Science and Mathematics Education Centre

Evaluation of Success Lab in Terms of Learning Environment, Attitudes Toward Mathematics and Academic Efficacy Among High School Algebra Students

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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 person except where due acknowledgement has been made.

Signature: Kathleen L. Landon

Date: March 15, 2011

Abstract

I investigated the effectiveness of an Algebra 1 intervention program, Success Lab, in terms of learning environment and students' attitudes toward mathematics and academic efficacy with 20 ninth grade classes (N = 313) in three central California high schools. A group of 56 students concurrently enrolled in Algebra 1 and Success Lab were matched and compared with 56 non-intervention students. Criteria of effectiveness consisted of learning environment scales from the What Is Happening In this Class? (WIHIC), attitude scales from the Attitudes Toward Mathematics Inventory (ATMI), and an academic-efficacy scale based on the Patterns of Adaptive Learning Scales (PALS).

Factor analysis (principal axis factoring with varimax rotation and Kaiser normalization) showed that the three learning environment scales accounted for 57.61% of the total variation for the pretest data and 63.17% of the total variation for the posttest data. The Cronbach alpha reliability coefficient exceeded 0.80 for every learning environment scale for both the pretest and posttest. Factor analysis of data for the attitude and efficacy scales of the ATMI/PALS revealed that the Value scale accounted for 47.99% of the total variation for pretest data and 52.49% of the total variation for posttest data. Cronbach alpha reliability coefficients all exceeded 0.85 for the attitude and efficacy scales for both pretest and posttest data.

A paired-samples *t*-test was used with each learning environment and attitude and efficacy scale to determine the statistical significance of differences between the intervention group and the non-intervention group. Posttest differences between the intervention group and the non-intervention group for the three learning environment scales were statistically significant even after a modified Bonferroni correction was applied. Also the between-group differences were sizeable in magnitude for all three learning environment scales (with effect sizes of over half a standard deviation indicating a medium effect).

However, posttest differences between the intervention group and the non-intervention group were statistically nonsignificant for the three attitude and efficacy

scales (after application of a Bonferonni correction) and were associated with relatively small effect sizes ranging from 0.18 to 0.34 standard deviations. Nevertheless, students participating in the intervention class, Success Lab, had somewhat more positive attitudes towards mathematics and academic efficacy than the non-intervention group.

For both pretest and posttest data, simple correlation analysis revealed positive and statistically significant correlations between each student attitude and efficacy scale and each of the three learning environment scales. Multiple regression analysis showed that the multiple correlation between the set of three learning environment scales and each attitude and efficacy scale separately was statistically significant for both the pretest and posttest data. Standardized regression coefficients revealed that Teacher Support and Task Orientation were significant independent predictors of Value for the pretest data and Involvement and Task Orientation were significant independent predictors of Value for the posttest data. All three learning environment scales were significant independent predictors of Enjoyment for both the pretest and posttest data, but only for pretest data for Academic Efficacy. Posttest analysis showed that Involvement and Task Orientation were significant independent predictors of Academic Efficacy.

Acknowledgements

> "Goals are a means to an end, not the ultimate purpose of our lives. They are simply a tool to concentrate our focus and move us in a direction. The only reason we really pursue goals is to cause ourselves to expand and grow. Achieving goals by themselves will never make us happy in the long term; it's who you become, as you overcome the obstacles necessary to achieve your goals, that can give you the deepest and most long-lasting sense of fulfillment." – Anthony Robbins (2010)

Obtaining my PhD has been a personal goal of mine. I have no grandiose ideas of what it will bring me in earnings or fame in the future. It has brought me great satisfaction by just achieving it. That is enough. I would like to thank the many people who, during the last 4 years, have helped me to reach my goal.

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Chapter 1

INTRODUCTION AND RESEARCH OBJECTIVES

1.1 Overview

In 2001, President George Bush signed into law a directive for education reform known as the No Child Left Behind Act (NCLB). The purpose of this act was to improve reading and mathematics test scores in schools across the United States. To address the NCLB directive in mathematics, Algebra 1 was designated as a high-school graduation requirement in California in 2004. Students are encouraged to take it in eighth grade, but must pass it in order to graduate. “Close to half of California's students don't take algebra by eighth grade, and about 40% who do are not proficient in it by the end of the year” (Goldberg, 2010, p. J4).

Imagine that you are a student who has had difficulty in mathematics throughout elementary and middle school and who is now entering high school, and now you are faced with the prospect of Algebra 1 as the entry-level mathematics class for 9th grade and a requirement for graduation. In Tulare, California, two options exist for that student.

Ninth grade students who are entering into the lowest level of mathematics are either placed in an Algebra 1 class only or placed in an Algebra 1 class as well as an intervention class, Success Lab, based on the recommendation of their grade 8 mathematics teacher and high school counsellor. If they are placed in Algebra 1 (without the intervention class), they are one of at least 30 students in that classroom. The expectation is that they will seek out extra help on their own in order to be successful. If they are placed in Algebra 1 and the intervention class, they will participate in the lesson in Algebra 1 on one day and, during the next day in Success Lab, they will review that material, have time to work on their homework with a teacher nearby, and preview the next day’s Algebra 1 lesson. In addition to this extra help, the class size of the intervention class is no more than 20 students, allowing the teacher to give more individual help.

My involvement in creating and instituting the Success Lab while I was working in the Tulare Joint Union High School District led me to this study. While it seems obvious that the intervention class is likely to yield more successful mathematics students, prior to this study, there has been no formal evaluation of the effectiveness of the Success Lab class.

Therefore, I evaluated the effectiveness of the Algebra 1 intervention class, Success Lab, among high school students in a high school district in Central California with a large Hispanic population and low socioeconomic status. The effectiveness of the Success Lab was evaluated in terms of the students' perceptions of the classroom environment in their Algebra 1 class, their attitudes toward mathematics, and academic efficacy.

1.2 Background to the Study

In 1990, Tulare Union High School began investigating a variety of changes to the school's learning environment in an effort to increase student success. Several issues relating to the school's stakeholders were at the core of this inquiry. The three largest communities from which Tulare Union High School receives students are Tipton, Pixley and Tulare City. These three communities have a high poverty rate, a large proportion of families with a female head of household with no male adult present, and low parental educational attainment (Table 1.1). These factors can influence a child's success in school (Child Trends and Center for Child Health Research, 2004). Some of the negative factors include not having a designated place to study or complete homework quietly, the need to work after school to supplement the family income, few role models who have education as a priority and, many times, the need for the older siblings to supervise younger children while the one parent works. The impact of these factors includes increased absence rates for these children, as well as a lack of time and motivation (internal as well as external) to study or do homework.

One of the innovative changes that Tulare Union High School adopted was to revise its schedule from six 50-minute classes each day to three 120-minute classes meeting every alternate day. This is known as an A/B block schedule. The two-hour block schedule allows for:

- a variety of teaching strategies to be incorporated into the classroom to engage students in different types of learning and to improve student achievement
- increased time for introducing new concepts and material, support activities such as labs, technology use, etc.
- time for students to begin independent or collaborative activities in class
- ample time for teachers to delve deeply into concepts during one period
- students to spend more instructional time in the classroom and less time out of class during passing periods (Berger, 2010).

One of the teacher-perceived problems with block scheduling was that the students with large absence rates and lack of a support for education would get further behind.

Table 1.1 Demographics of the Three Communities that Feed into Tulare Union High School

Demographic	Tulare City	Tipton	Pixley
Percent of families with children under 18 years who are below the poverty level	23.2	23	50.9
Percent of families with a female head of household (no male adult present) and with children	46.9	39.6	87.1
Median Income	$33,637	$26,379	$23,304
Percent of adults over 18 years with less than 9th grade education	18.8	45.5	41.4
Percent of adults over 18 years with grade 9–12 education but no high school diploma	16.1	21.6	19.4

Based on http://www.tularecog.org/census.php

As the chair of the mathematics department and a member of the committee visiting other schools which had already adopted block scheduling, the question of success for lower-ability students arose. Some of the schools had created a 'helper' class for those students. Although the class took many forms, they had common elements: the class was scheduled for the alternate day of the students' mathematics class; and part of the class period was dedicated to the completion of homework.

In 1990, at Tulare Union High School, the students with difficulty in mathematics were placed into a class called Math A, a pre-Algebra class. The first intervention class, Success Lab, was aimed at helping those students to be successful in Math A. As the first teacher of that class, my main goal was to teach basic skills that the students were lacking, review the lesson from the previous day, preview the lesson for the following day and provide a supportive environment in which students could complete homework. It seemed that it was helpful to the students, but no formal evaluation of the effectiveness of this class was undertaken.

In 2000, when the California Department of Education's 'Algebra for all' philosophy began, Algebra 1 became the entry-level mathematics course offered to students in the Tulare Joint Union High School District. Success Lab was retained but its emphasis became supporting students in the Algebra 1 class. The same structure was presented: prerequisite skills were addressed; review and preview of Algebra 1 lessons occurred and time was provided in class for homework help. During the next eight years, a second high school in Tulare began to offer this class and a third new high school also offered Success Lab. I was involved with the class for the next eight years until I retired from the Tulare Joint Union High School District.

I consistently maintained that Success Lab was an effective class in terms of attitudes towards mathematics, in general, and improved perceptions of the Algebra 1 class, specifically. During the time when I was involved with the class, both as an Algebra 1 teacher and a Success Lab teacher, I felt that students in the intervention class became more confident in their ability to solve mathematics problems and more involved in their Algebra 1 class. Informal inspection of student grades in Algebra 1 and informal student testimonies seemed to provide some evidence that the students who were taking both Algebra 1 and Success Lab were more successful in their Algebra 1 class.

With the emphasis on Algebra 1 in California, together with education budget problems, I felt that it was necessary to come to some conclusion as to whether Success Lab was a valuable class to continue offering. Thus, this study was begun.

1.3 Rationale for the Study

The effectiveness of an educational innovation is normally evaluated strictly in terms of achievement results. While the main outcome of an intervention course is improved achievement, evidenced by higher test scores and improved success rates in a course, other important benefits can be gained, such as better student attitudes towards mathematics and improved academic efficacy. Studies have shown that students' achievement can be influenced by their attitudes toward the subject matter as well as their academic efficacy (H. Wong & Wong, 1998). As well, student perceptions of the learning environment have been closely associated with students' attitudes toward the subject matter (Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007).

