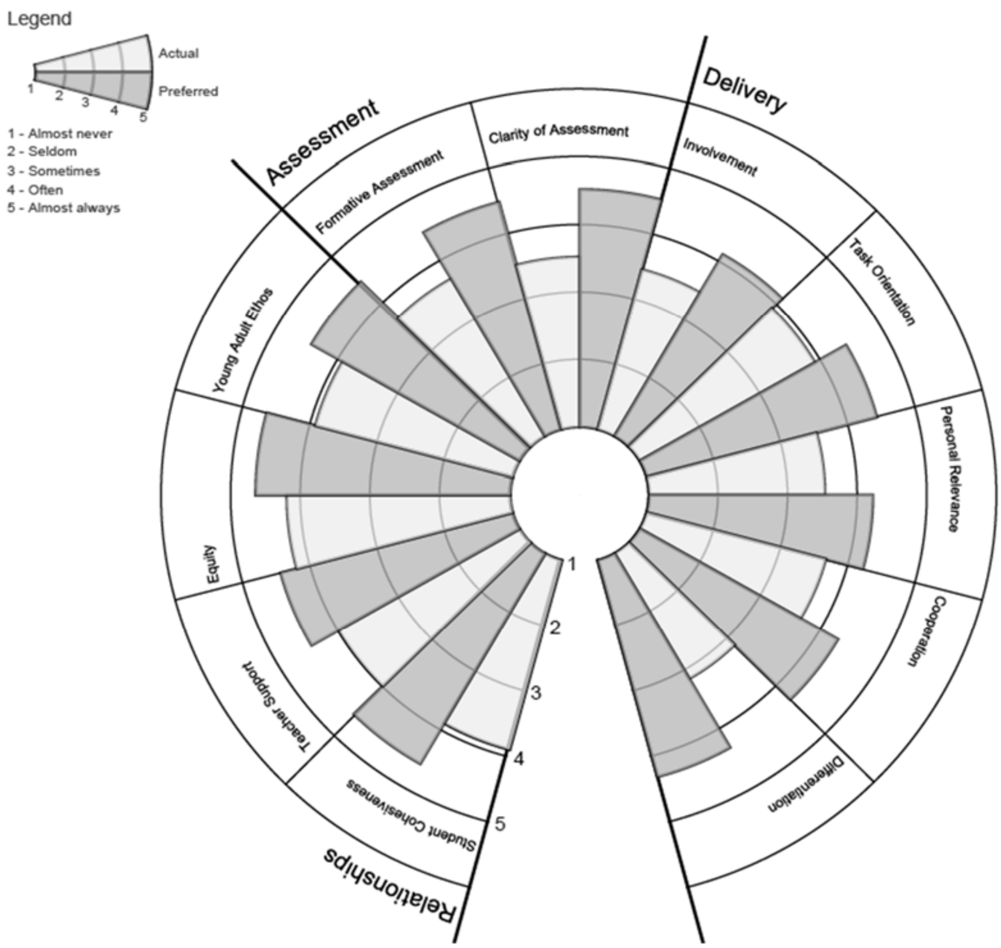

Figure 4.1. Pre-test profile for Maria's year 8 mathematics and science class

As Maria discussed the profiles with the researcher, it became clear that much of what the researcher had observed during the lessons (and described in the narrative) were also of concern to Maria. For example, when talking about the task orientation scale, Maria commented that a great number of students regularly wasted time chatting and distracting each other and were often off-task. As another example, when discussing the differentiation scale, Maria noted that her lessons rarely involved activities that were differentiated according to the students' abilities or interests.

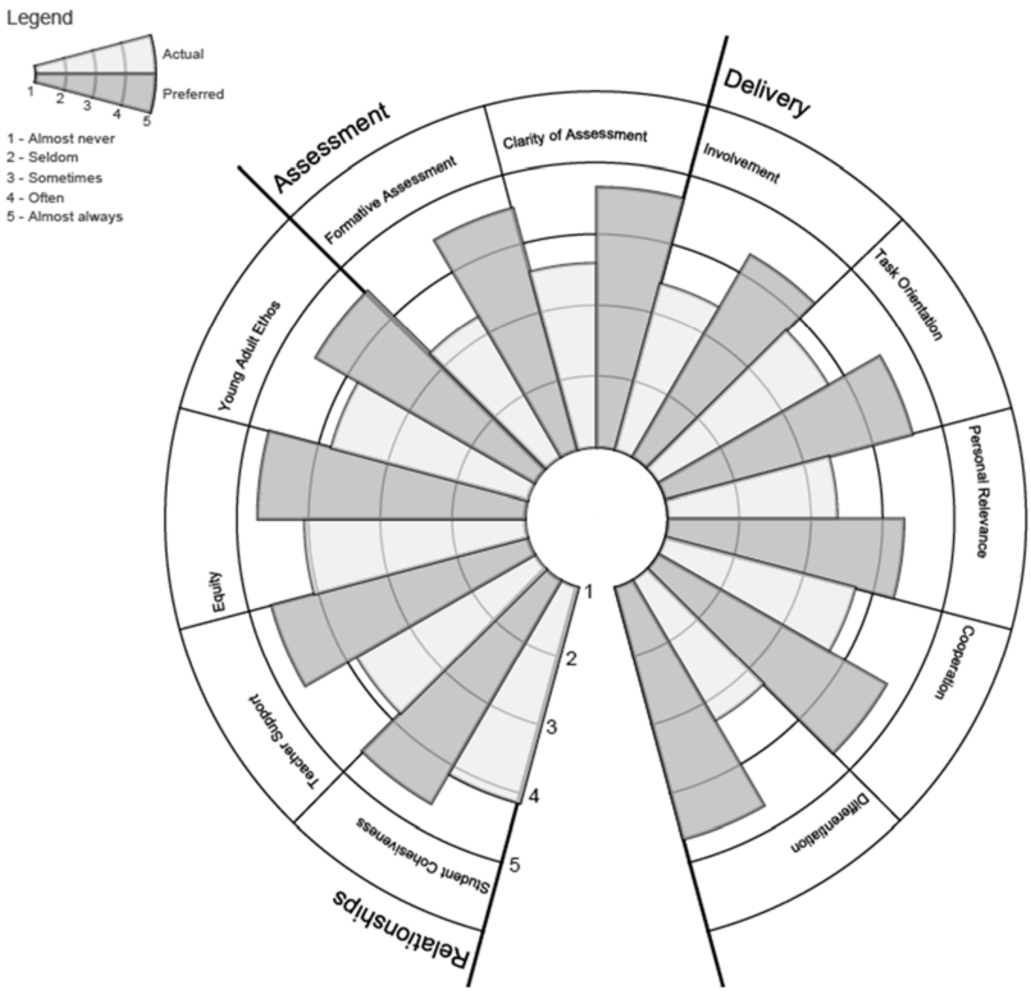

Figure 4.2. Pre-test profile for Maria's year 10 mathematics and science class

During this stage of the action research process, Maria critically reflected on her teaching and the strategies that she currently employed in the classroom. She made a decision that she would like to make changes in her classes that could improve her students' motivation, help her students to be more responsible for their own learning, and help them to use their time more productively. Maria felt that the student feedback and classroom observations highlighted a number of challenges; she summed up these challenges during the discussion meeting as follows:

- How could different tasks and programs be managed for each class?
- How could I motivate students with different abilities and interests?
- How could my lessons be more task-oriented?
- How could assessment tools help me to give clear instructions and expectations and provide better feedback to students?

The ways in which Maria planned strategies to improve aspects of her classroom learning environment are described in the next sections (Sections 4.4.3 to 4.4.3.4). These sections also describe the intervention processes and their outcomes.

4.4.3 Stages 3: Planning implementing strategies to Improve the Learning Environment - Improving Task Orientation and Differentiation

After Maria had reflected on the feedback as described in Section 4.4.2, she approached all of her students individually, before or after lessons, to ask for their opinions about the learning activities that she normally offered in her lessons. She also initiated classroom discussions to find out what her students thought about both current classroom activities and the types of activities which they would like to be exposed to if the opportunity arose.

As a result of these discussions, Maria realised that many of her students did not find the current classroom activities relevant and lacked interest in the topics that she offered. She said during a subsequent discussion: "My students don't think that what they are learning in my lessons could ever be applied in real life situation[s]. They don't see the areas where the knowledge could be applied at all".

Based on the feedback from students (both from the survey profiles and from her discussions with them), Maria decided that she would attempt to improve the level of task orientation, which, in her opinion, would be highly influenced by both the personal relevance and differentiation scales. In Maria's words: "If I try to improve personal relevance and differentiation, it may also impact on task orientation."

As indicated in the narrative in Section 4.4.1, the activities and tasks that Maria typically provided were aimed largely at students with lower academic abilities, were not differentiated, and did not allow more advanced students to do work which would be more suited to their abilities. Further, the relevance of what students were learning was not made clear. After the reflective discussion meeting with the researcher, Maria decided to adapt the learning activities that she used to take into account the students' interests, abilities, and career aspirations. She hoped that this change would allow her to improve the differentiation scores. In line with this decision, Maria incorporated several different programs to cater for the various learning needs that she had identified. This section describes the strategies that Maria put in place to cater for different students' abilities, interests, and career aspirations (Section 4.4.3.1) and to provide opportunities for self-assessment (Section 4.4.3.2).

4.4.3.1 Catering for Different Abilities, Interests, and Career Aspirations

Maria decided that her teaching strategies, for all of the programmes, would incorporate the use of small-group instruction and individual mentoring. In these ways, Maria hoped to ensure that the learning would be more individualised and, therefore, more suited to the needs and demands of particular students.

To complement the use of small-group instruction, Maria developed different learning programmes that would cater for students of different ability levels. First, she developed a programme for students with learning difficulties; this programme consisted of basic theory and simple tasks in which the basic concepts could be applied. Then, for students who were thinking of selecting career pathways related to mathematics and science, Maria created a programme consisting of more-challenging concepts and more challenging tasks as well as additional relevant activities such as quizzes and investigations for advanced students. Finally, she created a programme for students who needed mathematics and science only for everyday life.

Within the programs for differing abilities, there was provision for students to select from a range of programmes that were developed using the curriculum. By giving the students a choice of programmes, Maria hoped to better cater for their interests and career aspirations. For example, one of the topics that students were studying in mathematics was percentages; after discussing ideas with the students, Maria decided to make different worksheets for them entitled "Applying percentages in business," "Applying percentages in everyday life," and "Applying percentages in science." Maria decided to offer a choice of worksheets to the students and asked them to discuss with her which one they would like to work on. Students were able to work independently or in groups at their own paces, sharing their answers and discussing the issues appearing during the work.

4.4.3.2 Including Self- and Peer- Assessment

In addition to the differentiated programs described above, Maria also decided to include self- and peer-assessment strategies in her teaching. These strategies were intended to provide students with more opportunities to self-regulate. Maria worked on scheduling a sequence of activities for self-monitoring and self-management using Gantt charts, which show learning activities displayed against time. On the left of a Gantt chart there is a list of activities, and along the top there is a time scale. Each activity is represented by a bar, whose position and length reflect the start date, duration, and end date of the activity. In classroom contexts, Gantt charts show students what activities or tasks have to be completed and the schedule for these.

Maria also used immediate self-assessment strategies such as "stop light", "five finger score self-assessment", and mini whiteboards to check students' understanding of concepts. Each of these strategies is described below. It should be noted that each of these strategies was being promoted by the school and had been introduced to teachers during staff meetings held at the school.

Stop Light Method. Maria decided to implement the stop light strategy to allow students to self-assess their understanding of the concepts being learnt and to allow her to provide them with immediate feedback. Red and green coloured circles were given to each student in the class at the beginning of the lesson. After Maria explained a concept, those students who assessed their understanding as satisfactory showed a green circle; these students could move to the subsequent planned activities and independently complete them. Those who self-assessed their understanding as unsatisfactory displayed red circles. These students were gathered in a smaller group, and Maria provided additional instructions and clarifications until those students felt ready to move on to other activities. Sometimes these students were given different worksheets that included more worked examples and more explanations.

Five Finger Score Method. Five finger score self-assessment was also decided to be used by Maria as a strategy to promote student self-reflection. After Maria explained a concept, students were asked to rate their understanding from 0 to 5 by holding up their fingers. Those students who graded their understanding at level three or less were given additional explanations and a lower-level task with more examples and clarifications (similar to the approach taken with the stop light method).

Mini Whiteboards. Mini whiteboards were decided to be used mainly in the year 8 mathematics and science class for warm-up activities, multiple-choice, or quiz-type questions. Students had to write their answers on small whiteboards, which Maria provided at the beginning of every lesson. The answers had to be displayed by the students in a way that could be seen by the teacher. Those students who displayed correct answers were paired up with those who had made a mistake, in a bid to help the latter students to get through the question.

4.4.3.3 Identifying and Removing Disengaging Factors

During the interviews and discussions with the researcher, Maria noted that her students were distracted by various elements within the classroom (specifically, constant conversations in big groups, mobile telephones, and headphones). My observations, as indicated in the narrative in Section 4.4.1, identified a range of distracting factors, including the use of headphones and mobile telephones in the classroom, peer distractions, and poor time management on the part of the students. Each of these issues is discussed below.