The early work of Walberg in his evaluation of Harvard Project Physics (Walberg & Anderson, 1968) led the way for using learning environment criteria when evaluating educational innovations at all levels of education throughout the world. Learning environment instruments have allowed researchers to quantify important aspects of a classroom environment such as teacher support, involvement, task orientation, and equity, and to find associations between these scales and student outcomes of attitudes toward mathematics and academic efficacy. I chose to evaluate the effectiveness of Success Lab through the use of selected scales from the What Is Happening In this Class? (WIHIC) (Fraser, Fisher, & McRobbie, 1996) learning environment instrument, two scales from the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004), and an academic efficacy scale from the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1996). The histories of these questionnaires are discussed in Chapter 2, Sections 2.3.8, Section 2.4 and Section 2.5. More details regarding these instruments and scales are provided later in Sections 3.3 and 3.4.

1.4 Significance of the Study

The present study is the first to consider the learning environment in Algebra 1 classrooms as a criterion of effectiveness. My study is significant to the field of learning environment in that it is the first to investigate the effect of participation in an Algebra 1 intervention class in terms of students' perceptions of learning environment, attitudes toward mathematics and academic efficacy. In addition, it adds to the body of knowledge regarding associations between perceptions of the learning environment in the Algebra 1 class and student outcomes of attitudes toward mathematics and academic efficacy.

Educators are always trying to improve student success, usually in the form of course pass rates and test scores. The No Child Left Behind Act's directive to make Algebra 1 a graduation requirement for all students in the United States has provided an additional level of pressure on teachers to find ways to help students be successful. Educational innovations involving Algebra 1 should be evaluated to gauge their effectiveness and to guide further implementation decisions. Although the effectiveness of a class or program is most often viewed in terms of increased academic achievement as evidenced by end-of-course grades or test scores, there are other variables that can influence that one goal. Student attitudes toward mathematics, as well as academic efficacy, have been shown to be influential in improving achievement.

The results of this study will be beneficial to curriculum specialists, educators and researchers in that they will provide evidence of the degree of success of a model for an Algebra 1 intervention. Teachers could benefit from my study's findings through a better understanding of which types of behaviours are associated with improved perceptions, attitudes and beliefs, thereby helping their students become more successful in Algebra 1.

1.5 Purpose of the Study

The purpose of the study was to evaluate the effectiveness of an Algebra 1 intervention class, Success Lab, in terms of students' perceptions of the learning environment in Algebra 1, attitudes toward mathematics and academic efficacy.

Associations between the learning environment in Algebra 1 and the student outcomes of attitudes toward mathematics and academic efficacy were investigated to identify ways to improve students' attitudes toward mathematics and academic efficacy through changing the classroom environment.

A second purpose was to determine if a learning environment questionnaire based on scales from the What Is Happening In this Class? (WIHIC) questionnaire, the Attitudes Toward Mathematics Inventory (ATMI), and the Patterns of Adaptive Learning Scales (PALS) was valid when used with grade 9 mathematics students in central California.

1.6 Research Questions

The following three research questions were investigated:

1. Is it possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy?
2. How effective is Success Lab in terms of the learning environment and students' attitudes toward mathematics and academic efficacy?
3. Are there associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy?

1.7 Overview of the Thesis

This thesis is comprised of five chapters. Chapter 1 provided a background to the study, including information about the Algebra 1 intervention class, Success Lab, as well as the rationale for the study. The significance and purpose of the study were discussed and the three research questions were delineated.

Chapter 2 comprehensively reviews literature on learning environment, attitudes toward mathematics and academic efficacy. The development, history, and validation of learning environment instruments are reviewed, with an emphasis on the instrument chosen for this study: the What Is Happening In this Class? (WIHIC). The Attitudes Toward Mathematics Inventory (ATMI) and the Patterns for Adaptive

Learning Scales (PALS) are also reviewed in this chapter. A review of past research involving the evaluation of education innovations and associations between learning environment and student outcomes concludes the chapter.

Chapter 3 presents the research methodology used in this study. The instruments chosen, along with modifications, are discussed. It also describes the design, samples, and methods of data analysis used in this study. The chapter concludes with a discussion of the limitations of this study.

Chapter 4 reports the data analyses and results for the study, including: validation of the questionnaires; investigation of whether the Algebra 1 intervention class, Success Lab, is effective in terms of learning environment and students' attitudes toward mathematics and academic efficacy; and associations between the learning environment and students' attitudes toward mathematics and academic efficacy.

Chapter 5 concludes the thesis with an overview of the whole thesis. A discussion of the major findings, limitations and biases, and implications of my research is the foundation of this chapter. Recommendations for future research into the long-lasting effects of participation in an intervention class and other intervention programs are made.

Chapter 2

REVIEW OF THE LITERATURE

2.1 Introduction

Students who have trouble in mathematics are at risk of failing, becoming discouraged, and eventually dropping out of mathematics altogether (California Mathematics Framework, 2005). Algebra 1 is the mathematics course in California that determines whether a high-school student will graduate or not. Students not only must pass an Algebra 1 course, but also two-fifths of the mathematics portion of the California High School Exit Examination (CAHSEE) consists of algebra items. Although in California Algebra 1 has been designated as an eighth grade course, many students come to high school having failed it and being at risk of failing Algebra 1 again. In order to help these at-risk students, the California Department of Education has recommended intervention programs, one which is an extended-time model in which students are also placed in an intervention class. Three comprehensive high schools in the Tulare Joint Unified High School District in California have adopted this model by implementing an Algebra 1 intervention class, Success Lab.

Students with positive attitudes toward mathematics are more motivated to study, which often results in higher grades, which reinforces their positive attitudes toward mathematics (Aiken, 2002). Students who develop a strong sense of efficacy have the ability to approach challenges better and have more intrinsic motivation (Aiken, 2002). While the main outcome of an intervention course is improved achievement, other important benefits can be gained, such as better attitudes toward mathematics and improved academic efficacy. This study involved evaluating the effectiveness of the Success Lab class in terms of the learning environment and students' attitudes toward mathematics and academic efficacy.

This chapter reviews literature relevant to my study, especially research involving the three instruments used in my study. Section 2.2 reviews the history of learning environments. A discussion of the development of learning environment instruments follows in Section 2.3, especially a more in-depth discussion of the What Is Happening In this Class? (WIHIC) (Fraser et al., 1996) used in my study (Section 2.3.8). The history of research on attitudes toward mathematics, with an emphasis on the instrument used in my study, the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004), follows in Section 2.4. A review of research on academic efficacy, including studies using the Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 1996), is discussed in Section 2.5. Section 2.6 reviews past areas of research in the field of learning environments and their connections to my study: intervention programmes in mathematics (Section 2.6.1); and associations between learning environments and student outcomes (Section 2.6.2).

2.2 Historical Background of Learning Environments Field

> Educators often rely exclusively on assessing achievement and pay scant attention to the quality of the learning environments. Teachers should not feel that it is a waste of valuable teaching time to put energy into improving their classroom climates because the research convincingly shows that attention to classroom environment is likely to pay off in terms of improving student outcomes. (Fisher, Aldridge, Fraser, & Wood, 2001, p. 1)

Learning environment research involves "the social, psychological, and pedagogical contexts in which learning occurs and which affect student achievement and attitudes" (Fraser, 1998a, p. 3). Learning environment research has its roots in studies which go back more than 70 years to when Lewin (1936) recognized the importance of environments by suggesting that an individual's behaviour is determined by the interaction of personal characteristics with the environment.

Prior to the development of learning environment instruments, studies were conducted with observation techniques and perceptions of the viewer. In 1938, Murray classified perceptions as *beta press*, the perceptions of the environment by participants, and *alpha press,* the view of an outside observer. Stern, Stein and Bloom (1956) expanded these classifications for *beta press* to involve either *private beta press*, the perceptions of a specific individual in an environment, or *consensual beta press,* perceptions of the collective group as a whole. These classifications of perceptions led to analysis of data from a variety of viewpoints for different levels of statistical data analysis, including the whole class or the individual student.

In the late 1960s, Herbert Walberg and Rudolf Moos pioneered the development of instruments to measure perceptions of environments (Moos, 1974). Studies of the social climate of psychiatric wards (Houts & Moos, 1969), state mental hospitals (Gripp & Magaro, 1971), and correctional schools (Moos & Houts, 1968; Wenk & Moos, 1972) led to Moos' development of a theory to sort human environment dimensions into three areas. *Relationship dimensions* are those relating to the nature and intensity of personal relationships. *Personal development dimensions* refer to the path through which knowledge development progresses. *System maintenance and system change dimensions* refer the orderliness, clarity, control and responsiveness to change in the environment (Moos & Trickett, 1987). These three areas of human environment dimensions were instrumental in leading the way for the study of learning environments. Moos' studies led to the development of the Classroom Environment Scale (CES) (Moos & Trickett, 1974, 1987) which allowed researchers to study the specific learning environment related to schools.

Walberg developed the Learning Environment Inventory (LEI) to assess students' perceptions of their learning environment during the research and evaluation phase of Harvard Project Physics (Walberg & Anderson, 1968). The early works of Lewin and Murray, along with the contributions by Moos and Walberg, formed the basis for the beginning of the study of learning environments. For the next 30 years, as more studies were conducted, the field of learning environments gained international acceptance and became established as an important area to be studied. This validation of learning environment as a field of study led to the journal *Learning Environments Research: An International Journal* (Fraser, 1998a) and books on learning environment such as *Contemporary Approaches to Research on Learning Environments: Worldviews* (Fisher & Khine, 2006). Extensive literature reviews focusing on learning environments include chapters in the *Handbook of Research on Science Education* (Fraser, 2007) and, most recently, the *Second International Handbook of Science Education* (Fraser, in press).

2.3 Development of Learning Environment Research Instruments

The development and use of learning environment instruments has expanded since the LEI and CES were developed for use in the USA in the late 1960s (Moos, 1979;

Walberg & Anderson, 1968). It is interesting to note that, although the field of learning environments has spread internationally as well as into various subject areas, Moos' three areas (relationship, personal development, and system maintenance and system change) have continued to be a major influence.

As research grew internationally, the LEI and CES were translated into other languages. Walberg, Singh and Rasher's (1977) study in Rajasthan, India with 166 groups of students in 83 general science classes and 134 similar groups in 67 social studies classes used a version of the LEI, translated to Hindi, to examine measures of student perceptions of the social environment of learning. The learning environment of 989 twelfth grade physics students in 31 classes in Thailand was measured with a Thai version of the LEI to predict three attitudinal outcomes (Chatiyanonda, 1978). It was found that attitudes to physics learning were more favourable with classes perceived as having less friction. A 1979 study of elementary classrooms in Indonesia using the CES and three scales of the LEI revealed that an individual's positive attitude was enhanced in classrooms perceived as having greater task orientation, competition and difficulty and less order and organisation, while achievement was enhanced in classes higher in speed and lower in order and organisation (Paige, 1979).