The first disengaging factor that was identified in the course of the reflection meetings was the students' use of headphones and mobile telephones in classes. The students in both the year 8 and the year 10 classes were permitted to use their mobile telephones to perform complex calculations. However, it was evident that the telephones were also being used during class time for sending text messages, browsing the internet, playing games, and listening to music with headphones. As a result, the students were often distracted, were unable to focus on their work, and were likely to miss important instructions. My observations indicated that the use of mobile telephones during class time occurred more frequently in the year 10 class than the year 8 class.

The second disengaging factor that was identified during the reflection meetings involved peer distraction. Students in both classes were seated in groups. However, only one of the five groups in year 8 worked together efficiently. In the other groups (all the groups in year 10), the students distracted each other regularly, and there were numerous off-task conversations about topics different from those set by the teacher. Some students also interrupted other students who were trying to focus on an assigned task. There was also much evidence of students copying from peers who had already completed the activities. The researcher's observations highlighted that, while Maria was providing help to a particular group or individual, students from other groups quickly became off-task and appeared to lack the self-regulation needed to sustain focus. Maria decided that her class seating arrangement could be exacerbating the problem of disengagement, and, therefore, she decided to split the groups and separate the desks to seat the students either in pairs or individually. This change enabled Maria to see what every student was doing and made it easy for students to work in pairs or to move their desks into groups for cooperative work when required.

A third disengaging factor that was observed during the pre-intervention classroom observations was poor time management on the part of the students. For many of the students, it appeared that getting the required amount of work done was not important. Students did not use their time efficiently or became disengaged from the assigned tasks within the first several minutes. It was also evident from the observations that Maria did not set specific timeframes for class activities. If they were not reminded, students did not take notes and did not stay focused on their tasks, instead shifting their attention from learning to initiating conversations or to their mobile telephones.

However, it was also observed that on the occasions when the expectations *were* set clearly by the teacher and timeframes *were* set, students followed the instructions to complete their work satisfactorily.

Maria decided that these three disengaging factors could be influencing students' task orientation. Therefore, she made a clear plan and implemented it during the intervention stage of the action research process as follows:

- First, Maria forbade the use of mobile telephones and headphones during classes and provided a class set of calculators that could be used when necessary. Further, Maria re-directed students' use of technology towards more educational purposes by increasing the learning-related use of technology in each of the classes. Technologies that she incorporated in her lessons included iPads (involving educational software), data loggers, graphing calculators, and simulators.
- Maria rearranged both the groups and the seating arrangements in her classes. She sat students separately so that she could include more individual work and facilitate the re-positioning of any students who distracted others. When class activities required students to be in pairs or groups, these groupings were formed on an as-needed basis and directed by the teacher.
- To help students to better manage class time, Maria used a visual timer that would give students a reasonable time limit for each activity or task. This time limit was to be adhered to; Maria also ensured that she provided clear expectations about what activity the students should be engaged in (for example, taking notes from the board or drawing pictures such as shapes for geometry topics).

4.4.3.4 Improving Formative Assessment

Maria also focused on formative assessment within her teaching and set about identifying how the students' scores for this scale could be improved. Participating in the present study was not the first time that Maria had considered the role of assessment in student learning. Maria was already engaged in different committees at the school, including a Numeracy Committee and an Assessment Improvement Committee, whose role was to develop enhanced teaching strategies and rich assessment tasks. These committees aimed to improve numeracy skills that students would need as active members of society in various areas of their lives; to engage students in their mathematics and science learning and keep them so engaged; and to develop ways to measure students' learning outcomes against the ACARA strands. However, despite this previous involvement, until confronted by the student feedback, related to the present study Maria had not reflected on what was happening in relation to assessment in her own classroom.

Maria decided that she would change the way in which she provided feedback and attempt to use strategies that would more positively engage students in the processes of assessment. To do this, Maria decided, first, to provide the students with a better understanding of assessment and, second, to make her feedback more personalised and relevant. Maria then set a due date for students to submit drafts of a particular assessment task to her. She allocated time during the lessons for one-to-one meetings to discuss her feedback related to each student's draft.

Maria also decided to incorporate two new strategies when designing assessment tasks, namely, backward design and GRASPS (described below). Both of these strategies had been explored and discussed during previous school committee meetings.

Backward design. Backward design is a process that can be used to design learning activities and tasks to achieve specific learning goals, which are set in accordance with the relevant curriculum standards. Maria compared this approach to a road map: The destination is chosen first, and then the trip to the selected destination is planned. Although Maria was accustomed to a traditional way of planning, in which a list of content to be taught is created or selected according to the assigned curriculum, she was enthusiastic about trying out this new design for writing her assessment tasks. Maria used backward design to continue her year 8 class's energy topic by creating a project in which the students were required to design an energy efficient house. The task design began with an analysis of what students were expected to learn and be able to do. From here, the backward design process required Maria to work backwards to create classroom activities, tasks, or lessons that would allow the students to achieve these set goals. Starting with the end goal, rather than with the first lesson to be chronologically delivered during a unit, a sequence of lessons, tasks, projects, tests, and assignments was designed to help students to achieve the academic goals of the unit. Later, during an interview, Maria stated that backward design had helped her to create a unit that was focused on the learning goals rather than the process and one that supported students in learning what they were expected to learn in accordance with the curriculum.

GRASPS. The GRASPS design strategy was used to link classroom activities to the assessment task in order to help the students to better understand the requirements and performance standards. The GRASPS strategy can be used when creating assessment tasks using the backward design process and consists of six steps:

- G – Goal: The teacher provides a statement of the task and sets a goal for the task.
- R – Role: The teacher describes the role of the students in the context of the task.
- A – Audience: The teacher explains the target audience within the context of the task.
- S – Situation: The teacher establishes the context of the task and describes the situation.
- P – Product: The teacher explains what the students have to produce as a result of their work and why they have to create this product.
- S – Standards for performance: The teacher specifies clear performance criteria by identifying specific standards for success and creating rubrics for the students.

Maria implemented the interventions and strategies described in Sections 4.4.3.1, 4.4.3.2 and 4.4.3.4 and one after another, beginning one week after the pre-test administration of the surveys and the first set of classroom observations. The interventions were carried out over a period of seven weeks. This time restriction ensured that the energy unit did not last longer than a term, as the time limit imposed by the school's science faculty allowed one term each for physics, chemistry, biology, and geology. Throughout the intervention period, further classroom observations were carried out. Regular interviews and reflection sessions with Maria were also conducted to ensure that she was provided with all necessary support and that all strategies were discussed prior to their intervention.

4.5 Stage 4: Evaluating of the Effectiveness of the Intervention Strategies

This section (Section 4.5) reports results related to the success of the interventions. The section starts by reporting the results of the observation data using an impressionistic tale that draws on the lesson observations that were carried out towards the end of the intervention period and an impressionistic tale (see Section 4.5.1). Finally, changes in aspects of the learning environment and students' motivational beliefs are analysed using the feedback data collected from the students at the end of the action research cycle (Section 4.5.3).

4.5.1 Classroom Observation: Intervention Stage

As with the first narrative (provided in Section 4.4.1), the narrative in this section provides an impressionistic tale that describes a lesson typical of the year 8 classes taught by the critical instance case study teacher towards the end of the action research cycle. The narrative is related to the same year 8 science class as the pre-intervention observations. The aims of the narrative are, first, to provide contextual information to help the reader to better understand the changes in the learning environment and students' motivation and, second, to help to explain the possible reasons for those changes through the interpretative commentary provided after the narrative.

I was seated at the back of the classroom for another observation of Maria's year 8 class. The lesson involved the same physics topic, energy, but was focused on heat energy and how it could be transferred and conserved. The concepts were going to be investigated using technology: Texas Instrument (TI-84) graphics calculators with data loggers and laptops. Before the lesson, I had learnt from Maria that the students were in the process of completing a group project that involved a formative assessment task—designing an energy efficient house. This project involved both the GRASP and backwards design strategies. Maria had selected Energy Transfer and Conservation as this topic incorporated concepts needed for everyday life and general knowledge but could also cater for students who wanted to study mathematics and science at a more serious level. I arrived at the classroom just a minute *before the bell, greeted Maria, and asked for her permission to come in and observe the lesson. I took my seat at the back of the class and started my observation.*

I noted that the classroom layout had changed since the pre-intervention observations. The desks were now arranged in rows, rather than groups, with students seated in pairs. There was space between each of the pairs of desks, and, as this room accommodated practical science activities, there were benches around the perimeter of the room for such activities. I also noticed that the six students who had demonstrated higher levels of both motivation and ability during the first lesson were no longer seated together. Rather, these students were paired with students who had demonstrated the lowest levels of motivation and engagement in my initial observations.

Maria started her lesson by greeting the students as she distributed instruction sheets for the upcoming practical activity. As she moved about the class passing out the instructions, she started to explain the activity. I observed that the students were listening to Maria quietly as she explained that the activity was an experiment in which students would investigate one type of heat transfer, namely, conduction. Maria specified that the class would be completing this practical activity in their allocated pairs (based on the seating plan that she had drawn up). Maria drew the students' attention to the equipment that had already been set on the benches located around the perimeter of the classroom and explained the activity in detail.

Maria asked whether the students had any questions about the activity. A number of students raised their hands and asked clarifying questions related to the activity; students also questioned what they needed to submit as the final product. Maria explained that the students would need to submit a report on the practical activity consisting of an aim, materials, method, analysis, and conclusion. She then drew their attention to the instruction sheet. Maria pointed to the relevant sections of the instruction sheet that would guide the students through the activity and in the writing up stage. Once the instructions had been reviewed and the students' questions clarified, students moved quietly to begin the practical activity using the benches next to their desks. Those students who were not sure which bench and equipment they should use were directed to the right place by the teacher.

During this lesson, I observed the pair of students who were positioned closest to me. All of the instructions about how to use the equipment and how to conduct the experiment were provided on a worksheet that was ready at the students' workstation. Of the pair of students, the one who was considered to be more academically able was reading the instructions and explaining the task to her less capable partner. The more able student then poured hot water *into an aluminium can and measured the initial temperature of the water using temperature sensors with data loggers connected to a graphics calculator. As she did this, the other student opened her workbook, ready to record the data. The same steps were repeated by the students, first with a plastic cup and finally with a ceramic mug. The students were taking turns while conducting the experiment and measuring the temperature using the data logger. I observed that the stronger student was assisting the other student by explaining the steps of the experiment. Together, the students measured the temperatures in the three containers every three minutes for the next 15 minutes and recorded their observations. Their graphics calculator was automatically recording the measurements as well. The students also needed to make observations in relation to the temperature of the surfaces of the three containers in order to be able to write the analysis and conclusion sections of their practical reports.*

As I looked around the class, I was struck by the contrast with my pre-intervention observations. All of the students appeared to be involved in the activity. There were no mobile telephones or headphones being used. The conversations that I could hear from my vantage point were all related to the practical activity. The students appeared to be working productively and efficiently, keeping their focus on the assigned task.

At the beginning of the activity, Maria had projected a 20-minute timer on the whiteboard using a computer application, ensuring that it was visible to all of the students. I noted that, rather than constantly managing behaviours (as she had been in the lessons I observed prior to the intervention), Maria was now able to focus her attention on helping students. She was walking around the class and giving students one-to-one feedback on how they were doing and what they needed to do to improve their performance. I noticed that during these interactions, the students listened to Maria's feedback and explanations, and some students were taking written notes.

When the timer went off after 20 minutes, Maria explained how students could save the data on the graphics calculators and construct the necessary graphs. She asked students to move back to their desks and copy the graphs from the calculators into their workbooks, ready to be included later in the students' reports. Although the instructions for how to create the graphs were included on the instruction sheets, Maria noticed that some of the students were having difficulty saving the data and producing the graphs. She asked those students to gather around her (near the teacher's desk) and started to show them each of the steps. The rest of the class were quietly drawing the graphs in their books. Once all of the students working with Maria had the graphs on the screens of their calculators, Maria sent them back to their desks to copy the graphs into their workbooks.

When most of the students had completed copying their graphs, the noise level in the class started to rise as the students started to engage in individual conversations. Maria noticed this and immediately reacted by inviting the students who had completed the activity to share their observations from the experiments. As the remaining students completed their graphs, they also got involved in the discussion. Unlike the pre-intervention observations, I noticed that Maria did not need to push the students to participate in this discussion. There were many raised hands indicating that students were willing to share their experiences and describe what they had learnt from the activity.

Maria called one of the students by name. He started to talk about the differences in the temperature changes among the different containers. After he finished, a girl started to share what she had noticed about the different temperatures of the containers themselves, adding more details to the previous student's response. Finally, a third student made a comment about how the temperature change was related to the different materials of the three cups (aluminium, ceramic, and plastic).