Table 2.1 summarizes various learning environment instruments and shows the classification of each scale according to Moos' scheme. The following sections describe historically-important learning environment instruments and provide information on their development. Section 2.3.1 focuses on a review of literature about the My Class Inventory (MCI), and this is followed by Section 2.3.2, which provides a description of the background and development of the Individualised Classroom Environment Questionnaire (ICEQ). A review of the literature about the College and University Classroom Environment Inventory (CUCEI) (Section 2.3.3), the Questionnaire on Teacher Interaction (QTI) (Section 2.3.4), the Science Laboratory Environment Inventory (SLEI) (Section 2.3.5), and the Constructivist Learning Environment Survey (CLES) (Section 2.3.6) follows. Section 2.3.7 describes learning environment questionnaires that pertain to technology-based classrooms. Section 2.3.8 is a review of the literature on the chosen learning environment instrument in my study, the WIHIC.

Table 2.1 Scales from 12 Learning Environment Instruments for Educational Settings Classified According to Moos' Scheme

Instrument	Date Developed & Authors	Items per Scale	Scales Classified According to Moos' Scheme: Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	1968 Walberg & Anderson	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisations Democracy
Classroom Environment Scale (CES)	1974 Moos	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	1979 Rentoul & Fraser	10	Personalisation Participation	Independence Investigation	Differentiation
College and University Classroom Environment Inventory (CUCEI)	1986 Fraser & Treagust	10	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	1990 Creton, Hermans, & Wubbels	8–10	Leadership Helpful/Friendly Understanding Student Responsibility and Freedom Uncertain Dissatisfied Admonishing Strict		
Science Laboratory Environment Inventory (SLEI)	1995 Fraser, Giddings & McRobbie	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	1995 Taylor, Dawson & Fraser	7	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In this Class? (WIHIC)	1996 Fraser, McRobbie & Fisher	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity
Computer Laboratory Environment Inventory (CLEI)	1997 Newby & Fisher	5	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Distance and Open Learning Environment Scale (DOLES)	1998 Jegede, Fraser, & Fisher	5	Student Cohesiveness Teacher Support Personal Involvement	Task Orientation	Flexibility Material Environment Home Environment
Web-Based Learning Environment Instrument (WEBLEI)	2003 Chang & Fisher	4	Access Response	Interaction	Results
Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)	2003 Aldridge, Fraser, & Fisher	10	Student Cohesiveness Teacher Support Involvement Young Adult Ethos	Task Orientation Investigation Cooperation Differentiation	Equity Computer Usage

Adapted from Fraser (1998a)

2.3.1 My Class Inventory (MCI)

The My Class Inventory (MCI) was developed as a simplified form of the LEI to be used with younger children. The items are written at a lower reading level and the questionnaire is easily administered and hand scored. In addition, the MCI requires children to circle ‘yes’ or ‘no’ representing either ‘agreement’ or ‘disagreement’ for each item rather than the 5-point Likert scale of the LEI. A short form of the MCI was validated by Fraser and O’Brien (1985) with data from a sample of 758 grade 3 students from 32 classrooms in eight schools in the suburbs of Sydney.

The MCI has been found to be valid and useful in research applications with primary students in Singapore (Goh & Fraser, 1998, 2000). Although the MCI was developed to be used with primary students, its lower reading level makes it a good instrument for junior high students with reading difficulties. The factorial validity of the MCI was validated with secondary school mathematics students in Brunei Darussalam (Majeed, Fraser, & Aldridge, 2002).

Mink and Fraser’s (2005) evaluation of a K–5 mathematics program which integrated children’s literature was one of the first studies to evaluate an educational innovation using learning environment criteria. The MCI was used to gather data from 120 grade 5 students whose teachers had participated in a program integrating science and mathematics with literature. The results showed that the student of the teachers participating in the program had improved attitudes to mathematics and reading.

In Washington state, a revised 18-item MCI-short form was administered to 2800 grade 4–6 students from 20 schools to evaluate the feasibility of its use as an assessment tool in comprehensive school counselling programs (Sink & Spencer, 2005). Moderate scale reliability and factorial validity of this revised form were confirmed. A study using the MCI, conducted in Texas, with a sample of 588 grade 3–5 students, evaluated the effectiveness of instruction using a textbook, science kits, or a combination of both (Scott Houston, Fraser, & Ledbetter, 2008). Analysis of the data attested to the factorial validity and reliability of the MCI and suggested that using science kits was associated with a more positive learning environment.

2.3.2 Individualised Classroom Environment Questionnaire (ICEQ)

The Individualised Classroom Environment Questionnaire (ICEQ) was developed to assess those dimensions which distinguish individualised classrooms from conventional ones (Fraser, 1990). The ICEQ was validated through interactions with junior high and secondary students and teachers. Rentoul and Fraser (1980) analysed data from 225 junior high students in 15 classes in Sydney, Australia and found that student enjoyment of lessons was higher in classrooms which were perceived as having greater personalization and participation.

Further research using the ICEQ include: Wierstra's (1984) study of 398 15–16 year old students in 9 classes in the Netherlands; Fraser and Butts' (1982) validation with 712 students in 30 junior high school classes in Sydney, Australia; Fraser, Nash and Fisher's (1983) work with 116 grade 8 and 9 science students in Tasmania, Australia; and Fraser and Fisher's (1982) research involving 116 grade 8 and 9 science classes, also in Tasmania.

The ICEQ has been found to be valid and reliable in developing countries with early studies including Fraser, Pearse and Azmi's (1982) study in Indonesia with 373 grade 8 and 9 students in 18 social science classes. Using satisfaction and anxiety as student outcomes, they found that students' perceived satisfaction was greater in classes with less independence and greater involvement, while anxiety was reduced in classes with perceived greater differentiation and involvement.

Using the ICEQ, Asghar and Fraser (1995) investigated associations between students' attitudes and their classroom environment perceptions at the lower secondary school level in Brunei Darussalam. In this study, they found that classroom environment dimensions were predictors of students' attitudinal outcomes.

A more recent modified version of the ICEQ was developed to assess the effectiveness of laptop computers. The Science Classroom Environment Survey (SCES), based on the short form of the ICEQ, was administered to 863 grade 8 and 9 science students in 44 classrooms in 14 independent schools in four Australian states.

Of these 14 schools, only one had used laptop computers for three years or more and provided the 433 students from 23 science classes to compare to 430 students in 21 non-laptop science classrooms from the other schools (Stolarchuk & Fisher, 2001). The reliability and validity of the SCES for science laptop classroom research were confirmed and data indicated that laptops appeared to have little effect on students' perceptions of science classroom environment. The students from the laptop science classroom environment were found to have more positive attitudinal outcomes, however.

2.3.3 College and University Classroom Environment Inventory (CUCEI)

Most of the classroom learning environment research prior to the late 1980s was conducted with primary and secondary students. Fraser and Treagust (1986) developed the College and University Classroom Environment Inventory (CUCEI) for use in seminars in higher education. An action-research study of preservice teachers and their primary school students' perceptions of the classroom learning environment was conducted at Queensland University of Technology using the CUCEI (Yarrow, Millwater, & Fraser, 1997).

In the first evaluative study using both student perceptions of classroom environment and teacher perceptions of school environment within the same study, Fraser, Williamson and Tobin (1987) focused on a specific type of alternative high school in Australia. These 'Senior Colleges' catered to adult learners who were returning to complete their schooling. 536 students from 45 classes were administered the CUCEI. Student data revealed that, when compared to a control group, the alternative high school students perceived their classes as having greater involvement, satisfaction, innovation, and individualisation.

2.3.4 *Questionnaire on Teacher Interaction (QTI)*

In the early 1990s, researchers in the Netherlands began studies of the nature and quality of interpersonal relationships between teachers and students (Creton, Hermans, & Wubbels, 1990; Wubbels, Brekelmans, & Hooymayers, 1991). The Questionnaire on Teacher Interaction (QTI) was first used at the senior high level in the Netherlands but has also been used at various grade levels in the USA (Wubbels, 1993). The QTI assesses student perceptions of eight teacher behaviour aspects (Leadership, Helpful/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict). Comparative work by Wubbels and Levy (1993) provided cross-validation of the QTI at various grade levels in the USA.

In Indonesia, a study involving 422 private University students from 12 classes validated a modified and translated version of the QTI and investigated associations between students' perceptions of instructor-student interactions and the student outcomes of achievement and attitudes (Fraser, Aldridge, & Soerjaningsih, 2010). Data from 7484 grade 9–11 students from 278 science classes in Turkey confirmed the reliability and validity of a Turkish adaptation of the QTI (Telli, den Brok, & Cakiroglu, 2007). Results of the data analysis indicated that Turkish teachers were perceived by their students as very cooperative and moderately dominant.

In an effort to investigate different aspects of senior high science classroom environments in Korea, Lee, Fraser and Fisher (2003) conducted a study using a version of QTI translated into Korean as well as the Constructivist Learning Environment Survey and the Science Laboratory Environment Inventory. All three instruments were validated using numerous statistical analyses. A sample size of 439 grade 10 and 11 students provided data that was used to improve teacher-student interactions in Korean senior high schools. In another study in 12 different Korean schools with 543 students (Kim, Fisher, & Fraser, 2000), a Korean version of the QTI was validated. The WIHIC and QTI were used to investigate associations between student attitudes to science and their perceptions of the classroom environment. Gender-related differences in students' perceptions were also found in this study, with boys having more positive perceptions of their science classroom learning environment and teacher interpersonal behaviour and attitudes toward their science classes.

Scott and Fisher (2004) employed an elementary version of the QTI along with a scale for Enjoyment of Science Lessons, translated into Standard Malay, in a study of associations between student-teacher interpersonal behaviours and achievement based on an external science examination at the end of the school year. 3104 upper primary students from 136 classrooms in Malay-speaking elementary schools in Brunei Darussalam participated in this study. The Malay version of the QTI was confirmed to be valid and reliable for those students in Brunei (Scott & Fisher, 2004).

160 students from four classes in the southwest part of China were asked to assess their teachers' interpersonal behaviour in the first successful use of a Chinese translated version (Wei, den Brok, & Zhou, 2009). Statistical analysis of the data showed this Chinese translation to be valid and reliable when used with these students. A modified QTI instrument, the Principal Interaction Questionnaire (PIQ), was created to study a principal's interaction with teachers (Creswell & Fisher, 1999).

2.3.5 Science Laboratory Environment Inventory (SLEI)

In 1991, the Science Laboratory Environment Inventory (SLEI) was developed as an instrument that could be used to study science laboratory classrooms (Fraser, Giddings, & McRobbie, 1992, 1995). The SLEI assesses five dimensions of classroom environment, namely, Student Cohesiveness, Open-Endedness, Integration, Rule Clarity, and Material Environment. A new Personal form of the SLEI, as well as the Class form was administered to 5447 students in 269 senior high schools and university classrooms in six countries, namely, the USA, Canada, Australia, England, Israel, and Nigeria, in a cross-national field testing. The actual and preferred versions were found to be valid for either the individual or the class mean as the unit of analysis. The SLEI was also found valid in each of the six countries involved in the field testing (Fraser et al., 1992). It was then cross-validated in Australia with 1594 senior high school students in 92 classes. In addition to proving both forms were valid and reliable, several applications of these two forms were investigated (e.g.: gender differences in student perceptions when comparing both forms).

The SLEI was further validated with data from 761 grade 9 and 10 students in 26 science classrooms in a suburban public high school in southeastern United States. 558 of these students were tested in pretest/posttest study for achievement in Biology and a further group of 158 students, honours students in the researcher's biology class, provided data which was used to evaluate students' perceptions of the science classroom after participating in an integrated mathematics and science lesson on human body measurements (Lightburn & Fraser, 2007). Results of this study indicate that students' attitudes to science are more favourable in laboratory classes where there is a strong integration between concepts covered in theory classes and laboratory classes. Working in cooperative groups was also found to promote positive attitudes.

The SLEI was translated into Korean and administered to 439 grade 10 and 11 students in Korean senior high schools to investigate the perceptions of students in these different types of classrooms, some science and some humanities (Fraser & Lee, 2009). Data analysis suggested that students in the science-independent stream had more favourable perceptions of their science laboratory classroom environment than did students from the other two streams (science-oriented and humanities). The validity of the CLES was confirmed for use among Korean high school students.

A sample of 489 students from 28 senior biology classes in eight schools in Tasmania participated in a study investigating associations between students' perceptions of their biology teachers' interpersonal behaviour and their laboratory learning environment and student outcomes of attitude, achievement and performance in laboratory practicum (Henderson, Fisher, & Fraser, 2000). Data analysis revealed that associations with students' perceptions of the learning environment were stronger for the attitudinal outcomes than for their achievement or practicum outcomes.

2.3.6 Constructivist Learning Environment Survey (CLES)

At about the same time as the SLEI was developed, the Constructivist Learning Environment Survey (CLES) was developed to assist researchers and teachers in studying the learning environment of a constructivist science or mathematics classroom. The results can help teachers reshape their teaching practice to be more consistent with that type of classroom (P. C. Taylor, Fraser, & Fisher, 1997).

Aldridge et al. (2000) conducted a cross-national study of high school science classrooms in Australia and Taiwan to validate English and Chinese versions of the CLES. 1081 students from 50 classes in Australia and 1879 students from 50 classes in Taiwan participated in this study that involved six Australian and seven Taiwanese science education researchers. Data analyses confirmed that both the English and Mandarin versions of the CLES were valid and reliable.

Peiro and Fraser's (2009) research study using data collected from kindergarten students in an action-research study in Peiro's own classroom provided validation data for a modified English and Spanish version of the CLES. Additionally, in this study, 739 students in grade K–3 from two area schools in Miami-Dade County, Florida, participated in four phases to ensure that the modified and translated instruments were valid and reliable.

A derivative of the CLES was developed to monitor the quality of online teaching and learning. The Constructivist On-Line Learning Environment Survey (COLLES) (P. C. Taylor & Maor, 2000) was designed as an electronic questionnaire to monitor student's preferred online learning environment and compare it with his actual experience. The first study was with a group of distance online education students studying a Master's level unit on Multimedia in Science and Mathematics Education at Curtin University. The COLLES has become popular as an online survey instrument accessible through Modular Object-Oriented Dynamic Learning Environment (Moodle) (http://moodle.org), an open source software program (Dougiamas & Taylor, 2002).

Nix, Fraser and Ledbetter (2005) developed a new form of the CLES, namely, the CLES-Comparative Student version. Using this version, data from 1079 students from 59 classes in Texas were collected to evaluate the classroom impact of teachers' participation in a long-term professional development program based on constructivist principles. Analyses of data confirmed internal consistency, reliability, and discriminant validity for the CLES in this study.

Data from 1864 students in 43 classes were analysed to assess the validity and reliability of the CLES when used in South Africa (Aldridge, Fraser, & Sebela, 2004). In this study, students' perceptions of the constructivist emphasis in their science classrooms were measured to see if there was a change after a 12-week action-research intervention with their teachers. Validity and reliability were confirmed for the CLES when used in mathematics classes in South Africa.

2.3.7 Technology-based Classroom Learning Environment Questionnaires

Technology has created new types of classroom environments in education. Because computer laboratories could not be fully evaluated using existing learning environment instruments, the Computer Laboratory Environment Inventory (CLEI), based on the SLEI, was developed to study computer laboratory learning environments (Newby & Fisher, 1997). In 1998, the Distance and Open Learning Environment Scale (DOLES) was developed (Jegede, Fraser, & Fisher, 1998). The Web-based Learning Environment Instrument (WEBLEI) was developed to examine on-line courses in higher education (Chang & Fisher, 2003).

The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) was developed in 2003 to give educators a way to evaluate the environment of an outcomes-based course. The TROFLEI includes all WIHIC scales (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity) and three extra scales (Differentiation, Computer Usage and Young Adult Ethos). Data obtained from a sample of 1,249 high school students from Western Australia and Tasmania who responded to both the actual and preferred forms of the TROFLEI provided strong evidence of the sound psychometric properties of this new learning environment instrument

(Aldridge, Dorman, & Fraser, 2004). In Aldridge and Fraser's (2008) recent book, *Outcomes-Focused Learning Environments*, the learning environment of a school with an outcomes-based focus was investigated using the TROFLEI.

Research conducted with 4146 students from 286 classes in Australian secondary schools was used to further validate the TROFLEI and establish a typology of classrooms based on students' perceptions of classroom environment (Dorman, Aldridge, & Fraser, 2006). In addition, the development and validity of the TROFLEI is discussed in detail in Aldridge and Fraser's (2008) recent book. Data from 1035 students from 80 senior high classes were investigated to describe successes and challenges of an innovative new post-compulsory secondary school in creating an outcomes-focused curriculum.

2.3.8 What Is Happening In this Class? (WIHIC)

In this section, the learning environment instrument used in my study, the What Is Happening In this Class? (WIHIC) is discussed. The development of the WIHIC is discussed in Section 2.3.8.1. Recent studies using the WIHIC are reviewed below for the elementary-school level in Section 2.3.8.2, for the middle-school level in Section 2.3.8.3, for the secondary-school level in Section 2.3.8.4 and for the university level in Section 2.3.8.5.

2.3.8.1 Development of the What Is Happening In this Class? (WIHIC)

The What Is Happening In this Class? (WIHIC) questionnaire is a relatively recent instrument containing additional scales of equity and constructivism which make it more relevant to current classrooms. Two forms, Class and Personal, allow researchers to distinguish between the *private beta press*, an individual's view of the environment, and the *consensual beta press* which is the view that a group has of an environment (Stern et al., 1956). Each of those two forms has two versions: the actual classroom and the preferred classroom. The WIHIC has been translated into and cross-validated in several languages (Aldridge & Fraser, 2000; Aldridge, Fraser, & Huang, 1999; Aldridge, Fraser, & Ntuli, 2009; Allen & Fraser, 2007) and used in studies of science, mathematics and geography classes in junior and senior high schools (Chionh & Fraser, 2009; Dorman, 2008; Ogbuehi & Fraser, 2007).

The original WIHIC, containing nine scales and 90 items, was refined in a study of 355 junior high school students (Fraser et al., 1996). After extensively interviewing students, seven scales and 54 items comprised this second version. It was field tested in Australia and in Taiwan using a translated version (Aldridge et al., 1999). The final form of the WIHIC emerged, with seven scales and 56 items. Table 2.2 lists these final seven scales and provides a sample item and description of each scale.

The seven scales contained in WIHIC measure perceptions across the three dimensions proposed by Moos (1974): relationship, personal development, and system maintenance and system change. The WIHIC measures the *relationship dimension* using the scales of Student Cohesiveness, Teacher Support, and Involvement, the *personal development dimension* using the Investigation, Task Orientation, and Cooperation scales, and *system maintenance and system change dimension* using the Equity scale.

2.3.8.2 Elementary-School Studies with WIHIC

Many studies using the WIHIC focused on the elementary school. Validity for the WIHIC was confirmed when used in a study of a two-year science mentoring program for beginning elementary school teachers and their 573 grade 3–5 students in a large, culturally- and ethnically-diverse urban school district in the United States (Pickett & Fraser, 2009). In the study, a positive change in students' perceptions of the learning environment was associated with teacher training.

MacDowell-Goggin (2005) investigated the effects of technology on primary education students' perceptions of their science learning environment with 860 grade 4–6 students in Miami. Strong associations were found between most of the WIHIC scales and students' positive perceptions of their science classes. It was found that the modified version of the WIHIC exhibited satisfactory factorial validity and internal consistency reliability when used with this sample of students.

Khine and Fisher (2001) used the WIHIC in Brunei to study the classroom environment and teachers' cultural background with 1188 students from 54 science classes in ten schools. The study revealed that teachers from different cultural backgrounds created different types of learning environments. The study showed the WIHIC is a reliable and valid instrument for use in Brunei.

Using translated versions of the WIHIC in different languages has widened the use and validity of the instrument and opened the learning environment studies research to include non-English speaking participants. Using a Spanish translation of the WIHIC, Soto-Rodriguez and Fraser (2004) studied 1105 grade 2–5 students and concluded that limited English proficient students perceived their learning environment less favourably than English proficient students. In South Florida, data gathered from 520 grade 4–5 students and 120 parents in three schools using two modified and Spanish translated versions of the WIHIC were analysed (Allen & Fraser, 2007). Researchers reported that students and parents preferred a more favourable learning environment than they actually perceived. It was also found that parents' perceptions of the actual learning environment were less favourable than those of students. Both studies established the validity and reliability of Spanish versions of the WIHIC when used in the United States with elementary school students.

Table 2.2 Sample Item and Scale Description for Each Scale in the WIHIC (What Is Happening In this Class?)

Scale Name	Sample Item	Description
Student Cohesiveness	I work well with other class members.	Extent to which students know, help, and support each other.
Teacher Support	The teacher goes out of her/his way to help me.	Extent to which the teacher helps, befriends, trusts, and shows interest in students.
Involvement	I discuss ideas in class.	Extent to which students have attentive interest, participate in discussions, perform additional work, and enjoy the class.
Investigation	I carry out investigations to answer the teacher's questions.	Emphasis on the skills and processes of inquiry and their use in problem solving and investigation.
Task Orientation	I pay attention during this class.	Extent to which it is important to complete activities planned and to stay on the subject matter.