Once Maria noticed that all of the students had finished copying their graphs, she stopped the discussion and started to explain the next activity, which involved a worksheet with questions related to heat transfer. Again the teacher set the timer on the screen, but this time the students were only given five minutes to complete the assigned activity. Once Maria had explained the activity, the students immediately took their pens, put their heads down, and started to write on the worksheet. I noticed that the students worked quietly without distractions. Maria walked around the class, helping individual students who were experiencing problems with the worksheet or answering questions. The class was noiseless, apart from Maria who was talking to one of the students. As she finished talking to this student, Maria noticed another student taking his mobile telephone out of his pocket. Maria moved to where he was sitting and firmly asked him to put it in his bag. The student complained that he needed the telephone to complete some mathematical calculations. In response, Maria reminded the student that the graphics calculators provided during the activity should be used. Without arguing, the student put his mobile telephone into his bag and started to use the graphics calculator.

The timer buzzed, signalling that the five minutes were up, and Maria walked around the room to collect the worksheets. After doing so, Maria started to explain the next activity, which involved the students answering a question using their laptops with the pre-installed computer simulations, "Energy 2D and 3D". The students moved from the benches back to their desks, opened the lids of their laptops, and opened the simulation application. They quickly turned their attention to the activity, which involved working through a task in their "Design Project:

Energy Efficient House" booklet. This booklet was designed to lead students through the simulation and contained set questions for the students to answer as they worked through the situations. The teacher read the first question from the worksheet: "In which material does the heat energy flow faster: metal or wood?" and instructed students to watch the simulation to help them to answer the question. Before they began the simulation, she told them that they had only three minutes to complete the task (including two minutes to watch the simulation and one minute to write the answer). On the projector screen, I noticed that the teacher had again set a timer to count down this time. As I looked around the room, I noticed that all students appeared to be on task and were completing the activity with obvious enthusiasm and interest. The students did not ask any questions to clarify what they needed to do as the task was well structured and clear instructions had been given. It was also obvious that the students were finding the task very engaging. I observed that the practical nature of the questions.

The students were focused on watching the simulation and seemed to be concentrating on the activity. From my position at the back of the room, the simulation appeared to make the task look real: The first simulation showed how energy was transferred through different materials (showing how heat is transferred through both wooden and metal bridges).

At the end of the third minute, the timer buzzed and Maria called the students' attention to the front of the class, asking them to move to the next simulation. There was a shuffle of activity as the students opened the next file of the simulation. Maria then read the next question aloud: "Does more heat flow through a wider bridge?" Again, she instructed the students that they had three minutes (two minutes to watch the simulation and one to write down the answer). The students immediately turned to their screens and watched the simulation, which showed the energy flow through two bridges of different widths. All of the students in the class were on task and engaged in answering the questions; they talked only when they had finished the activity, at which point many of the students compared their answers.

This process was repeated for three further simulations, with three associated questions: "Does heat flow faster from a hotter source?" "Does heat flow faster through a shorter bridge?" and "Through which material does heat flow faster: A material with a low heat capacity or one with a high heat capacity?" Throughout the ensuing activities, the students remained engaged and focused on the task. Each student was attempting to complete the activity in the given time. During each simulation, Maria walked around the class and observed how the students were completing the activity. If she noticed a problem or misunderstanding, she stopped to help.

Once the students had completed their last question, Maria explained that they would be working with their groups (which had been formed during the previous lesson to conduct the project "Building an Energy Efficient House") to answer one final question. She told the students that they would be given a further three minutes to answer this question, which was: "How would a building with a high heat capacity behave differently from a building with a low heat capacity?" Maria instructed the students to join their groups. The students took their worksheets and pens, got up from their seats, and moved to join their groups. There were five groups of five to six students each. The noise level increased as the students were moving and joining their groups. However, once the groups were formed, the students appeared to start discussing the assigned question. I observed members of the various groups writing down the answers onto their worksheets. When the timer buzzed to show the end of the third minute, Maria again called for the students' attention. She explained that, for the next task (also to last three minutes), students were to discuss how they would implement this knowledge into the design of their energy efficient house. She instructed the students that she wanted the answer to consist of only a few words that would be handed in with the name of their team.

After three minutes, the timer on the screen buzzed, and I observed students rushing to finish writing their answer and to hand it to the teacher. As one group passed me, I read the words "masonry" and "metal frame" on their piece of paper.

The bell sounded, but the students did not rush to leave the classroom. Instead, they took their Gantt charts (which showed the list of activities that they needed to complete over the course of the energy efficient house project) out of their folders and ticked off the tasks that they had completed during the lesson. I could hear exclamations from some of the students as they did so, and one student called out, "Wow, I made it!" Other students were heard to say "Cool!" or "Awesome!" The students then started to pack up, discussing how much they had managed to achieve during the lesson.

As the students left the room, Maria smiled at them and praised them for the productive lesson. I realised that I had actually enjoyed observing this lesson. It was so very different from the observations made prior to the intervention. Before leaving, I expressed my deep gratitude and appreciation to Maria for the great work that she had done in motivating her students and changing the learning environment in her class.

The data collected through lesson observations and interviews was analysed to identify changes that had occurred during the action research cycle. In the lessons that were observed, students displayed a number of patterns of behaviour that indicated that, overall, their motivation had improved. For example, the observations indicated that students had become more focused during activities, the noise levels had reduced, and instances of disruptive or off-task behaviour had become rare. Overall, Maria's students seemed to achieve more during their lessons than they had previously, were happier, and, as demonstrated during their use of the Gantt chart (described in Section 4.4.3.2), were proud of their achievements.

The classroom observations indicated that, during the intervention, the students were more interested in the classroom activities and the tasks provided by the teacher than they had previously been. This increase was demonstrated through the constant attempts, made by all of the students, to complete assigned tasks in a timely manner. The observations provided evidence that students found the learning activities that Maria had introduced during the intervention to be more interesting than the activities provided before the intervention.

The observations also indicated that the classroom activities that Maria provided were now more differentiated and catered for students with different ability levels, including advanced students. For example, the activities observed included opportunities for higher-order thinking and creativity with the use of graphics calculators, data loggers, and computer simulations.

The classroom setting during the intervention lessons appeared to be more conducive to engagement. The students no longer worked in groups but, rather, worked either in pairs (as described for the first practical activity in the narrative) or individually. It appeared that this setting encouraged students to concentrate on the assigned activities and made it more difficult for them to distract each other, reducing the number of off-task conversations. It is possible that the complete ban of mobile telephones and headphones could also have contributed to this increased student self-regulation because these devices were no longer distracting factors.

The classroom observations during the intervention period indicated that Maria had started to time all class activities using an on-screen timer that was visible to all the students. The observed increase in students' task focus suggested that using the timer provide visible time limits had prompted students to get on with their work and to stay on task.

The classroom observations also indicated that task instructions were clearer than they were prior to the intervention and that the goals set by the teacher were more obvious. The observations showed that students were getting on with tasks immediately after the instructions had been explained and that students were clear about what they needed to do. The use of Gantt charts appears to have made a difference to students' motivation to finish the assigned activities. There were also indications that the students had started to use self-assessment and self-regulation strategies to assess their progress in the course of the project, allowing them to reflect on what else was required to be done.

4.5.2 Student feedback: Evaluating the pre–post changes

The previous section reported the classroom observations, which suggested that students' levels of motivation and self-regulation had increased over the course of the action research cycle. The next step was to examine whether the pre–post data, collected using the two instruments (the COLES and the SALES), showed any changes. The surveys were re-administered to both of Maria's students at the end of the intervention period, the results for which are depicted in the form of circular profiles similar to the pre-test profiles (see Figure 4.3 for the grade 8 class and in Figure 4.4 for grade 10 class), allowing the students' scores for the pre-test and post-test to be compared. These figures depict the average item means for students' actual and preferred perceptions of the learning environment scales for both the pre-test and the post-test.

For each scale, the two figures depict four different scores. The two scores shown in the lighter grey are for the pre-test. The scores for the post-test are depicted in the darker grey – with the lighter of the two being for actual and the darker being for preferred. The mean scores are provided in Table 4-8.

These results indicated that, for both classes, students' scores for the majority of the scales had improved. These improvements included the task orientation, differentiation, and personal relevance scales, all of which were targeted by the case study teacher during the intervention period. Interestingly, the scores also improved for formative assessment.

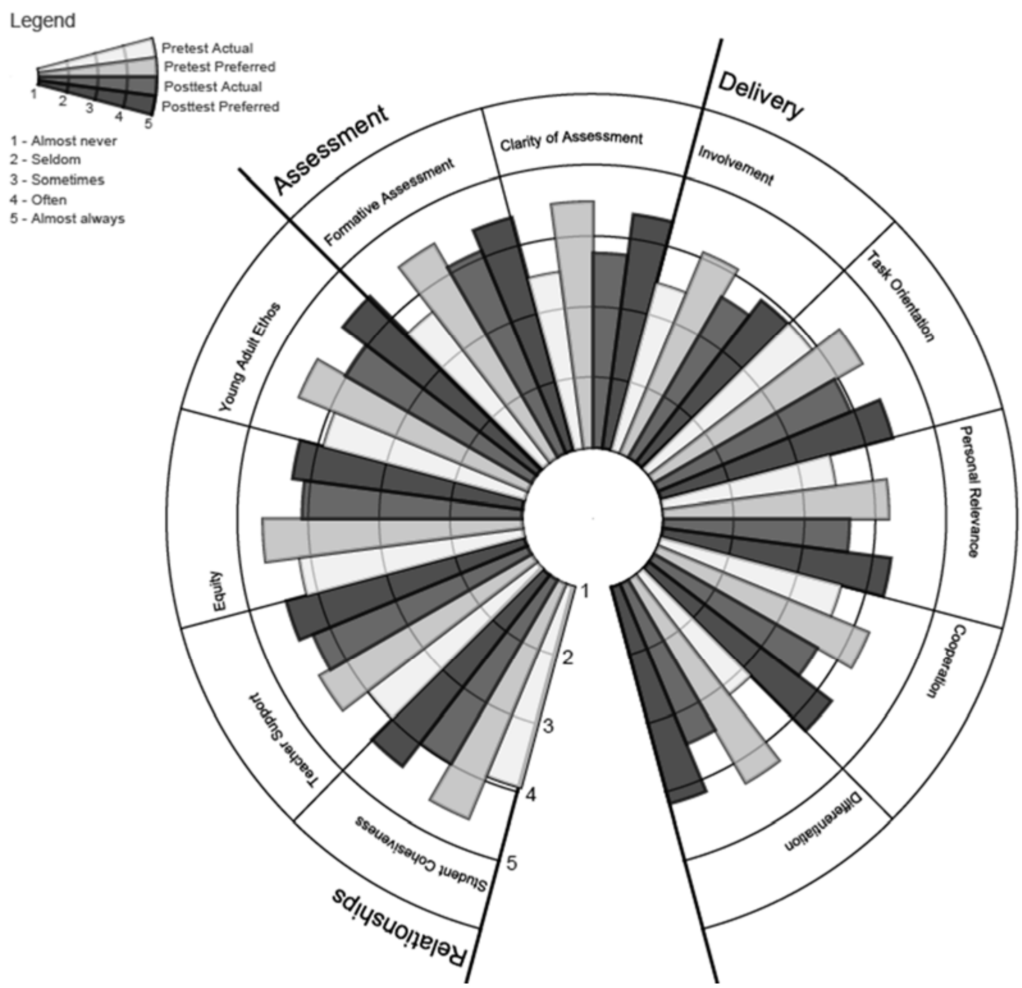

Figure 4.3. Pre-post profile for Maria's year 8 mathematics and science class

With respect to the formative assessment scale, Maria had offered to provide detailed feedback for student assessment and, Maria stated: "… several students finished their drafts early to give me a chance to get the work marked and to provide detailed feedback." Maria observed that her students were not only listening to the feedback that she gave but were also taking notes and making changes in their work based on her recommendations. Instances of the students paying attention to Maria's feedback and recording her suggestions from one-to-one feedback conversations were also recorded by the researcher during classroom observations. Towards the end of the intervention period, Maria also reported noticing that her students were becoming more engaged in the process of assessment, that they better understood the assessment requirements, and that they were using her feedback to improve their learning by making improvements to their work.

Maria noted that the mean scores for the actual responses in the post-test surveys shifted upward (as evident from Figure 4.3 and Figure 4.4), showing improvements in the measured scales. Maria assumed that this meant that her students had liked being able to choose a learning program that suited their learning needs. She also shared some comments that students had made indicating that they now enjoyed their lessons more and felt more confident as learners; these remarks were supported by improvements in the quantitative scores for the academic efficacy scale. Finally, Maria highlighted that she had shifted her focus from "What I do as a teacher during lessons" to "What my students do." The classroom observations confirmed that Maria's lessons during the intervention were more engaging and student-centred and catered more effectively for students' interests than the lessons prior to the intervention had done.

During the interview at the end of the intervention period, Maria noted the positive changes and commented that the strategies that had been aimed at improving task orientation and differentiation had worked well: The disengagement factors in the classroom had been eliminated or minimised; the student disengagement rate had decreased noticeably; and students now appeared to be more motivated, interested, and task-focused and were able to manage their own time within the scope of an overall task more successfully. There were also more effective and meaningful interactions between students when working in groups. The classroom observations during the intervention period showed that students were more engaged, that they used their class time more wisely, and that the classroom environment seemed to be more goal-oriented.

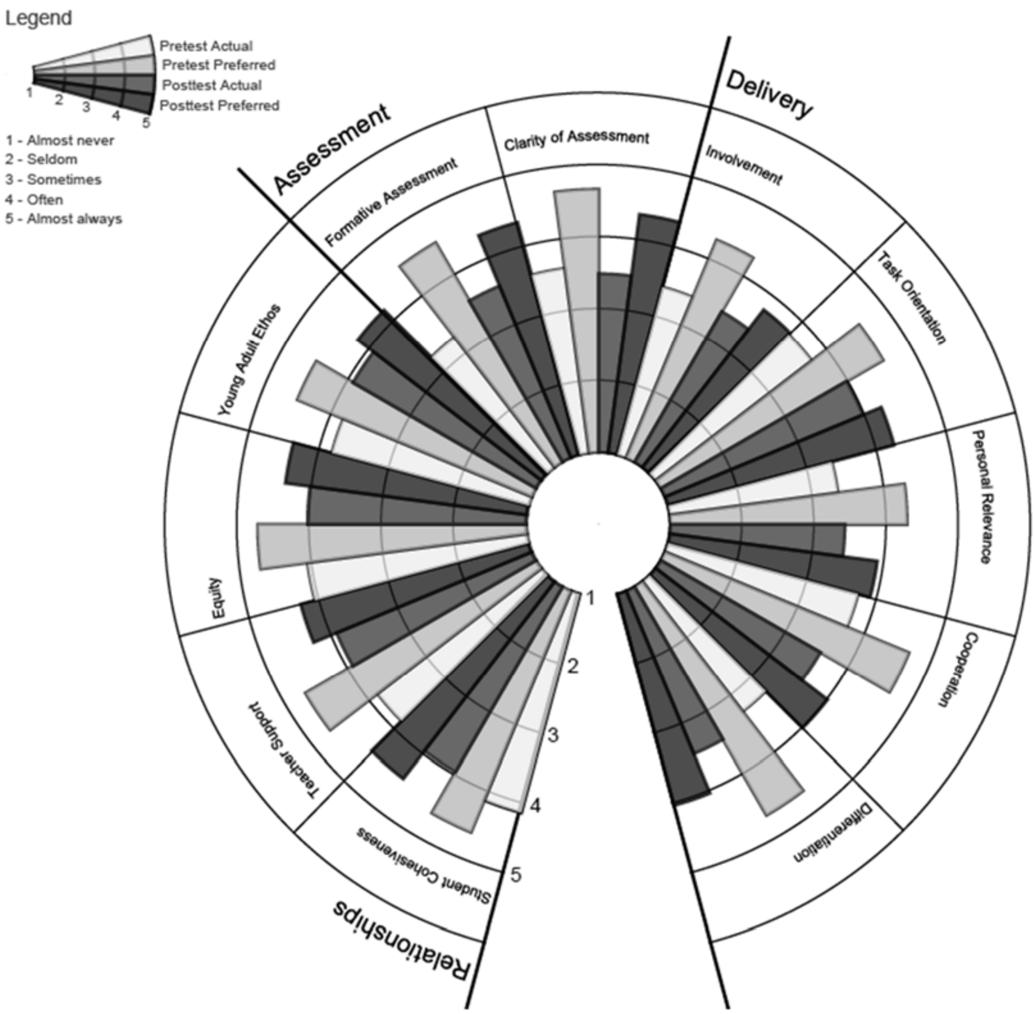

Figure 4.4. Pre-post profile for Maria's year 10 mathematics and science class

Maria found that the strategies that she had introduced had provided her more capable students with the opportunity to work more productively and independently and gave her more time to spend more time with the less able students who needed extra support.

The results of the MANOVA, used to determine whether the pre poet changes were statistically significant, indicated that the students' scores for three scales that were the focus of the intervention (formative assessment, task orientation and differentiation) were statistically significantly higher for the post-test.

Further, the effect sizes for these three scales ranged from 0.21 to 0.32 standard deviations. Although, according to Cohen (1992), these magnitudes are considered small effects, positive changes in students' task orientation support the changes that were noted during my second set of classroom observations (as described in the narrative in Section 4.5.1). For example, students were no longer using mobile telephones and the conversations that I could hear from my vantage point were task-related.

The improvement in the quantitative scores for formative assessment also support my classroom observations. For example, students appeared more engaged in the task and appeared to know what they were doing.

Finally, the changes in the quantitative differentiation scores also support my observations which reported that students of different abilities were working together with different tasks that required differing levels of ability.

During the interviews, when the researcher shared the results with Maria, she noted that several factors had contributed positively towards improvements in the scores for the learning goal orientation scale (one of the motivational constructs). The factors that Maria identified were eliminating disengaging factors from the classroom environment; using technology for educational purposes; setting clear expectations and goals during lessons at the beginning of each activity; incorporating the backward design and GRASPS strategies into assessment tasks; and having discussions with students to clarify goals and performance standards.

In Maria's opinion, students' beliefs related to their self-efficacy and self-regulation had improved due to her use of a range of techniques to help students to plan, monitor, and assess their learning. Performance monitoring strategies (for example, utilising the immediate self-assessment strategies, requiring drafts of assessment tasks by particular dates, one-to-one discussions, and personalised feedback) played significant roles in those positive changes. Maria also mentioned that she consciously encouraged less confident students to not give up but, rather, to seek help when needed and to utilise all available resources, such as textbooks, internet, the library, the teacher, peers, other teachers, and parents.

At the end of the action research, Maria reported that, in addition to the improvements evident from the analysis of the case study post-test data, she also felt that there had been other improvements and she now felt much more satisfied with her teaching practices and her students' learning outcomes. Maria also stated that her students seemed to be much happier and more cooperative. She felt that participating in the action research had been valuable because it had enabled her to take charge of her own professional development needs through an inquiry form of learning that was evidence-based and directly linked to her classrooms. Maria reported that her involvement in the present research had provided opportunities for both experimentation and professional learning through requiring her to reflect on her own instructional practices. She expressed her belief that student feedback could be a useful method to guide positive changes to classroom learning environments.

4.5.3 Changes in Students' Perceptions and Self-Reports of Motivation

To examine whether the changes in the learning environment reported in the previous section led to changes in students' self-reports of motivation and self-regulation, MANOVA, involving the pre-test and post-test SALES data were used. Because the multivariate test yielded statistically significant results overall for the set of four dependent variables (using Wilks' lambda criterion), the univariate ANOVA was interpreted separately for each of the scales. Table 4-9 reports the ANOVA results.

Whereas MANOVA was used to investigate the statistical significance of any changes between the pre-test and the post-test, effect sizes were used to describe the magnitude, or educational importance, of those differences (as recommended by Thompson, 2004; Cohen, 1992). The effect size, which is calculated by dividing the difference between means by the pooled standard deviation, expresses a difference in standard deviation units. These effect sizes provide evidence about whether the pre-post differences in students' perceptions of the classroom learning environment (see Table 4-8) and the students' motivation and self-regulation beliefs (see Table 4-9) were educationally important.

Table 4-8 Average item mean, average item standard deviation, and difference (effect sizes and MANOVA with repeated measures) between the pre-test and post-test scores on each scale of the COLES

Scale	Average item mean		Average item standard deviation		Difference	
	Pre-test	Post-test	Pre-test	Post-test	Effect size	*F*
Learning Environment (COLES):						
Student cohesiveness	4.03	3.91	0.55	0.55	0.11	0.62
Teacher support	4.02	4.11	0.59	0.73	0.07	0.32
Equity	3.84	3.68	0.82	1.05	0.08	0.43
Young adult ethos	3.88	3.89	0.74	0.72	0.01	0.01
Formative assessment	3.68	4.07	0.76	0.75	0.25	3.74*
Clarity of assessment criteria	3.68	3.59	0.62	0.89	0.06	0.20
Involvement	3.56	3.59	0.62	0.89	0.02	0.02
Task orientation	3.61	4.02	0.65	0.57	0.32	6.41*
Personal relevance	3.46	3.57	0.86	0.77	0.07	0.30
Cooperation	3.80	3.61	0.71	0.83	0.12	1.08
Differentiation	3.28	3.51	0.65	0.40	0.21	3.11*

N= 56 students in 2 classes who were present for both the pre-test and the post-test.
*$p < .05$; **$p < .01$.

Table 4-9 Average item mean, average item standard deviation, and difference (effect sizes and MANOVA with repeated measures) between the pre-test and post-test scores on each scale of the SALES

SALES Scale	Average item mean		Average item standard deviation		Difference	
	Pre-test	Post-test	Pre-test	Post-test	Effect size	*F*
Learning goal orientation	4.38	4.63	0.37	0.33	0.34	7.08**
Task value	3.65	3.77	0.63	0.54	0.10	0.63
Self-efficacy	3.48	4.11	0.76	0.55	0.43	13.11**
Self-regulation	3.30	4.07	0.72	0.55	0.52	20.79**

N= 56 students in 2 classes who were present for both the pre-test and the post-test.
*$p < .05$; **$p < .01$.

In terms of motivation, the results reported in Table 4-9 show that the pre-post differences for three of the four SALES scales were statistically significant ($p < .05$); these scales were learning goal orientation, self-efficacy, and self-regulation. For these three scales, the effect sizes ranged from 0.34 to 0.52 standard deviations. These effect sizes, according to Cohen (1992), can be considered to be medium in magnitude. As such, it is obvious that the changes in the classroom learning environment impacted on the motivation of students.

4.6 Chapter Summary

The first objective of the present research was to test the validity and reliability of two established instruments, the Constructivist-Oriented Learning Environment Survey (COLES) and the Students' Adaptive Learning Engagement in Science (SALES) survey, when used with high school students in South Australia. To ensure that teachers could be confident when using the feedback collected using these surveys, it was important to establish the reliability and validity of both instruments.

The analysis of 351 students' responses to both the COLES and the SALES indicated that the factorial validity and internal consistency of each instrument were satisfactory. This results confirmed that the items within each scale were assessing the same construct and that each scale assessed a distinct construct, thus supporting both the convergent and discriminant validity of the instruments. Concurrent validity was assessed using ANOVAs, the results of which showed that each scale of the COLES and the SALES was able to differentiate between the perceptions of students in different classrooms. As such, the results presented in this chapter support both the COLES and the SALES as valid and reliable instruments for assessing students' perceptions of learning environments and their motivational beliefs at the secondary school level.

The results also address the second research objective, in terms of determining which learning environment constructs are most likely to contribute towards students' motivation and learning engagement in mathematics and science. Simple correlation and multiple regression analyses were undertaken using the 11 COLES scales as the independent variables and the four SALES scales as the dependent variables. The analyses of 351 students' responses to the surveys indicated that all 11 COLES scales were statistically significantly ($p < .01$) and positively correlated with all four SALES scales. Examination of the standardised regression weights (β) showed that four of the 11 learning environment scales were positively, statistically significantly ($p < .05$), and independently related to learning goal orientation: student cohesiveness, teacher support, task orientation, and personal relevance. Four of the 11 learning environment scales were also statistically significantly ($p < .01$) and independently related to task value: teacher support, formative assessment, personal relevance, and cooperation. All of the statistically significant relationships between learning environment constructs and task value were positive, except that the cooperation scale was negatively related to task value. Two of the 11 learning environment scales were statistically significantly ($p < .01$) and independently related to self-efficacy: clarity of assessment and task orientation. Again, all of the statistically significant relationships between learning environment constructs and self-efficacy were positive, except that the cooperation scale was negatively related to self-efficacy). Finally, three of the 11 learning environment scales were positively, independently, and statistically significantly ($p < .05$) related to self-regulation: teacher support, task orientation, and cooperation.

This chapter has also reported how student perception data (gathered during the quantitative component of the research program) guided action research and intervention strategies aimed at improving the learning environments in mathematics and science classes of a critical instance case study teacher. The chapter has also reported the qualitative findings of these parts of the research.

To investigate whether the critical instance case study teacher's reflection and interventions derived from the post-test COLES and SALES data led to improvements in students' perceptions of their classroom environments, the pre-post sample ($N = 56$) obtained from this teacher's classes was analysed using MANOVA. Because the multivariate test yielded statistically significant results, the univariate ANOVA was interpreted for each of the scales. The results indicated that, for this teacher, the pre-post differences were statistically significant ($p < .05$) for three of the 11 COLES scales: formative assessment (effect size = 0.25 standard deviations), task orientation (effect size = 0.32 standard deviations), and differentiation (effect size = 0.21 standard deviations). There were also statistically significant ($p < .05$) pre-post difference for three of the four SALES scales: learning goal orientation (effect size = 0.34 standard deviations), self-efficacy (effect size = 0.52 standard deviations), and self-regulation (effect size = 0.52 standard deviations).

Qualitative data gathered using classroom observations and semi-structured interviews and discussions with the critical instance case study teacher were analysed, using grounded theory methods (Strauss & Corbin, 1994). The purpose of this analysis was to investigate how student feedback can guide improvements to the classroom learning environment and the implementation of strategies that target issues related to students' motivational beliefs. A closer examination of the ways in which the teacher approached the data highlighted a number of features, the most important of which was that the data were interpreted in a way that was meaningful in the context of the specific classes.