Cooperation	I work with other students in this class.	Extent to which students cooperate, rather than compete, with each other on tasks.
Equity	I am treated the same as other students in this class.	Extent to which students are treated equally by the teacher.

Based on Aldridge, Fraser & Huang (1999)

A modified version of the WIHIC in Spanish and English was given to 172 kindergarten students and 92 parents and was found to be valid and reliable (Robinson, 2003). In this study, significant associations between kindergarten student's perceptions of their classroom learning environment and student outcomes of achievement and attitudes towards science were found. Adamski, Peiro and Fraser's (2005) study of 223 grade 4–6 students also used a Spanish version of the WIHIC.

In South Africa, Aldridge, Fraser and Ntuli (2009) confirmed the validity of an IsiZulu version of the WIHIC with data from their study of teachers using action research on their teaching practice in their school classrooms in South Africa. Data from 1077 primary students was analysed to evaluate a 12-week intervention program.

2.3.8.3 Middle-School Studies with WIHIC

Evaluating an innovative teaching strategy for enhancing the classroom environment, students' attitudes and conceptual development was the purpose of a study in California (Ogbuehi & Fraser, 2007). Data were collected from 661 inner-city middle-school mathematics students from 22 classes using three instruments (CLES, WIHIC and TOSRA). Another study in California used WIHIC data from 665 middle-school science students in 11 schools in investigating the influence of gender, socioeconomic status, ethnicity and class size on perceptions of classroom learning environment (den Brok, Fisher, Rickards, & Bull, 2006). Azimioara and Fraser (2007) analysed data from 499 middle school mathematics students from 22 classes in California to evaluate the effectiveness of increased allocated instruction time in algebra classes in terms of learning environment, achievement and attitudes. These studies supported the WIHIC’s validity and reliability for use with middle school students in California.

Using the WIHIC, Wolf and Fraser (2008) evaluated the use of inquiry teaching in science using 1434 New York students from 71 middle-school classes by comparing student perceptions’ of inquiry and non-inquiry science classes. Data analyses supported the WIHIC's factorial validity and internal consistency reliability for middle-school students in New York. A teacher professional development program that integrated technology into mathematics and science lessons was the focus of a study using a sample of 759 students of seven mathematics/science teachers in one middle school in Florida (Biggs, 2009). When scales from the CLES and WIHIC were used in this study, results supported the validity and reliability of the learning environment scales chosen for assessing perceptions of the classroom environment among middle-school mathematics/science students in Miami-Dade County, Florida.

A cross-validation study of the WIHIC in English and Chinese was conducted with 1081 middle school Australian students from 50 classes and 1879 middle school Taiwanese students from 50 classes (Aldridge & Fraser, 2000; Aldridge et al., 1999). Six Australian and seven Taiwanese researchers participated in this study which involved independent back translation of the instrument with the instrument proving to be valid in both English and Chinese. It was found that social and cultural expectations of the teacher’s role in the classroom hindered teachers’ initiative to create more positive learning environments.

The validity of a Korean version of the WIHIC was confirmed in a study of gender differences in classroom environment, interpersonal teacher behaviour, and the student outcome of attitude (Kim et al., 2000). Data collected from a sample of 543 grade 8 students in 12 schools in metropolitan and rural areas of Korea were analysed to reveal gender-related differences in students’ perceptions of their learning environments and teacher interpersonal behaviour. Statistically significant differences were found between boys’ and girls’ perceptions of the learning environment, with boys perceiving more Teacher Support, Involvement, Investigation, Task Orientation, and Equity than did girls.

2.3.8.4 Secondary-School Studies with WIHIC

In the first study to investigate the connection between learning environments and the attitudes that students hold toward their teachers, the WIHIC and two attitude and anxiety instruments were used to collect data from 745 grade 9–12 students from 34 mathematics classes in four high schools in Southern California (B. A. Taylor, 2004). Results indicated that girls perceived a more positive learning environment in **mathematics** than boys perceived. The WIHIC was found to exhibit good reliability and factorial validity in mathematics classrooms in Southern California.

The WIHIC was used by Zandvliet and Fraser (2005) in a study in Australia and Canada among 1404 students from 81 classes in investigating the effects of educational Internet use in classroom settings. In another secondary school study in Canada, Raaflaub and Fraser (2002) investigated 1173 students' perceptions of the environment in mathematics and science classrooms when laptop computers are used. Data analyses revealed that male and female students perceived the actual learning environment much the same but females preferred less computer usage than boys. The actual and preferred versions of the WIHIC proved to be valid and reliable for use in this context.

Most secondary-school studies using the WIHIC have focused on science classrooms. An English version of the WIHIC was cross-validated in Brunei with a sample of 644 grade 10 chemistry students (Riah & Fraser, 1998). Castillo (2007) analysed data from 600 grade 9 and 10 science students in order to investigate grade-level and ethnic differences in classroom environment perceptions. A study by Dorman (2008) involved a sample of 978 students from 63 classes in Queensland in investigating the construct validity of the actual and preferred forms of the WIHIC. Analyses provided validation evidence for both forms of the WIHIC, thereby allowing researchers to use these instruments with confidence (Dorman, 2008).

The WIHIC was chosen as the learning environment questionnaire in several recent studies of associations between students' grade level, gender and ethnicity and their perceptions of the classroom learning environment. In one study, data collected from grade 9 and 10 biology students in North Carolina revealed that students in higher grades perceived more cooperation than students in lower grades, and that there were no statistically significant differences in perceptions between African-American students and other students (Moss & Fraser, 2002). The WIHIC's *a priori* factor structure, internal consistency reliability, discriminant validity and ability to differentiate between the perceptions of students in different classrooms were confirmed when used with this sample.

Several recent studies investigated differences in WIHIC scores according to student gender and ability. Hoang (2008) validated the WIHIC in a study involving 600 grade 9 and 10 mathematics students in 30 classes in one high school in California and identified gender as a key predictor of students' perceptions of their learning environment. When Kilgour (2009) collected data from 581 upper- and lower-stream year 9 and year 10 mathematics students from 36 classes at seven Christian schools in four Australian states, he found that lower-stream students had more negative perceptions of classroom learning environment and wanted less change. Students' perceptions of teacher support, task orientation and equity worsened as they moved from year 9 to year 10. A study in Bursa, Turkey revealed that girls perceived their biology classrooms as being more task oriented and having more teacher support and equity than their male classmates. This study, involving 1474 grade 9–11 students from 52 classes in four schools (Telli, den Brok, Tekkaya, & Cakiroglu, 2009), showed the WIHIC to be valid and reliable for use with Turkish secondary-school students.

The WIHIC was validated for assessing actual and preferred classroom environment among geography and mathematics in Singapore in a study by Chionh and Fraser (2009). Associations between learning environment and three student outcomes of examination results, attitudes and self-esteem were investigated with a sample of 2310 grade 10 geography and mathematics students from 75 classes. Data analyses suggested that, when students perceived the classroom environment as more cohesive, higher examination scores were achieved. Self-esteem and attitudes were more favourable in classrooms perceived as having more teacher support, task orientation and equity (Chionh & Fraser, 2009).

A bilingual version with every item presented in both Chinese and English was cross-validated using data from 1460 grade 9 students in 25 government schools in

Singapore. Data analysis showed that each of the scales exhibited high internal consistency reliability and satisfactory discriminant and factorial validity (Chua, Wong, & Chen, 2009).

Cross-national studies have been conducted with the WIHIC in Australia and Indonesia and in Australia, Canada and the United Kingdom. Fraser, Aldridge and Adolphe (2010) surveyed 567 students in 18 classes in Australia and 594 students in 18 classes in Indonesia to investigate differences between countries and sexes in perceptions of classroom environment and to investigate associations between students' attitudes to science and their perceptions of classroom environment. Analyses of the data revealed some differences between countries and between sexes in students' perceptions of their classroom environments and positive associations between the classroom environment and student attitudes to science in both countries. This study confirmed the WIHIC questionnaire's validity and reliability for the assessment of students' perceptions of their psychosocial classroom environments in both Indonesia and Australia.

Dorman's (2003) cross-national research using a large sample of 3980 grade 8, 10, and 12 mathematics students in Australia, Canada and the United Kingdom validated scales from the WIHIC in high school mathematics classes and examined the factor structure of the WIHIC across country, grade level and student gender. In another study by Dorman (2008), 978 secondary school students from Australia responded to actual and preferred forms of the WIHIC. The use of multirait-multimethod modelling for these data also supported the WIHIC's construct validity. The results of these studies supported the wide international applicability of the WIHIC as a valid measure of classroom psychosocial environment (Dorman, 2003, 2008).

2.3.8.5 University Studies with WIHIC

Studies involving university students have used translations of the WIHIC in many languages including English, Indonesian, Arabic and Chinese. An English version was used in Singapore by Khoo and Fraser (2008). A sample of 250 adults in 23 computer classes in five computer education centres was used to validate a modified version of the WIHIC using only five of the scales. Also, analyses indicated that males perceived greater involvement in their classes, while females perceived more equity.

In a large urban university in California, an innovative science class for preservice elementary school teachers was studied using scales from three instruments: WIHIC, SLEI and TOSRA (Martin-Dunlop & Fraser, 2008). A sample consisting of 27 classes with 525 female students provided data describing their ideas and attitudes prior to the course and compared to data collected at the end of the course. An investigation of attitude-environment associations revealed numerous positive and statistically significant associations. Instructor Support was the strongest independent predictor of student attitudes in the analysis. Data analyses confirmed the validity of WIHIC scales (Student Cohesiveness, Instructor Support, Cooperation, Investigation) when used in this study to be valid for use with prospective elementary teachers.

Soerjaningsih, Fraser and Aldridge (2001) analysed WIHIC data from 422 students from 12 research methods classes in Indonesia using an Indonesian translation of the WIHIC and the QTI to establish links between learning environment and student outcomes of course achievement, interest in computers, and attitude towards the internet. When parallel versions in English and Arabic of the actual and preferred forms of the WIHIC were administered to 763 students from 82 college classes in Dubai (MacLeod & Fraser, 2010), factorial validity and internal consistency reliability held up for both its actual and preferred forms, and the actual form differentiated between the perceptions of students in different classrooms. Comparison of students' scores on actual and preferred forms of the questionnaires revealed that students preferred a more positive classroom environment on all scales (MacLeod & Fraser, 2010).

Indonesian university computer-based mathematics classes were involved in an investigation of the relationship between students' perceptions of their learning environment and cognitive and affective outcomes using parallel versions of the WIHIC in English and Indonesian. 2498 students from 24 statistics and 25 linear algebra classes provided data that supported the validity and reliability of the WIHIC (Margianti, Aldridge, & Fraser, 2004). The validation information provided confidence that this instrument could be used in studies in Indonesia at the university level (Margianti et al., 2004).

2.4 Research on Attitudes toward Mathematics

> The teacher is a central figure in the classroom environment. How the teacher behaves in the classroom determines whether students feel comfortable, happy, threatened or motivated. (Fraser, 2001, p. 4)

In my study, associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy were explored. Section 2.3 was devoted to the development of learning environment instruments, with Section 2.3.8 focusing on my chosen learning environment instrument, the What Is Happening In this Class? (WIHIC). In this section, the study of attitudes toward mathematics and the development of instruments to assess mathematical attitudes are reviewed. The background of and development of assessment instruments related to the other student outcome of my study, academic efficacy, are discussed in Section 2.5.

The idea of attitude was introduced into psychology in the 1860s and has been associated with varied meanings over time (Aiken, 2002). Aiken (2002, p. 244) defines attitude as “a relatively stable, learned tendency to respond positively or negatively to a given person, situation or object”. Teachers have a great influence on students and need to be aware that the learning environment that they present to students can influence their attitudes towards the subject matter (Fraser, 2001).

In education, teachers and administrators like to blame success and failure on many outside influences. In *The First Days of School,* Harry Wong and Rosemary Wong (1998, p. 37) state that “there is only one correlation with success, and that is attitude.” Fraser (1994) says that students’ perceptions of their learning environment account for appreciable amount of variance in learning outcomes. For example, a study of 453 8^{th} and 9^{th} grade students revealed a relationship between teacher support and academic efficacy (Kumar & Hruda, 2001). Supportive relationships with teachers have been found to be associated with enhanced classroom motivation (Goodenow, 1993; Rigby, Deci, Patrick, & Ryan, 1992; Wentzel & Asher, 1995) and higher levels of perceived academic efficacy (Roeser, Midgley, & Urdan, 1996).

Instruments for assessing mathematics attitudes originally focused on mathematics anxiety. The Dutton Scale (Dutton, 1954; Dutton & Blum, 1968) measured 'feelings' toward arithmetic. Further development of attitude inventories included one-dimensional scales as well as multidimensional scales (Aiken, 1974; Gladstone, Deal, & Drevdahl, 1960; Michaels & Forsyth, 1977; Sandman, 1980).

The Purdue Master Attitude Scales developed in 1960 had nine master attitude scales including one measuring attitudes toward any school subject (Remmers, 1960). The Fennema-Sherman Mathematics Attitude Scales, developed in 1976 for studying gender differences in attitudes towards mathematics, also consisted of a group of nine scales: (1) Attitude Toward Success in Mathematics Scale, (2) Mathematics as a Male Domain Scale, (3) Mother Scale, (4) Father Scale, (5) Teacher Scale, (6) Confidence in Learning Mathematics Scale, (7) Mathematics Anxiety Scale, (8) Effectance Motivation Scale in Mathematics, and (9) Mathematics Usefulness Scale (Fennema & Sherman, 1976). This instrument became the most widely-used scale for assessing mathematics attitudes over the last 30 years (Melancon, Thompson, & Becnel, 1994). Questions regarding the validity, reliability (Mulhern & Rae, 1998; Suinn & Edwards, 1982), and integrity of the Fennema-Sherman Mathematics Attitude Scales scores (O'Neal, Ernest, McLean, & Templeton, 1998) led to further developments of attitude instruments.

Sandman's 1980 Mathematics Attitude Inventory measures attitudes with six scales: (1) Value of Mathematics, (2) Self-concept in Mathematics, (3) Anxiety towards Mathematics, (4) Enjoyment of Mathematics, (5) Motivation in Mathematics, and (6) Perceptions of Mathematics Teachers. Earlier studies focused on gender differences and the correlation of attitudes to mathematics with achievement in mathematics. The scale of Enjoyment of Mathematics was a new concept to be measured.

During the same time frame as the development of the Fennema-Sherman Mathematics Attitude Scales and the Mathematics Attitude Inventory, Fraser (1981) designed the Test of Science Related Attitudes (TOSRA) to measure attitudes toward science among secondary school students. The seven scales in this instrument include areas of favourable attitude towards science and scientists, acceptance of scientific inquiry as a way of thought, adoption of science attitudes, enjoyment of science lessons, and development of interest in science, science-related activities or possible science-related courses. A modified version of the TOSRA, Test of Mathematic Related Attitudes (TOMRA), has been used to investigate attitudes toward mathematics in recent studies (Ogbuehi & Fraser, 2007; Raaflaub & Fraser, 2002; Sebela, Fraser & Aldridge, 2004; Spinner & Fraser, 2005).

The instrument used in my study to assess two attitude scales (namely, Enjoyment and Value) was the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004). This instrument was developed to fulfil a need for a shorter instrument with a straightforward factor structure that dealt with attitudes that could contribute to mathematics anxiety and extend beyond the measurement of enjoyment (Tapia & Marsh, 2004). The ATMI was developed in several stages, with the original instrument measuring six dimensions of attitudes toward mathematics. Extensive item analysis and exploratory factor analysis using 544 students in an American private high school in Mexico City resulted in a 40-item questionnaire measuring four factors identified as Self-confidence, Value, Enjoyment, and Motivation. In 2005, Marsh (2005) validated the four-factor structure using 134 college-aged American students. In 2007, Moldavan confirmed the validity in a study of 89 precalculus and calculus students in a small liberal arts college in the United States.

Recent studies using the ATMI have involved associations between social interaction and attitudes toward mathematics with 8^{th} graders in Australia (Buckley, 2008), the effect of a new instructional strategy on mathematics attitudes and achievement among Algebra 1 students (Schroeder, 2007), multimedia interventions for middle-school mathematics students in the United States (Kolodzy, 2007; Stokes, 2008), and the perceptions of tertiary students of the use of multimedia presentations in mathematics classes in Malaysia (Yoag, Na, Salimun, & Japang, 2007). The ATMI was used to investigate associations between gender and attitudes toward mathematics with college undergraduate students taking precalculus and calculus courses (Moldavan, 2007). A modified ATMI has been employed to assess the effects of game playing on fifth-graders' mathematics performance and attitudes (Ke, 2008; Ke & Grabowski, 2007).

2.5 Academic Efficacy Research

> The primary goals of secondary education are to teach students content knowledge in a particular subject area and to build students' reading, writing, and arithmetic skills. Given the proliferation of federal mandates for establishing minimum academic proficiency levels and statewide tests for assessing students' academic skills, it is understandable that education focus intensely in these areas. However, a broader, more long-term goal of secondary education should involve empowering students to become independent, self-regulated learners. (Zimmerman & Cleary, 2006, p. 56)

Self-efficacy is defined as one's capabilities to organize and execute courses of action to attain designated goals (Bandura, 1977, 1997). Studies of self-efficacy are based in social cognitive theory (Pajares, 2002). In 1941, a theory of learning which did not take into account the key element of self-belief was introduced (Miller & Dollard, 1941). After several years of studies of social learning, the idea of self-efficacy or self-belief was introduced (Bandura, 1977). Bandura's conclusion that "what people think, believe, and feel affects how they behave" (Bandura, 1986, p. 25) has been supported by many researchers.

Correlations between student motivation and future career choices were studied using the Occupational Self-Efficacy Scale (OSES) (Hackett & Betz, 1989), a study of the correlation between mathematics self-efficacy and mathematics problem-solving was conducted by Pajares and Miller (1994), and the relationship between a students' self-efficacy and accuracy in mathematics and intrinsic interest in mathematics was studied by Bandura and Schunk (1981).

Over the past 20 years, there have been many studies that focused on mathematics and self-efficacy (Betz & Hackett, 1983; Hackett, 1985; Pajares & Miller, 1995). Schunk and Rice (1993) studied self-efficacy among students receiving remedial educational services. Zeldin and Pajares (2000) explored the self-efficacy beliefs of women in mathematical, scientific and technological careers. Lui, Lim, Liu, and Toh (2005) used scales from the Self-Description Questionnaire (SDQ-II) (H. W. Marsh, 1990), the Motivational Orientation Scales (Nicholls, 1989), and the Intellectual Achievement Responsibility (IAR) (Crandall, Katkovsky, & Crandall, 1965) to measure students' self-concept in mathematics classes in secondary schools in Singapore. Self-efficacy scales have been revised and refined to meet specific needs but mainly have been used in science classes (Dorman, Waldrip, & Fisher, 2008;

Fisher, Rickards, & Fraser, 1996; Jinks, Lorsbach, & Morey, 2001; McCoach & Siegle, 2003; Morgan & Jinks, 1996, 1999; Tippins, 1991).

Self-efficacy is associated with important variables related to how a student functions in a classroom: academic motivation and academic achievement (Zimmerman & Cleary, 2006). Motivation has been consistently associated with academic competence during teachers' discussions of students who struggle in the classroom (Linnenbrink & Pintrich, 2002). Motivation can be exhibited in a student's effort, persistence, and choice of activities. Over the past two decades, studies have confirmed that, when students believe that they can do the work in a proficient manner, they will become more engaged, work harder, and sustain higher levels of effort even when obstacles are encountered consistently (Bandura, 1997; Bouffard-Bouchard, Parent, & Larivee, 1991; Multon, Brown, & Lent, 1991; Pajares, 1996; Schunk, 1981; Schunk & Hanson, 1985). Schunk and his colleagues' studies of mathematics students showed that their perceived self-efficacy for learning correlated positively with their rate of solution of arithmetic problems (Schunk & Hanson, 1985).

Merely possessing knowledge and skills does not mean that one will use them effectively under difficult conditions (Bandura, 1993). In an experiment with mathematics students with differing levels of mathematical ability (high, medium and low) and high or low perceived mathematics efficacy in each, similarities in achievement were found (Collins, 1984). Collins tested students on mathematical achievement and found that, regardless of mathematical ability, students with high self-efficacy demonstrated higher achievement and persistence on difficult problems. Self-efficacy was found to be a better predictor of positive attitudes to mathematics than was actual ability (Bouffard-Bouchard et al., 1991). These studies revealed that students' self-efficacy beliefs contribute to academic performance over and above the effects of their ability (Bandura, 1993).

Pajares and Kranzler (1995) investigated the impact of mathematics self-efficacy and general aptitude on the mathematics problem-solving skills of high school students. They found that general intelligence and self-efficacy had comparable direct effects on students' mathematical problem-solving skills. In studies of self-monitoring, it was found that higher self-efficacy resulted in better self-monitoring (Bouffard-Bouchard et al., 1991; Schunk, 1983; Zimmerman & Paulsen, 1995).