The findings reported in this chapter also addressed the final research question, concerning the identification of teaching strategies that support increases in students' motivation and engagement. The findings derived from the surveys, classroom observations, and interviews provided the case study teacher with data that she could use as the basis for reflection that was evidence-based and directly linked to her classroom context.

In conclusion, the results reported in this chapter suggest that improving learning environments and student motivation in the mathematics and science classes of the case study teacher required, first and foremost, an enthusiastic teacher who was ready to consider student feedback, reflect on it, and trial new strategies that could lead to improvements in students' motivation and engagement. The strategies trialled by the critical instance case study teacher included identifying and then minimising or eliminating disengaging factors in the classroom environment; thorough lesson planning; diversifying teaching materials and activities; using technology; providing engaging and authentic assessment tasks; articulating clear goals for learning activities and assessment tasks (through drawing on the backward design and GRASPS strategies); differentiating learning activities and tasks depending on students' abilities, rates of learning, interests, and career aspirations; providing personalised and timely feedback to students; and providing task-focused lessons with activities that are timed and include peer tutoring, team work, and hands-on activities.

The next chapter provides a discussion of the results and limitations of the present study and makes suggestions for future research. Finally, the next chapter provides a discussion of key contributions of this research along with concluding comments.

Chapter 5

DISCUSSION

5.1 Introduction

The study reported in this thesis used a multi-method design that involved the collection of both quantitative and qualitative data. The first phase of the study was used to address two of the three research questions: to provide evidence to support the validity and reliability of the surveys used (Research Objective 1); and to examine whether students' perceptions of the learning environment was related to their motivation and self-regulation beliefs (Research Objective 2). This phase involved a large-scale administration of two instruments: the Constructivist Oriented Learning Environment Survey (COLES)' to assess students' perceptions of the learning environment' and the Student Adaptive Learning Engagement Survey (SALES)' to assess student self-reports of motivation and self-regulation. The surveys were administered to a sample of 351 secondary students in 19 mathematics and science classes that were taught by seven teachers.

The second phase of the study was used to investigate how student feedback, collected using surveys, could be used to guide decisions about how the learning environments could be changed to improve students' motivational and self-regulation beliefs. The qualitative information was gathered from one of the seven science and mathematics teachers involved in the quantitative sample. The classes of this teacher became part of a critical instance case study in which the teacher planned and implemented new strategies during an action research process.

The second phase also involved a pre-post design in which the two surveys were administered to students before and after the intervention. This student feedback was used to guide the development of teaching strategies, implemented using an action research process, designed to improve both the learning environment. Throughout the nine-week action research process, qualitative information, including classroom observations, reflection discussions and interviews, were analysed to investigate the ways in which the teacher utilised the student feedback to develop teaching strategies and the success of these in improving students' perception of learning environments and, subsequently, their motivational and self-regulatory beliefs.

This chapter concludes the thesis using the following headings: summary and discussion of findings are provided in Section 5.2. Section 5.3 discusses limitations of the study. Section 0 provides a summary of recommendations. Contributions of study is discussed in Section 5.5. Finally, Section 5.6 provides concluding comments.

5.2 Summary and Discussion of Findings

This section is organised according to the research objectives and provides a summary of the results: the validity and reliability of the COLES and SALES (Section 5.2.1); learning environment – motivation associations (Section 5.2.2); and the teaching strategies enabling the increase in students' motivation and engagement (Section 5.2.3).

5.2.1 Validity and Reliability of the COLES and the SALES

To provide confidence in the results of the subsequent research objectives, the initial focus of this study was to provide evidence to support the validity and reliability of the two surveys when used in middle school mathematics and science classes in South Australia. Given that these surveys were both previously established, the validation of the surveys for this study involved only the criterion-related factors were examined. The results are summarised and discussed separately for the COLES (Section 5.2.1.1) and the SALES (Section 5.2.1.2).

5.2.1.1 Validity and reliability of the COLES

To examine the convergent validity of the COLES, the factor structure, internal consistency reliability, ability to differentiate between the classes and discriminant validity of the COLES was examined. The results are summarised below:

- The *a priori* factor structure for the 11 scales of both the actual and preferred versions of the COLES was replicated for both the pre-test and post-test data sets. All 67 items of the COLES (with the exception of four items for pre-test and three items for the post-test) met the criteria, with a loading of more than .40 on its own scale and less than .40 on all other scales.

- The internal consistency reliability of each COLES scale, estimated using Cronbach's alpha coefficient for two units of analysis (the individual student and the class mean), were all above .70. The coefficients ranged from .84 to .98 for the pre-test and from .85 to .98 for the post-test.
- A one-way analysis of variance (ANOVA), with class membership as the independent variable, was used to support the ability of the actual form of each of the 11 COLES scales (actual form only) to differentiate between classrooms. The results suggest that, for the pre-test, all scales were able to differentiate between classes. For the post-test all scales but one (student cohesiveness) were also able to differentiate significantly ($p < .01$) between classes.
- The component correlation matrix generated during oblique rotation, was used to examine the discriminant validity of the COLES scales using both the pre-test and post-test data sets. The results indicated that there was no value greater than .80, suggesting that, although there was a degree of overlap between the scales, this overlap was acceptable.

The findings above support the validity and reliability of the COLES compared favourably with past research that have utilised the COLES in Australia (Aldridge et al., 2012; Bell & Aldridge, 2014; Stuckey, 2016). As such, the results provide evidence to support the reliability and validity of the COLES when used with students at the secondary high school level in Adelaide, South Australia.

5.2.1.2 Validity and reliability of the SALES

As with the COLES, the convergent validity of the SALES was also examined in terms of the: factor structure; internal consistency reliability; ability to discriminate between classes; and discriminant validity. Below, the results are first summarised and then discussed:

- The factor loadings for the four SALES scales were replicated for both the pre-test and post-test data sets. All 32 items of the SALES, with no exceptions, met the criteria, with a loading of more than .40 on its own scale and less than .40 on all other scales.

- The internal consistency reliability of each SALES scale, estimated using Cronbach's alpha coefficient for two units of analysis. Using the individual as the unit of analysis, the scale reliability estimates were ranging from .89 to .93 for the pre-test and from .95 to .98 for the post-test. Using the class mean as the unit of analysis, the scale reliabilities ranged from .90 to .92 for the pre-test and from .92 to .96 for the post-test.
- To provide support for the concurrent validity, a one-way analysis of variance (ANOVA), with class membership as the independent variable, was used to examine the ability of each of the four SALES scales to differentiate between classrooms. The statistically significant results suggest that the SALES scales, for both the pre-test and post-test versions were able to differentiate between the perceptions of students in different classes.
- To examine the discriminant validity of the four scales of the SALES, a component correlation matrix, obtained from oblique rotation, was used. The results indicated that, as none of the correlations were above 0.80, there was an acceptable degree of overlap between the scales. Hence, the analysis indicated that the SALES met the requirement of discriminant validity as recommended by Brown (2006).

These findings were similar to those of: Velayutham, Aldridge and Fraser (2011) in their study involving 1,360 students in 78 lower secondary science classes; Al Zubaidi et al. (2016), in their research involving 994 university students in Jordan; Roger (2013), in her study involving 431 year 9 and 10 students in Australia; and Koren and Fraser (2013), in his research involving 495 middle school students in the US. The findings, summarised above, provide evidence to support the reliability and validity of the SALES.

Both the COLES and SALES are relatively new surveys, therefore, there is only a limited number of studies that have involved their use. Although, strong evidence was provided to support the validity and reliability of the surveys when used with high school students in South Australia, it is recommended that future research involve samples from a wider population which would include different schools, universities, states and countries (*Recommendation 1*).

5.2.2 Learning Environment–Motivation Associations

The second research objective was to xexamine the impact of students' perception of the learning environments on their self-report of motivation and self-regulation in mathematics and science. For that purpose, simple correlation and multiple regression analysis using the individual as the unit of analysis were utilised. Multiple correlation analysis was undertaken using the set of 11 COLES scales as independent variables and the SALES scales as the dependent variables.

The results of the simple correlation analysis indicated that all 11 COLES scales were statistically significantly and positively related to all four scales of the SALES. The results of the multiple correlation (*R*) were statistically significant for all four SALES scales and ranged from .10 to .40 for individual scales. In all cases the multiple correlation was positive. To identify which classroom environment scales contributed to the variance in the SALES scales, the standardised regression weights were examined. The results for each SALES scale are summarised below:

- Learning goal orientation was positively and significantly related to student cohesiveness ($p < .05$), teacher support ($p < .05$), task orientation ($p < .05$) and personal relevance ($p < .01$);
- Task value was positively and significantly related to teacher support ($p < .01$), formative assessment ($p < .05$) and personal relevance ($p < .01$) and negatively related to cooperation ($p < .05$);
- Self-efficacy was positively and significantly related to clarity of assessment ($p < .01$); and task orientation ($p < .05$); and
- Self-Regulation was positively and significantly related to teacher support ($p < .05$), task orientation ($p < .01$) and cooperation ($p < .05$).

Overall the findings reported above demonstrated a strong positive relationship between students' perceptions of the learning environment and their motivational and self-regulatory beliefs. These findings are discussed below.

The results indicate that the student cohesiveness scale is an independent predictor of learning goal orientation ($p < .05$). The finding highlights that friends and social acceptance are important factors that can affect students' goal orientation and hence their motivation to learn. These findings also suggest that, when students feel that they are encouraged and supported by members of their class and that they can positively interact with them during lessons, they are more goal-orientated and motivated. This finding supports those of previous studies (Al Zubaidi et al., 2016; Ryan and Patrick, 2001; Velayutham et al., 2011, 2013). Given these findings, it is recommended that teachers encourage positive student relationships in their mathematics and science learning by using strategies to help students to feel that they are supported by their peers (*Recommendation 2*). Such activities might include group projects and peer-assessment (this is discussed further in Section 5.2.3).

The results indicate that the teacher support scale is an independent predictor of three of the four SALES scales (learning goal orientation, $p < .05$, task value, $p < .01$ and self-regulation, $p < .01$). This finding supports past studies that have found that the role of the teacher in the classroom influences student motivation (Aldridge et al, 2012; Middleton and Midgley, 2002). Given these findings, it is recommended, that teachers consider their role in the classroom and examine ways to ensure that they are perceived to be helpful, friendly and trustworthy to students (*Recommendation 3*).

The task orientation scale was found to be statistically significantly related to three of the four SALES scales, namely self-efficacy ($p < .01$), self-regulation ($p < .05$) and learning goal orientation ($p < .05$). This finding supports those of previous studies which have found that a focus on task orientation can increase students' motivation (Aldridge et al, 2012; Khalil, 2015; Killen, 2002; Spady, 1994). This finding also supports the work of Seifert (2004) who purports that, if teachers apply task-orientation strategies (e.g. by setting clear and relevant goals), then the students are more likely to be motivated in their learning process. Given these findings, it is suggested that teachers wishing to improve students' motivation and engagement should consider enhancing students' task-orientation by providing students with clear and relevant goals (*Recommendation 4*). This might be achieved by setting clear goals, expectations and giving frequent personal feedback to promote students' efficacy.

The cooperation scale was found to be an independent predictor of student self-regulation ($p < .05$). This finding corroborates past studies that have reported that the cooperative learning environment positively influences student self-regulation and motivation towards science (Freeman, Alston, & Winborne, 2008; Khalil, 2015; Moebius-Clune, Elsevier, Crawford, Trautmann, Schindelbeck, & Van Es, 2011). Also, according to Kirik and Boz (2012) and Foster (1985), when compared to traditional instruction, cooperative learning activities improved students' motivation to study chemistry. Given this finding, it is recommended that teachers consider the inclusion of collaborative activities, such as group experiments/inquiry-based investigations or team activities, in their lessons (*Recommendation 5*).

The clarity of assessment task scale is positively and statistically significantly related to students' self-efficacy beliefs ($p < .01$). According to Seifert (2004), teachers need to clearly communicate the objectives of the tasks and the goals have to be clear and relevant, so the students would be more engaged in the learning process and perform the tasks more efficiently. Aldridge et al. (2012) further suggest that, clarity of tasks and providing frequent feedback to optimise students' performance and time-on-task could increase both students' motivation and self-regulation in science learning. Minner, Levy and Century (2010), also reported in their study that it is important in science education that the tasks are authentic, relevant and inquiry-based, so the students could actively participate in the learning process. Therefore, it is suggested that teachers ensure that the assessment tasks they create have clear and relevant goals. Also, it is recommended to provide a frequent feedback to students in the course of completion of assessment task (*Recommendation 6*).

The personal relevance scale is positively and statistically significantly related to both learning goal orientation ($p < .05$) and task value ($p < .01$). These findings supported the previous study by Velayutham et al. (2011, 2013). Britner and Pajares's (2006) also found that teachers should create personally relevant, interesting, inquiry-based tasks and activities to encourage lower-secondary science students' to engage in authentic science learning. Therefore, given the findings, it is recommended that teachers wishing to improve students' motivation and engagement in mathematics and science learning should consider creating authentic tasks and investigations with clear goals and expectations (*Recommendation 7*).