The National Longitudinal Study of Mathematical Abilities (NLSMA) was the first mathematics self-efficacy measure developed (Dowling, 1978). Dowling's Mathematics Confidence Scale (MCS) was used with 121 undergraduate students. The Mathematics Self-Efficacy Scale (MSES) and the Mathematics Problems Performance Scale (MPPS) (Betz & Hackett, 1983) were administered to 262 undergraduate students and included two additional subscales that Dowling did not use (namely, the mathematics tasks scale and the mathematics courses scale). Studies using these instruments, as well as aptitude tests such as the Stanford Achievement Test (SAT-Q) and ACT-Q, revealed weak correlations between self-efficacy and mathematics performance (Cooper, 1991; Hackett & Betz, 1989; Lent, Lopez, & Bieschke, 1991; Siegel, Galassi, & Ware, 1985). These weak correlations were attributed to the fact that the aptitude measures of the SAT-Q and ACT-Q are not pure measures of aptitude and are confounded by attitudinal and mathematics anxiety elements (Llabre & Suarez, 1985).

Self-efficacy scales have been developed over the years for many different areas in education, including teacher efficacy (Hillman, 1986), 4^{th}–6^{th} grade reading efficacy (Morgan & Jinks, 1996), and student self-efficacy beliefs and their potential for motivating academic performance in science (Jinks et al., 2001). The Morgan-Jinks Self-Efficacy Scales (MJSES) (Morgan & Jinks, 1996) was designed to assess student efficacy beliefs in science. In 2001, Fisher, Aldridge, Fraser, and Wood, used an adapted version of the MJSES to examine students' beliefs about their academic competence. The TROFLEI, WIHIC, and TOSRA (Fraser, 1981), Computer Attitude Scale (CAS) (Newhouse, 2001) and an academic-efficacy scale from the MJSES (Jinks et al., 2001) were used to investigate associations between students' perceptions of their academic competence and their learning environment. The School Attitude Assessment Survey–Revised (SAAS–R) (McCoach & Siegle, 2003) assesses factors involving students' attitudes toward school and teachers among underachieving, academically-able students.

Many instruments have been created for measuring efficacy in science including: the Science Teaching Efficacy Belief Instrument (STEBI–A) (Riggs & Enochs, 1990) for teachers' level of self-efficacy, the Teacher Efficacy Scale (TES) (Gibson & Dembo, 1984; Kushner, 1993; Pontius, 1998), the Test of Science Self-Efficacy (TSSE) and Student Self-Efficacy Scale (SSES) (Tippins, 1991), the Science Self-Efficacy Questionnaire (SSEQ) (Smist, 1992) and the Biology Self-Efficacy Scale (BSES) (Baldwin, Ebert-May, & Burns, 1999).

The instrument chosen for my study was the Patterns of Adaptive Learning Survey (PALS) (Midgley, Maehr, Hruda et al., 2000). Measures for PALS have been under development for over a decade. In the early 1990s, through a three-year, federally-funded grant to study goal orientation theory with elementary and middle schools, Carol Midgley and Martin Maehr (1996) refined and used PALS. A further grant allowed them to follow students from fifth grade to ninth grade in order to study changes in students' achievement goals (Midgley, 2002). The Spencer foundation funded a study of students' achievement goals as they transitioned from elementary to middle school (Turner et al., 2002). Throughout these studies, PALS' psychometric properties were examined and the instrument was refined.

PALS has been used in studies in the People's Republic of China (Mu et al., 1997), with multiple ethnic groups (Urdan & Giancarlo, 2001) and with over 5000 adolescents who viewed the Channel One television news program (Anderman & Johnston, 1998; Johnston, Brzezinski, & Anderman, 1994). One scale from PALS was used in a study of 237 upper elementary students in the United States to examine the effect of using small-group settings in mathematics on students' academic efficacy (Linnenbrink, 2005). Smith, Sinclair, and Chapman (2002) used PALS to study the role of motivation in influencing learning and performance with students in their final year of school in Australia. Mathematics students from four economically and ethnically diverse school districts in the United States were studied using scales from PALS to reveal associations between their perceptions of teachers' support and their behaviour in the class (Friedel, Marachi, & Midgley, 2002).

2.6 Past Research Involving Learning Environment Questionnaires

The field of learning environment research has developed over the past five decades and a student's perception of the learning environment in his classroom has been acknowledged as a mediating factor between characteristics of the learning environment and a student's learning (Stern et al., 1956). "To improve student achievement, improving the learning environment became a starting point of many reform movements" (Fisher & Khine, 2006, p. v). The study of learning environments has moved from descriptive studies investigating the relations between learning environment characteristics and student outcomes and studies of the impact of interventions on learning environments (curriculum reforms) to intervention studies and action research (Fisher & Khine, 2006).

Fraser (1998a) has identified 12 lines of past research in learning environments. Previous studies have focused on associations between outcomes and environment (Chionh & Fraser, 2009; Fraser, Aldridge, & Soerjaningsih, 2010; Margianti et al., 2004; Ogbuehi & Fraser, 2007; Quek, Wong, & Fraser, 2005), evaluating educational innovations (Azimioara & Fraser, 2007; Khoo & Fraser, 2007; Mink & Fraser, 2005; Nix et al., 2005; Raaflaub & Fraser, 2002; Scott Houston et al., 2008; Spinner & Fraser, 2005), differences between student and teacher perceptions (Allen & Fraser, 2007; Kilgour, 2006; P. C. Taylor & Maor, 2000), whether students achieve better in their preferred environment (Dart et al., 1999), teachers' use of learning environment perceptions in guiding improvements in classrooms (Sebela et al., 2004; Yarrow et al., 1997), mixed-methodology research (Adamski et al., 2005; Aldridge et al., 1999; Campbell, 2009; Dart et al., 1999; Sebela et al., 2004; Spinner & Fraser, 2005; Tobin & Fraser, 1998; Waxman & Chang, 2006), links between different educational environments (Majoribanks, 2004; Moos, 1979), cross-national studies (Aldridge & Fraser, 2000; Dorman, 2003; Fraser, Aldridge, & Adolphe, 2010), the transition from primary to high school (Ferguson & Fraser, 1998), and incorporating educational environment ideas into school psychology (Burden & Fraser, 1993), teacher education (Yang, Huang, & Aldridge, 2002), and teacher assessment (Sink & Spencer, 2007).

One of the aims of my research study was to evaluate the effectiveness of an intervention program, Success Lab, for Algebra 1 for grade 9 students in three high schools in central California in terms of the learning environment and students' attitudes toward mathematics and academic efficacy. A second aim was to determine if there are associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy. Therefore, the next two sections will review literature on the two past lines of research on which my study focuses: evaluation of educational innovations (Section 2.6.1) and outcome-environment associations (Section 2.6.2).

2.6.1 Evaluation of Educational Innovations

The pioneering work of Walberg in his evaluation of Harvard Project Physics (Walberg & Anderson, 1968) has led to a wide range of learning environment studies aimed at evaluating educational innovations at all levels of education throughout the world. Evaluations of educational innovations are discussed below. Section 2.6.1.1 focuses on studies that evaluated technology in the classroom, Section 2.6.1.2 discusses studies evaluating innovative educational curricula, and Section 2.6.1.3 details studies evaluating innovative approaches for teacher education.

2.6.1.1 Evaluation of Technology in the Classroom

Many schools have spent large amounts of money increasing the availability of technology to their students. In the last two decades, computers have become readily available with higher operating power and lower cost. Most schools have designated computer laboratories for students to use and have made computers available in classrooms. Despite this intense infusion of technology, the effectiveness of the addition of technology to these schools has not been evaluated. In an effort to evaluate the effectiveness of increasing the availability of technology to students, several studies have been conducted.

In Australia, data gathered from over 800 students in years 8 and 9 science classes were used to assess the effectiveness of laptop computers in the classroom (Stolarchuk & Fisher, 2001). Students' responses to the Test of Science-Related Attitudes (TOSRA), Test of Enquiry Skills (TOES), and Science Classroom Environment Survey (SCES) provided researchers with quantitative data about effectiveness in terms of students' attitudinal and achievement outcomes and their perceptions of classroom environment. In this study, perceptions of students using laptop computers were found to be more positively associated with students' attitudinal outcomes than with their achievement scores from the TOES. Overall, laptops appeared to have little effect on students' perceptions of science classroom environment.

A three-year study at one girls' school involved perceptions of students and teachers toward the use of laptop computers (Newhouse, 2001). Data were collected from 102 year 12 students, 104 year 8 students and 40 teachers. There was very little change at the classroom level which could be attributed to the availability of computers. Only a perceived lack of use of the computers appeared to have a consistently negative influence on students' attitudes and behaviours. The lack of use of computers was found to be directly related to the teacher's comfort with technology. The teachers who facilitated the use of computers in their classrooms did so in conjunction with providing a student-centred learning environment. The preferred environment was one in which computer use was optional, associated with major activities in the course, available when and where it was needed, and focused on tool applications. Conclusions for this study included a need for targeted professional development, systematic support for the development of student computer-related skills, and changes in the curriculum towards more learner-centred approaches.

In Canada, Raaflaub and Fraser (2002) studied associations between the use of laptop computers and the learning environment in mathematics and science classrooms using a comprehensive questionnaire comprising scales from the WIHIC, TOSRA, and the Computer Attitudes Survey (CAS) (Loyd & Gressard, 1984). Data from 1173 students in 73 mathematics classes in four boarding and day schools in Ontario, Canada were used to study differences in students' perceptions of their classroom learning environment. Data were analysed by gender in order to determine how to make technology use more equitable for male and female students. It was found that while male and female students perceived the actual learning environment similarly, females preferred greater involvement, investigation and task orientation and less computer usage then boys. It was also found that the females' learning environment perceptions in classes using computers were more favourable than the males' perceptions.

The learning environment in computer-networked classrooms was the focus of Zandvliet and Fraser's (2005) cross-national study in Australia and Canada. Analyses of data from 1404 students in 81 classes revealed that the two WIHIC classroom learning environment scales of autonomy and task orientation were significantly associated with students' satisfaction with their learning. It was also found that there were significant associations between physical and psychosocial learning environment variables in classrooms using new information technologies.

2.6.1.2 Evaluation of Innovative Educational Curricula

Research on the effects of using a teacher-made graphic organizer (PRIDE) on the learning environment and attitudes toward science among 860 fourth-grade students was conducted in Florida (MacDowell, 2005). The study involved a modification of the WIHIC and the TOSRA. Action-research involving 110 students from 29 classrooms using the graphic organizer provided pretest and posttest scores on classroom environment and attitude scales. Paired *t*-tests revealed significant differences during the intervention period when the graphic organizer was used. Associations were found for the learning environment and attitudes toward science.