Overall, the results of the study reported in this thesis support findings of previous studies which also investigated environment – outcome links (Al Zubaidi et al., 2016; Telli et al., 2006; Urdan & Schoenfelder, 2006; Velayutham, et al., 2011; Wong, Young, & Fraser, 1997; Zandvliet & Fraser, 2004, 2005). These results support that a strong relationship exists between the learning environment factors and students' self-regulation and motivation.

5.2.3 Teaching strategies enabling the increase in students' motivation and engagement.

The third research objective sought to examine how reflection on student feedback can be used to guide changes in learning environment and whether this improves students' self-report of motivation and self-regulation. Teaching strategies were decided upon in light of the teachers' reflections on student perception data and implemented over the action research cycle. This section describes the results of this objective in two sections. First, Section 5.2.3.1 summarises and discusses changes in pre-post data in the classes of the critical instance case study teacher. Second, Section 5.2.3.2 summarises and discusses the ways in which the teacher utilised students' feedback.

5.2.3.1 Pre-post changes

The pre–post sample was comprised of the classes of the critical instance case study teacher and included one Year 8 and one Year 10 mathematics and science class. The case study total sample size for the pre-test–post-test component consisted of 56 students, 26 of whom were girls and 30 of whom were boys.

At the end of the action research process, examination of the pre–post changes indicated that there were improvements in students' perceptions of the learning environments factors and their motivational beliefs overall. MANOVA was used to examine whether these pre-post differences were statistically significant. The results indicated that:

- For three of the 11 COLES scales (Formative Assessment, Task Orientation and Differentiation) the pre-test and post-test results were statistically different ($p < .05$) .
- The effect sizes for these three scales ranged from .21 to .32 (Formative Assessment, effect size = 0.25 standard deviations; Task Orientation, effect size = 0.32 standard deviations; Differentiation, effect size = 0.21 standard deviations). The results signify a small effect, according to Cohen (1992).
- For three of the four SALES scales (Learning Goal Orientation, Self-Efficacy and Self-Regulation), there were statistically significant pre–post differences ($p < .05$).
- For these three SALES scales, the effect sizes were 0.34 standard deviations for Learning Goal Orientation, 0.43 standard deviations for Self-Efficacy and 0.52 standard deviations for Self-Regulation. The results signify a medium effect, according to Cohen (1992).

These findings suggest that, providing teachers with feedback based on students' perceptions, as the means for reflection on their teaching practices, could be a powerful tool for effecting change. It also indicates that when teachers reflects on students' perceptual data, they are likely to alter the classroom environment in ways that are favourable to their students. These findings support previous research findings (Aldridge & Fraser, 2008; Aldridge et al., 2012; Borko, 2004; Lankshear & Knobel, 2004) which used student perception data to assess learning environments with a subsequent aim to reflect upon the students' feedback and to guide improvements to the classroom environment. The findings of the current research corroborate the findings of the past research which signified the importance of teacher reflection for their practices and its effectiveness in supporting the implementation of intervention strategies and new teaching practices (Aldridge et al., 2012; Fraser, & Aldridge, 2017)

The action research, used in the present study, involved a cycle of critical, self-critical and reflective processes throughout which the case study teacher could find out more information about the learning environments in her classrooms and about her teaching practices, as recommended by Car and Kemmis (1983). An important element of the action research in the current study was the reflection stage during which the critical instance case study teacher had an opportunity to reflect on her teaching practices, to discuss it with the researcher, then plan interventions to address the issues. These reflection processes embedded in the present study also supported the past studies involving action research which elaborated on teacher reflection during action research (Aldridge & Fraser, 2008; Borko, 2004; Lankshear and Knobel, 2004; Schön, 1983, 1987). The findings also contribute to past learning environment research which has successfully involved teachers using students' feedback based on their perceptions of learning environments to implement changes. (Aldridge & Fraser, 2008; Aldridge, Fraser & Sebela, 2004; Fraser & Fisher, 1986; Sinclair & Fraser, 2002; Yarrow et al., 1997). Given that the findings of the current study supported previous research which utilised student feedback to examine learning environments and used the feedback for teachers' reflection, it could be recommended to consider the importance of teacher reflection on their practices based on students' feedback to guide improvements in their classrooms (*Recommendation 8*).

5.2.3.2 Ways in which the teacher utilised the student feedback

The findings of the present study provided insights into the ways in which the students' feedback was used by the teacher to change her classrooms. The findings suggest that the case study teacher devoted much time for reflection on the student and researcher's feedback and accessed other resources such as professional development forums and specialised committees. The reflection processes, used by the teacher, corroborate the findings of past studies involving action research which found teacher reflection to be an important element of the action research aiming to improve classrooms (Kemmis and Wilkinson, 1998; Lankshear and Knobel, 2004; Schön, 1983, 1987). Past studies also highlighted the potential of the teachers' reflection as a tool for implementation of the strategies to improve students' perception of their learning environments and their motivational beliefs, which also support the finding of the previous studies (Aldridge & Fraser, 2008; Borko, 2004; Dewey, 1981).

From the reflection stage, the case study teacher moved to the planning and deliberate intervention stage. The case study teacher reported that the students' responses allowed her to see different viewpoints about her teaching. She also specified that reflecting on student feedback in the course of the action research, enabled her to better understand her teaching, her students and also the different ways they learn. During this stage she decided on a number of strategies to help her to improve students' perceptions of the learning environment and motivation, including:

- The determination and elimination of disengaging factors, which appeared to be an inhibiting element when creating a motivation-driven learning environment;
- Thorough lesson planning, with lessons that included diversified teaching materials, activities and use of technology;
- Writing and using engaging and authentic assessment tasks, that included setting clear goals for each learning activity and task (such as backward design and GRASPS model);
- Differentiated learning and tasks, depending on students' abilities, rates of learning, interests and career aspirations;
- Engaging and authentic assessment tasks;
- Personalised and timely feedback is a compulsory element of the model as well as constructing lessons which would be task focused and which would include activities that are timed and involve peer-tutoring, team work and hands-on activities
- Setting clear goals for learning activities and assessment tasks;
- Providing task-focused lessons with activities that are timed and include peer tutoring, team work, and hands-on activities.

This process of action, enabled by reflecting on student feedback data, was viewed by the case study teacher to be instrumental in bringing about improvements in students' perceptions of learning environments and their motivational beliefs. The results of the interviews with the case study teacher established that teacher action research which utilises student feedback was considered to be a valuable tool of professional development and implementation strategies for improvement in the classroom environment and students' motivation and self-regulation. Importantly, the approach was effective in helping to address the core research problem related to increasing students' motivation and self-regulation. These findings support results from the previous studies which involved teachers using students' perceptual measures to implement changes in order to improve students' motivational and self-regulatory beliefs (see for example, Aldridge & Fraser, 2008; Aldridge, Fraser & Sebela, 2004; Fraser & Fisher, 1986; Sinclair & Fraser, 2002; Yarrow et al., 1997).

To summarise, the action research approach, which included close collaboration with and monitoring of the critical instance case study teacher, provided evidence of the important role of a teacher and teacher's qualities in building the motivation-driven learning environments. Importantly, the approach taken in the present study, positioned the teacher central to the improvements of learning environment factors and students' motivational and self-regulatory beliefs. This approach provided insights into the actions taken by the teacher to target areas within the learning environments for improvement. As a results of the teachers' efforts, the students' self-reports of motivation and self-regulation in the mathematics and science classrooms improved.

5.3 Limitations of the Study

As with all research, the current study involved a number of limitations that need to be considered when interpreting the results. This section outlines the limitations of the study, including the sample.

There were limitations related to the size and representativeness of the samples used in the present study. First, the study involved only one school, the workplace of the researcher. Even though the researcher carefully selected the sample within the school, to ensure that it was representative (the number of participating classes was maximised and that the selection of students involved a range of year levels, student ability levels and genders), caution needs to be taken when generalising the results to other schools or to other states in Australia.

Second, the critical case study involved only one teacher and her two integrated mathematics and science classes. Although the researcher attempted to minimise this limitation by collecting in-depth information from this teacher, the results should be generalised to other teachers with caution. Future studies might benefit from having a wider sample which could include different schools from South Australia and other states (*Recommendation 9*). Furthermore, it could be recommended for future research that the data be analysed in accordance with grade-level, gender or age and explore how the influence of classroom learning environment on students' motivation changes with students' grade level or age (*Recommendation 10*).

The presence of the researcher in the classroom during classroom observations could have been a limitation as it may have created a difference in the students' behaviour and attitude. To minimise this limitation, the researcher took all possible steps to ensure that the impact of the observer's visits was minimised such as sitting at the back of the classroom apart from the students, not intervening into the discussions or the learning activities, and using field notes to record the data rather than a video recorder.

Another limitation was related to the extraneous factors, other than the teacher intervention strategies, which could affect the results, such as changes in school policies, different topics being studied, various complexity of the concepts being learned, growth in student maturity and etc., which could have influenced the pre–post changes in students' perceptions of their classroom learning environment and their motivational and self-regulatory beliefs. To minimise the influence of the extraneous factors on student perceptions, the intervention stage of the action research between pre-test and post-test was minimised. To overcome this limitation, it is recommended that future research keep the intervention period relatively short to ensure that the level of change in the sample can be attributed to the actions of the teachers over that time rather than other external factors (*Recommendation 11*).

Finally, the research methods did not involve students' interviews, the inclusion of which would have provided valuable information about students' feelings, thoughts and beliefs related to the learning environment, intervention strategies and their motivation. Therefore, for future study it could be recommended to include in-depth interviews with students as a potential data collection instrument. (*Recommendation 12*).

5.4 Summary of Recommendations

This section summarises the recommendations provided above.

Recommendation 1	In order to provide further validation for the COLES and the sales, it is recommended that, future research involve samples from a wider population which would include different schools, universities, states and countries.
Recommendation 2	Given that cooperation and student cohesiveness is positively related to learning goal orientation, task value and self-regulation, it is recommended that teachers encourage positive student relationships in their mathematics and science learning by using strategies to help students to feel that they are supported by their peers.
Recommendation 3	Given that teacher support is positively related to learning goal orientation, task value, self-efficacy, self-regulation, it is recommended that teachers consider their role in the classroom and examine ways to ensure that they are perceived to be helpful, friendly and trustworthy to students.
Recommendation 4	Given that task orientation is positively related to learning goal orientation, task value, self-efficacy and self-regulation, it is recommended that, to improve students' motivation and engagement, teachers enhance students' task-orientation by providing students with clear and relevant goals.
Recommendation 5	Given that cooperation and student cohesiveness is positively related to learning goal orientation, task value and self-regulation, it is recommended that teachers consider the inclusion of collaborative activities, such as group experiments/inquiry-based investigations or team activities, in their lessons.
Recommendation 6	Given that clarity of assessment task is positively related to students' self-efficacy beliefs, it is recommended that teachers provide a frequent feedback to students in the course of completion of assessment task.
Recommendation 7	Given that personal relevance scale is positively related to learning goal orientation and task value, it is recommended

that teachers wishing to improve students' motivation and engagement in mathematics and science learning consider creating authentic tasks and investigations with clear goals and expectations.

Recommendation 8	Given that findings suggest that, providing teachers with feedback based on students' perceptions, as the means for reflection on their teaching practices, could be a powerful tool for effecting change, it is recommended that teachers reflect on their practice and include students' feedback to guide improvements in their classrooms.
Recommendation 9	Given the limitations related to the size and representativeness of the samples used in the present study, it is recommended that future studies involve a wider sample that includes different schools from South Australia and other states.
Recommendation 10	It is recommended that future research involve analysis that takes into account different grade-level, gender and age in exploring the influence of the classroom learning environment on students' motivation.
Recommendation 11	It is recommended that future research keep the intervention period relatively short to ensure that the level of change in the sample can be attributed to the actions of the teachers over that time rather than other external factors.
Recommendation 12	Given that the research instruments did not include student interviews, it can be recommended to include in-depth interviews with students for collection of valuable qualitative data on students' feelings, thoughts and beliefs related to the learning environment, intervention strategies and their motivation.

5.5 Significance of the Study

This section discusses the significance of the research reported in this thesis. It is, to the best of my knowledge, one of only a handful of studies within field of learning environment research to investigate the impact of learning environment factors on student motivation and self-regulation in integrated secondary mathematics and science classrooms. Given the current emphasis on STEM education, findings of the present study have the potential to make significant contributions to the field of learning environments research and mathematics and science education.

One of important contributions of this study is the identification of psychosocial learning environment factors that can impact students' motivational and self-regulatory beliefs in mathematics and science learning. These findings can be important for teachers and educational practitioners who are willing to reflect on their mathematics and science classroom environments and pedagogic practices in a bid to improve students' motivation and self-regulation.

In the present study, the COLES and the SALES, have been validated for use with high school students in mathematics and science classes in South Australia. This important contribution provides two economical and reliable instruments that can be used by practitioners and researchers. In particular, the validation of these two instruments provides teachers with tools that they can use to gather student feedback. As demonstrated, this feedback data can be a valuable source of information to guide efforts to improve the learning environment and students' motivation and engagement.

This thesis provides support to similar studies which prompt teachers to examine and reflect on the views of their students to improve their classroom environments and students' outcomes (Aldridge & Fraser, 2008; Schön, 1983, 1987). Also, the findings of this study corroborates past studies that found that action research can be an effective strategy in improving learning environments (Aldridge & Fraser, 2008; Fraser & Fisher, 1986; Sinclair & Fraser, 2002; Yarrow et al., 1997). Additionally, the methodology for the action research component within the present study, including collection of both qualitative and quantitative data, reflection on these data and action, has extended previous studies.

Another key contribution of the study reported in this thesis is use of teacher action research as a tool of teachers' professional development (which was undertaken by the researcher and the critical instance case study teacher in her classrooms). The study could be of practical significance to future attempts by teachers and educational practitioners to improve mathematics and science teaching as the research encouraged the teacher participating in the study to systematically and purposefully reflect on her teaching practices using students' meaningful and valid feedback about the learning environment and their motivational and self-regulatory beliefs. The results and findings of the present study emphasise the potential of using student feedback and an action research process as an authentic opportunity to link their knowledge about teaching, learning and assessment to the immediate classroom context.

The results of the present study have the potential to be of significance to teachers and educational practitioners, as it identified the factors within the learning environment that are likely to improve students' motivational and self-regulatory beliefs. Also, the results of the study have the potential to be of practical significance to educators by proposing teaching strategies which can be used by practitioners to improve their classroom practices and students' motivation and engagement. Furthermore, the present study bridged a gap in motivational research by identifying teaching strategies that can be implemented to improve learning goal orientation, students' self-efficacy and self-regulation. The current research also extended the past learning environment research by determining teaching strategies which could facilitate student task orientation, differentiation and formative assessment.

5.6 Concluding Comments

The present study contributed to the identification of factors within the learning environment that could impact students' motivational and self-regulatory beliefs. It also examined teaching strategies that could, potentially, improve learning environments and, as a result, students' motivation and engagement.

The results of the study could have important applications for educational systems concerning how learning environments can be changed and new teaching strategies can be developed and implemented to improve both the learning environments in mathematics and science classes and students' motivation and self-regulation in these classes. The findings provide: a greater understanding of the problem of students' motivation and self-regulation, a view of the issue of students' motivation and self-regulation from the perspective of the classroom environment and teachers' actions, and practical applications for teachers in terms of teaching strategies and how they can alter learning environment factors to enhance students' motivation and self-regulation.

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APPENDIX A

CONSTRUCTIVIST-ORIENTED LEARNING ENVIRONMENT SURVEY (COLES)

Source of scales

Aldridge, Fraser, Bell and Dorman (2012)

Constructivist-Oriented Learning Environment Survey (COLES)

Directions

This section of the questionnaire contains statements about practices that could take place in your class. The 'Actual' column is to be used to describe how often each practice actually takes place in this class. The 'Preferred' column is to be used to describe how often you would like each practice to take place (a wish list).
Draw a circle around

1 if this happens (actual) or you would like it to happen (preferred) **Almost Never**
2 if this happens (actual) or you would like it to happen (preferred) **Seldom**
3 if this happens (actual) or you would like it to happen (preferred) **Sometimes**
4 if this happens (actual) or you would like it to happen (preferred) **Often**
5 if this happens (actual) or you would like it to happen (preferred) **Almost Always**

Be sure to give an answer for all questions. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Your responses will be confidential.

		ACTUAL					**PREFERRED**				
	Student Cohesiveness	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
1	I make friends among students in this class.	1	2	3	4	5	1	2	3	4	5
2	I know other students in this class.	1	2	3	4	5	1	2	3	4	5
3	I am friendly to members of this class.	1	2	3	4	5	1	2	3	4	5
4	Members of the class are my friends.	1	2	3	4	5	1	2	3	4	5
5	I work well with other class members.	1	2	3	4	5	1	2	3	4	5
6	I help other class members who are having trouble with their work.	1	2	3	4	5	1	2	3	4	5
7	Students in this class like me.	1	2	3	4	5	1	2	3	4	5
8	In this class, I get help from other students.	1	2	3	4	5	1	2	3	4	5
	Teacher Support	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
9	The teacher is interested in my problems.	1	2	3	4	5	1	2	3	4	5
10	The teacher goes out of his/her way to help me.	1	2	3	4	5	1	2	3	4	5
11	The teacher considers my feelings.	1	2	3	4	5	1	2	3	4	5
12	The teacher helps me when I have trouble with the work.	1	2	3	4	5	1	2	3	4	5
13	The teacher talks with me.	1	2	3	4	5	1	2	3	4	5
14	The teacher takes an interest in my progress.	1	2	3	4	5	1	2	3	4	5
15	The teacher moves about the class to talk with me.	1	2	3	4	5	1	2	3	4	5
16	The teacher's questions help me to understand.	1	2	3	4	5	1	2	3	4	5

	Involvement	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
17	I discuss ideas in class.	1	2	3	4	5	1	2	3	4	5
18	I give my opinions during class discussions.	1	2	3	4	5	1	2	3	4	5
19	The teacher asks me questions.	1	2	3	4	5	1	2	3	4	5
20	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5	1	2	3	4	5
21	I ask the teacher questions.	1	2	3	4	5	1	2	3	4	5
22	I explain my ideas to other students.	1	2	3	4	5	1	2	3	4	5
23	Students discuss with me how to go about solving problems.	1	2	3	4	5	1	2	3	4	5
24	I am asked to explain how I solve problems.	1	2	3	4	5	1	2	3	4	5
	Task Orientation	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
25	Getting a certain amount of work done is important to me.	1	2	3	4	5	1	2	3	4	5
26	I know what I am required to do when completing a task.	1	2	3	4	5	1	2	3	4	5
27	I know the goals for this class.	1	2	3	4	5	1	2	3	4	5
28	I am ready to start this class on time.	1	2	3	4	5	1	2	3	4	5
29	I set my own goals for this class.	1	2	3	4	5	1	2	3	4	5
30	I pay attention during this class.	1	2	3	4	5	1	2	3	4	5
31	I try to understand the work in this class.	1	2	3	4	5	1	2	3	4	5
32	I know how much work I have to do.	1	2	3	4	5	1	2	3	4	5
	Personal Relevance	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
33	I relate what I learn in this class to life outside school.	1	2	3	4	5	1	2	3	4	5
34	I draw on past experiences to help me in this class.	1	2	3	4	5	1	2	3	4	5
35	What I learn in this class is relevant to my everyday life.	1	2	3	4	5	1	2	3	4	5
36	I apply my everyday experiences in this class.	1	2	3	4	5	1	2	3	4	5
37	This class is relevant to my life outside of school.	1	2	3	4	5	1	2	3	4	5

38	I link my class work to my life outside of this class.	1	2	3	4	5	1	2	3	4	5
39	In this class, I get an understanding of life outside school.	1	2	3	4	5	1	2	3	4	5
40	I apply my past experience to the work in this class.	1	2	3	4	5	1	2	3	4	5
	Cooperation	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
41	I cooperate with other student when doing assignment work.	1	2	3	4	5	1	2	3	4	5
42	I share my books and resources with other students when doing assignments.	1	2	3	4	5	1	2	3	4	5
43	When I work in groups in this class, there is teamwork.	1	2	3	4	5	1	2	3	4	5
44	I work with other students on projects in this class.	1	2	3	4	5	1	2	3	4	5
45	I learn from other students in this class.	1	2	3	4	5	1	2	3	4	5
46	I work with other students in this class.	1	2	3	4	5	1	2	3	4	5
47	I cooperate with other student on class activities.	1	2	3	4	5	1	2	3	4	5
48	Students work with me to achieve class goals.	1	2	3	4	5	1	2	3	4	5
	Equity	Almost Never	Seldom	Some-times	Often	Almost Always	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	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	1	2	3	4	5
51	I have the same amount of say in this class as other students.	1	2	3	4	5	1	2	3	4	5
52	I am treated the same as other students in this class.	1	2	3	4	5	1	2	3	4	5
53	I receive the same encouragement from the teacher as other students do.	1	2	3	4	5	1	2	3	4	5
54	I get the same opportunity to contribute to class discussions as other students.	1	2	3	4	5	1	2	3	4	5
55	My work receives as much praise as other students' work.	1	2	3	4	5	1	2	3	4	5
56	I get the same opportunity to answer questions as other students.	1	2	3	4	5	1	2	3	4	5

	Differentiation	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
57	I work at the speed which suits my ability.	1	2	3	4	5	1	2	3	4	5
58	Students who work faster than me can move on to the next topic.	1	2	3	4	5	1	2	3	4	5
59	I can choose topics I wish to study.	1	2	3	4	5	1	2	3	4	5
60	Tasks are suited to my interests.	1	2	3	4	5	1	2	3	4	5
61	Tasks are suited to my ability.	1	2	3	4	5	1	2	3	4	5
62	I use different materials from those used by other students.	1	2	3	4	5	1	2	3	4	5
63	I use different assessment methods from other students.	1	2	3	4	5	1	2	3	4	5
64	I do work that is different from other students' work.	1	2	3	4	5	1	2	3	4	5
	Young Adult Ethos	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
65	I am treated like a young adult.	1	2	3	4	5	1	2	3	4	5
66	I am given responsibility.	1	2	3	4	5	1	2	3	4	5
67	I am expected to think for myself.	1	2	3	4	5	1	2	3	4	5
68	I am dealt with as a grown up.	1	2	3	4	5	1	2	3	4	5
69	I am regarded as reliable.	1	2	3	4	5	1	2	3	4	5
70	I am considered mature.	1	2	3	4	5	1	2	3	4	5
71	I am given the opportunity to be independent.	1	2	3	4	5	1	2	3	4	5
72	I am encouraged to take control of my own learning.	1	2	3	4	5	1	2	3	4	5
	Formative Assessment	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
73	I use feedback from assessment tasks to improve my learning.	1	2	3	4	5	1	2	3	4	5
74	Assessment tasks help me to understand the topic.	1	2	3	4	5	1	2	3	4	5
75	There is a link between classroom activities and my assessment tasks.	1	2	3	4	5	1	2	3	4	5
76	Assessment tasks help my understanding.	1	2	3	4	5	1	2	3	4	5

77	Assessment tasks are an important part of my learning.	1	2	3	4	5	1	2	3	4	5
78	Assessment tasks help me to recognise weaknesses in my understanding.	1	2	3	4	5	1	2	3	4	5
79	Assessment tasks help me to monitor my own learning.	1	2	3	4	5	1	2	3	4	5
80	I find the assessment tasks meaningful.	1	2	3	4	5	1	2	3	4	5
	Clarity of Assessment Criteria	Almost Never	Seldom	Some-times	Often	Almost Always	Almost Never	Seldom	Some-times	Often	Almost Always
81	I am aware of which activities and tasks are used to assess my performance.	1	2	3	4	5	1	2	3	4	5
82	I know what types of information I need to complete an assessment task.	1	2	3	4	5	1	2	3	4	5
83	The instructions for assessment tasks are clear to me.	1	2	3	4	5	1	2	3	4	5
84	The requirements for the assessment tasks are clear to me.	1	2	3	4	5	1	2	3	4	5
85	I understand how to complete assessment tasks successfully.	1	2	3	4	5	1	2	3	4	5
86	The assessment criteria are clear to me.	1	2	3	4	5	1	2	3	4	5
87	I understand how the teacher judges my work.	1	2	3	4	5	1	2	3	4	5
88	I know how to complete different assessment tasks.	1	2	3	4	5	1	2	3	4	5

APPENDIX B

STUDENTS' ADAPTIVE LEARNING ENGAGEMENT SURVEY (SALES)

Source of scales
Velayutham, Aldridge and Fraser (2011)

Students' Adaptive Learning Engagement Survey (SALES)

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.

	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 C

SAMPLE INTERVIEW QUESTIONS AND NOTES

Case Study Teacher 5/12/12, Post-test Interview sample questions and notes

<u>What did you find particularly useful in the course of the action research?</u>

- Going through the feedback from students' surveys
- Discussing the strategies how to improve the situation

<u>What was the major focus in implementing the changes?</u>

- Clarity of assessment tasks
- Students involvement and immediate self-assessment (mini-white boards)
- Differentiation
- Sitting Plan to move from the one type - group work
- Relevance: To connect the activities to the outside world;

<u>What worked well, what did not work?</u>

- Teacher thinks that all of the planned strategies worked well in both classes
- Use of engagement activities and games ("bingo" activities, matching cards)
- Links with outside worlds, more VET type questions;
- Sitting plan

<u>Is it possible to create engaging and motivation-driven LE in classes?</u>

- Yes, Yes and Yes.
- Although more work for teachers is required when you need more preparation time to prepare games, non-text book teaching; different assessment tasks, not just tests.
- ACER results show increase in academic efficacy in my classes.

<u>Obstacles which teachers face when they try the improvements?</u>

- Time
- Confidence (some teachers may be not trained in maths)
- No sharing with other teachers.

APPENDIX D

EXAMPLE OF A TEACHER INTERVENTION PLAN FOR ACTION RESEARCH: TEACHER'S PLAN FOR ACTION

Teacher Plan for Action

Teacher: Critical Instance Case Study **Class:** Y8 and Y 10

My teaching, learning and assessment strategies will focus on:	What observations tell me:	Teacher's Plan – What will I do to transform the learning environment
Student Cohesiveness & Cooperation	Y 8: Students in this class are friendly. The students work in groups all the time, however only one group out of six work well and efficiently. In other groups the students distract each other, discuss topics different from given by the teacher, interfere with the students who are ready to be on task, copy from those who has completed something. Y 10: Students have good relationships with each other, sometimes show good level of cooperation. But sometimes, instead of sharing ideas, knowledge and helping each other, they prefer to socialise and distract each other. Main distraction comes from their talks with each other	Reorganise the groups, reorganise the desks (Different arrangement of desks implying more individual work and faster shift of the students who distract others. If pair work or group work - the groups are to be formed by the teacher.)
Task Focus / Goal Orientation	Most students get distracted by each other in groups and while the teacher is providing help to another group, can't use the independence properly, have no self-control to go back to the task. Moreover, in the Y 10 the students use mobiles to do calculations, but very quickly move to texting/internet browsing. Some of the Y 10 students are distracted listening to the music (headphones on) and miss important bits of explanation. Getting the required amount of work done is not important to the students in both classes. When the expectations are set clearly, they take notes and copy from the board. If they are not required, only a few students do that. The students are not inclined to use their time efficiently to finish the tasks even when the teacher sets time. If they are not pushed, they do not take notes, do not copy from the board and do not keep focused on the task.	More individual work; Time management (set time for the tasks and stick to it); Clear expectation to take notes, to copy from the board in the course of the explanation; to draw shapes (for geometry topics); Clear expectation to use calculators instead of phones; Clear expectation not to use headphones;
Relevance	The activities in all the classes are related to life outside of school and are relevant to the students' day-to-day life. The tasks in the class satisfy students' curiosity and have practical value. The format of the tasks allows the students to apply everyday experiences in this class. The Y 10 students looked more interested and motivated to complete them than Y 8 (in the Y 8 connection with everyday life was not really clear).	To set tasks more connected to everyday life in the Y 8.
Individualisation Differentiation	Although the activities and tasks offered by the teacher are engaging and have practical value, they are differentiated only for the students with poorer abilities. The tasks are the same for everyone, they do not imply differentiated approach for better students and do not enable them to do work which is more suited to their abilities.	Have prepared activities (worksheets, mental maths questions) for the better students to keep them busy and not to complain and distract each other.

APPENDIX E

COPY OF ETHICS CLEARANCE APPROVAL LETTER

Curtin University

Memorandum

To	Yulia Burdakova, SMEC
From	Pauline Howat, Administrator, Human Research Ethics Science and Mathematics Education Centre
Subject	Protocol Approval **SMEC-18-12**
Date	20 April 2012
Copy	Jill Aldridge, SMEC

Office of Research and Development

Human Research Ethics Committee

Telephone 9266 2784
Facsimile 9266 3793
Email hrec@curtin.edu.au

Thank you for your "Form C Application for Approval of Research with Low Risk (Ethical Requirements)" for the project titled *"Investigating the impact of the learning environment on students' motivation and engagement: Developing a model for motivation-driven learning environments in mathematics and science classes"*. On behalf of the Human Research Ethics Committee, I am authorised to inform you that the project is approved.

Approval of this project is for a period of twelve months **19th April 2012** to **18th April 2013**.

The approval number for your project is **SMEC-18-12**. *Please quote this number in any future correspondence*. If at any time during the twelve months changes/amendments occur, or if a serious or unexpected adverse event occurs, please advise me immediately.

Pauline

APPENDIX F

COPY OF DECD ETHICS APPROVAL LETTER

Government of South Australia

Department for Education and Child Development

Policy and Communications

31 Flinders Street
Adelaide SA 5000
GPO Box 1152
Adelaide SA 5001
DX 541

Tel: 8226 0119
Fax: 8226 7836

DECD CS/12/26-2.3

6 June 2012

Dear Principal/Director/Site Manager

The research project titled *"Investigating the impact of the Learning Environment on Students' Motivation and Engagement: Developing a Model for Motivation-Driven Learning Environments in Mathematics and Science Classes"* conducted by Ms Yulia Burdakova from Curtin University has been reviewed centrally and granted approval for access to Department for Education and Child Development (DECD) sites. However, the researcher will still need your agreement to proceed with this research at your site.

Once approval has been given at the local level, it is important to ensure that the researchers fulfil their responsibilities in obtaining informed consent as agreed, that individuals' confidentiality is preserved and that safety precautions are in place.

Researchers are encouraged to provide feedback to sites used in their research, and you may wish to make this one of the conditions for accessing your site. To ensure maximum benefit to DECD, researchers are also asked to supply the department with a copy of their final report which will be circulated to interested staff and educators for future reference.

Please contact Jeffrey Stotter, Project Officer – Research and Innovation on (08) 8226 0119 for further clarification if required, or to obtain a copy of the final report.

Yours sincerely

for

Ben Temperly
HEAD OF POLICY AND COMMUNICATIONS

APPENDIX G

INFORMATION SHEET AND CONSENT FORM FOR PARENTS/STUDENTS

Science and Mathematics Education Centre

Research Project Information Sheet

Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes

I am Yulia Burdakova. I am currently completing research for my Ph.D. degree at Curtin University.

I am investigating the relationships between the Learning Environment factors and Student Motivation and Engagement. The main aim of my research is to find out ways to improve Student Motivation and Engagement in Maths and Science classes. The research is likely to become professional development for the teachers involved at your child's school and, ultimately, may be used as a tool to guide other teachers in secondary schools towards improvement of their practices.

To assess students' perceptions of the classroom learning environment, the Constructivist-Oriented Learning Environment Survey will be administered. To assess students' motivation and engagement in mathematics and science classes, the Students' Adaptive Learning Engagement Survey will be used. It will take approximately 20 minutes to fill in each of the surveys. They will be used twice: once at the beginning of the action research, to diagnose the initial situation (August, 2012), and again at the end of the action research to assess whether the situation, after the teachers have made changes in their classrooms, has improved (December, 2012).

Work samples such as student exercise books, written works, tests, projects and portfolios will be used to assess levels of engagement with learning tasks.

Classroom observations will be conducted in the maths and science classes to provide information about teachers' relationships with their students, teaching and assessment strategies that the teachers use, interactions of the students with each other, their attitudes towards classes and how they interact with the classroom materials. The observations will also provide an indication of the extent to which the students are engaged and motivated.

Participation in the research is entirely voluntary and can be withdrawn at any time. Participants' names will not be mentioned in the thesis reports and complete anonymity and confidentiality will be maintained at all times.

You will be requested to complete, sign and return the attached consent form to your child's teacher if you agree to your child participating in this research.

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee, Approval number SMEC 18-12. If you would like further information about the study, please feel free to contact me on 0430671921 or by email yulia.burdakova@student.curtin.edu.au. Alternatively, you can contact my supervisor Dr Jill Aldridge, Associate Professor on +61 8 9266 3592 or by e-mail: J.Aldridge@curtin.edu.au.

Thank you very much for your involvement in this research.
Your participation is greatly appreciated.

Yulia Burdakova

Curtin University

PARENT/STUDENT CONSENT FORM

Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes

• I understand the purpose and procedures of the study entitled: "Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes".

• I have been provided with the Research Information Sheet.

• I understand that the procedure itself may not benefit me.

• I understand that my involvement is voluntary and I can withdraw at any time without a problem.

• I understand that **no** personal identifying information like my/my child's name and address will be used in any published materials.

• I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

• I consent to allow my child____ to participate in the study outlined to me.

Name of parent: ____

Signature of parent: ____

Name of child:____

Signature of child:____

Date: _______________________

APPENDIX H

INFORMATION SHEET AND CONSENT FORM FOR TEACHERS

Science and Mathematics Education Centre

Research Project Information Sheet

Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes

Dear Teacher,

I am Yulia Burdakova. I am currently completing research for my Ph.D. degree at Curtin University of Technology.

I am investigating Relationships between the Learning Environment factors and Student Motivation and Engagement. The main aim of my research is to find out ways to improve Student Motivation and Engagement in Maths and Science classes. The research is likely to become professional development for the teachers involved at your school and, ultimately, may be used as a tool to guide other teachers in secondary schools towards improvement of their practices.

To assess students' perceptions of the classroom learning environment, the Constructivist-Oriented Learning Environment Survey will be administered. To assess students' motivation and engagement in mathematics and science classes, the Students' Adaptive Learning Engagement Survey will be used. It will take your students approximately 15 minutes to fill in each of the surveys. They will be used twice: once at the beginning of the action research, to diagnose the initial situation (August, 2012), and again at the end of the action research to assess whether the situation in the classrooms has changed (December, 2012).

As a teacher you will be requested to participate in face-to-face interviews. They will take no longer than 15 minutes each and will be obtained up to 5 times during the action research.

Work samples such as student exercise books, written works, tests, projects and portfolios will be used to assess levels of engagement with learning tasks.

Classroom observations will be conducted in your classes (up to 5 observations) to provide information about the extent to which the students are engaged and motivated. They will also provide an indication of your relationships with the students, teaching and assessment strategies that you use, interactions of the students with each other, their attitudes towards classes and how they interact with the classroom materials.

Your participation in the research is entirely voluntary and can be withdrawn at any time. Participants' names will not be mentioned in the thesis reports and complete anonymity and confidentiality will be maintained at all times.

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee, Approval number SMEC 18-12. If you would like further information about the study, please feel free to contact me on 0430671921 or by email yulia.burdakova@student.curtin.edu.au. Alternatively, you can contact my supervisor Dr Jill Aldridge, Associate Professor on +61 8 9266 3592 or by e-mail: J.Aldridge@curtin.edu.au.

Thank you very much for your involvement in this research.

Your participation is greatly appreciated.

Yulia Burdakova

TEACHER CONSENT FORM

• I understand the purpose and procedures of the study entitled: "Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes".

• I have been provided with the Research Information Sheet.

• I understand that the procedure itself may not benefit me.

• I understand that my involvement is voluntary and I can withdraw at any time without a problem.

• I understand that **no** personal identifying information like my name and address will be used in any published materials.

• I understand that all information will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

• I agree to participate in the study outlined to me.

Name: ____

Signature: ____

Date: ______________________

APPENDIX I

INFORMATION SHEET AND CONSENT FORM FOR PRINCIPALS

Science and Mathematics Education Centre

Research Project Information Sheet

Investigating the impact of the Learning Environment on Students' Motivation in Mathematics and Science Classes

Dear Principal,

I am Yulia Burdakova. I am currently completing research for my Ph.D. degree at Curtin University.

I am investigating the relationships between the Learning Environment factors and Student Motivation and Engagement. The main aim of my research is to find out ways to improve Student Motivation and Engagement in Maths and Science classes. The research is likely to become professional development for the teachers involved at your school and, ultimately, may be used as a tool to guide other teachers in secondary schools towards improvement of their practices.

To assess students' perceptions of the learning environment, the Constructivist-Oriented Learning Environment Survey will be administered. To assess students' motivation and engagement in mathematics and science classes, the Students' Adaptive Learning Engagement Survey will be used. It will take approximately 15 minutes to fill in each of the surveys. They will be used twice: once at the beginning of the action research, to diagnose the initial situation (August, 2012), and again at the end of the action research to assess whether the situation, after the teachers have made changes in their classrooms, has improved (December, 2012).

Teachers also will be requested to participate in face-to-face interviews (up to 5 interviews with a teacher during the action research). They will take no longer than 15 minutes each.

Work samples such as student exercise books, written works, tests, projects and portfolios will be used to assess levels of engagement with learning tasks.

Classroom observations will be conducted in the maths and science classes to provide information about teachers' relationships with their students, teaching and assessment strategies that the teachers use, interactions of the students with each other, their attitudes towards classes and how they interact with the classroom materials (up to 5 observations per each class). The observations will also provide an indication of the extent to which the students are engaged and motivated.

Participation in the research is entirely voluntary and can be withdrawn at any time. Participants' names will not be mentioned in the thesis reports and complete anonymity and confidentiality will be maintained at all times.

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee, Approval number SMEC 18-12. If you would like further information about the study, please feel free to contact me on 0430671921 or by email yulia.burdakova@student.curtin.edu.au. Alternatively, you can contact my supervisor Dr Jill Aldridge, Associate Professor on +61 8 9266 3592 or by e-mail: J.Aldridge@curtin.edu.au.

Thank you for your time and consideration,

Yulia Burdakova

PRINCIPAL CONSENT FORM

• I understand the purpose and procedures of the study entitled: “Investigating the impact of the Learning Environment on Students’ Motivation in Mathematics and Science Classes” and give my approval to Yulia Burdakova, Ph.D. Candidate, Curtin University of Technology, to conduct the action research at Hallett Cove School R-12.

• I have been provided with the Research Information Sheet, copies of Teacher and Parent Consent forms, a copy of the DECD approval and a copy of the Research Proposal.

• I understand that all information collected in the course of the study will be securely stored for at least 5 years before a decision is made as to whether it should be destroyed.

• I have been given the opportunity to ask questions about this research.

Principal:

School:

Signature: __________________

Date: ______________________