A one-year study of 120 fifth grade students whose teachers participated in a program entitled Project SMILE (Science and Mathematics Integrated with Literary Experiences) provided data which were analysed to illuminate the extent to which Project SMILE positively influenced the classroom environment and attitudes toward reading, writing and mathematics (Mink & Fraser, 2005). It was found that teachers who participated in Project SMILE had a positive impact on the students' attitudes toward mathematics and an improvement in reading. Students' satisfaction was greater in classrooms with a more positive learning environment.

The CLES, ICEQ, TOMRA and concept map tests were administered to two groups of fifth-grade students as pretests and posttests over one school year to evaluate the effectiveness of the Class Banking System (CBS), an innovative mathematics program using real-life experiences (Spinner & Fraser, 2005). Analyses of data showed that CBS students experienced more favourable changes in terms of mathematics concept development, attitudes toward mathematics, and perceived classroom environment. The two samples were comprised of 35 students in the two control classes (traditional curriculum) along with 18 students from the experimental class (CBS curriculum) for one group and 40 students from the two classes in the control group and 26 students from one experimental class. The data supported the effectiveness of the CBS in providing elementary mathematics students with an individualized and constructivist classroom learning environment.

An evaluative study in which high school biology students engaged in student-centred anthropometric activities revealed that students' attitudes to science are most likely to be positive in laboratory classes where students perceive a strong integration between the concepts covered in the regular lecture classroom and in laboratory classes (Lightburn & Fraser, 2007). Student achievement was measured by administering a biology pretest and posttest to 558 students in a suburban high school in the United States. A final grade in biology was collected from 662 students to add to the assessment data. The questionnaire was composed of items from the SLEI, the Modified Fennema-Sherman Science Attitude Scales (Doepken, Lawsky, & Padwa, 1998), and TOSRA. When data from 761 students in 25 classes were analysed to investigate associations between environment and student attitudes, it was found that students' attitudes toward science were more positive when students work in cooperative learning groups. Also the positive influence of using anthropometric activities in terms of students' attitudes and the classroom learning environment was supported.

An innovative teaching method that involved solving systems of linear equations using a numerical method (Cramer's rule) was investigated as to its effectiveness for enhancing the classroom environment, students' attitudes and conceptual development (Ogbuehi & Fraser, 2007). A sample of 661 students from 22 middle-school mathematics classrooms in four inner city schools in California were administered a questionnaire consisting of scales from the Constructivist Learning Environment Survey (CLES), What Is Happening In this Class? (WIHIC) and Test of Mathematics Related Attitudes (TOMRA). Data analyses compared the results from the experimental group (innovative strategy) to the control group. Data analyses supported the efficacy of the innovative teaching method in terms of learning environment, attitudes, and mathematics concept development.

Students' perceptions of a variety of science teaching materials used in grades 3–5 were examined to reveal which approach to science teaching, using textbooks or science kits, created more favourable learning environments and student attitudes. The sample consisted of 588 students in 28 classes in three schools in Texas (Scott Houston et al., 2008). School 1 used science kits, School 2 used a combination of science kits and textbook, and School 3 used the textbook. Analyses revealed the scores for Cohesiveness and Satisfaction were considerably larger for the group using the kits than the other two groups.

Wolf and Fraser (2008) compared inquiry and non-inquiry laboratory teaching in terms of student perceptions of the classroom learning environment, achievement, and attitudes toward the science class among students in Long Island, New York. Student perceptions of the learning environment were assessed with the WIHIC, while student attitudes were assessed with a scale from the TOSRA. Achievement was measured with a modified version of a New York state science test. Analyses of data from a sample of 1,434 middle-school science students in 71 classes confirmed the validity and reliability of the instruments used. A subsample of 165 middle-school students in 8 classes participated in action research designed to compare non-inquiry laboratory activities with inquiry-based laboratory activities. Data analyses supported the WIHIC's factorial validity, internal consistency reliability and ability to differentiate between the perceptions of students in different classrooms. All seven WIHIC scales correlated significantly and positively with student attitudes. Task Orientation was found to be an independent predictor of student attitudes and achievement. Students in the inquiry classes reported statistically significantly higher Student Cohesiveness scores. Inquiry-based instruction was more effective for males than females.

Teaching grades 9 and 10 mathematics with the use of hands-on manipulatives was the focus of a study in Miami-Dade County, Florida. The effectiveness of this strategy was evaluated in terms of classroom environment, attitudes, and achievement (Campbell, 2009). Selected scales from the What Is Happening In this Class? (WIHIC) and the Test of Mathematics-Related Attitudes (TOMRA) were administered to 470 students in 15 mathematics classes. The sample was split into two groups, one using manipulatives and a comparison group of students who didn't use manipulatives. Analyses revealed that the students using hands-on manipulatives perceived a more favourable learning environment and had more positive attitude and achievement scores than the students from the comparison group.

2.6.1.3 Evaluation of Innovative Approaches for Teacher Education

In California, the effectiveness of an innovative science course for prospective elementary teachers in terms of learning environments and attitudes toward science was investigated at a large urban university with a sample of 525 female students from 27 classes (Martin-Dunlop & Fraser, 2008). This course used a guided open-ended approach to investigations and the instructors of this course used cooperative learning groups. A questionnaire which focused on previous science laboratory courses was comprised of scales from the Science Laboratory Environment Inventory (SLEI), the What Is Happening In this Class? (WIHIC), and the Test of Science-Related Attitudes (TOSRA). Comparisons to data collected at the end of the course revealed that students reported large and statistically significant improvements on all scales assessing the laboratory learning environment and attitudes toward science.

The effectiveness of a teacher professional development program (Alliance+) in Miami-Dade County, Florida was evaluated using data from a questionnaire constructed from scales from the Constructivist Learning Environment Survey (CLES), What Is Happening In this Class? (WIHIC), and the Test Of Science-Related Attitudes (TOSRA) (Biggs, 2009) that was administered to a sample of 759 students of seven mathematics/science teachers participated in this study. Four of the teachers had completed the Alliance+ project and three had not taken part in the Alliance+ project. It was found that students' perceptions of three classroom learning environment scales (Teacher Support, Cooperation, and Critical Voice) were more positive for the Alliance+ teachers than for the other group. The Alliance+ project was not found to be effective in improvement of students' attitudes to science.

A two-year science mentoring program for seven first-year, second-year, and third-year grade 3–5 teachers in terms of their students' perceptions of classroom learning environment, achievement and attitudes was examined in a study by Pickett and

Fraser (2009). The WIHIC questionnaire was modified and administered to 573 students in grades 3–5. Data analyses from the modified version of the WIHIC revealed that there were small, significant differences for the attitude survey between pretest and posttest. Science achievement scores showed substantially higher and significantly different results between pretest and posttest with students in classes with more investigation and equity. Results from the teachers' responses to the attitude portion of the survey indicated that they had more positive attitudes toward teaching science after the two-year mentoring program.

2.6.2 Studies of Associations between Learning Environments and Student Outcomes

In Fisher and Khine's (2006) recent book, *Contemporary Approaches to Research on Learning Environments,* Waxman and Chang (2006, p. 196) report that results of studies from various researchers such as Fraser (1994), Fraser and Fisher (1982), Haertel, Walberg and Haertel (1981), and McRobbie and Fraser (1993) show that "students' perceptions of their classroom learning environments have been found to explain a significant amount of variance for both students' cognitive and affective outcomes". In particular, teacher support and task orientation usually are positively related to students' improvement in academic achievement (Waxman & Chang, 2006).

Taylor's (2004) study of how the classroom learning environment affects high school students' feelings of mathematics anxiety and their attitudes toward mathematics used three instruments: the What Is Happening In this Class? (WIHIC), the Test of Mathematics-Related Attitudes (TOMRA), and the Revised Mathematics Anxiety Ratings Scale (RMARS) (Plake & Parker, 1982). Quantitative data were gathered from 745 students in 34 mathematics classes from grades 9 through 12 in four high schools located in Southern California. Data analyses revealed that, while no statistically significant gender differences were detected for either of the attitude or anxiety scales, significant gender differences were found in the area of classroom learning environment. Females were found to have significantly more positive perceptions of the classroom in the areas of Equity, Student Cohesiveness, Task Orientation, and Cooperation. Data analyses further revealed that associations between the learning environment scales and mathematics anxiety scales included significant and negative relationships with Student Cohesiveness, Task Orientation and Cooperation. Significant and positive associations were found between the learning environment scales and Investigation. Positive and significant associations between Investigation and Task Orientation and student enjoyment during lessons were further revealed from data analyses. Cooperation was found to have a significant and negative association with the Enjoyment of Mathematics Lessons.

Studies in Singapore have revealed associations between learning environment and student outcomes. The MCI and QTI were used with 1,512 primary mathematics students of ages 10 and 11 years to establish associations between the classroom environment and mathematics achievement and attitudes (Goh & Fraser, 1998, 2000). In a separate study, a modified version of the WIHIC was used together with 24 items from an attitude instrument and a 20-item self-esteem inventory. Associations between learning environment and the outcomes of attitudes and self esteem were found for this sample of 2310 grade 10 geography and mathematics students from 75 classes (Chionh & Fraser, 2009). Additionally, Wong and Fraser (1996) studied the relationship between attitudes and learning environments using the SLEI in 1592 grade 10 chemistry students in 56 classes in 28 schools in Singapore.

There have been many studies of associations between learning environments and student outcomes in science classes (Fraser, 2007). Lightburn and Fraser (2007) collected data from 558 high-school science students in the United States and investigated associations between learning environment and attitudes toward science using the SLEI. A finding of this study was that students' attitudes to science were more favourable in laboratory classes and when working in cooperative groups. In Brunei, when Scott and Fisher (2004) used the QTI and a scale to measure students' enjoyment of their science lessons with 3,104 elementary students and their teachers, students' end-of-year achievement was associated with the learning environment.

Other studies investigating associations between classroom environment and student outcomes in mathematics have taken place more recently. Ogbuehi and Fraser's (2007) study of middle-school students in California revealed associations between perceptions of classroom learning environment and students' attitudes to mathematics and conceptual development. A sample of 661 students completed the CLES, WIHIC and TOMRA questionnaires. Webster and Fisher (2004) investigated whether a relationship exists between learning environments and student outcomes of achievement, career aspirations, attitudes toward mathematics, and academic efficacy with a sample of 620 teachers and 4645 students in 57 Australian secondary schools. When the SLEQ was used to collect data, students' perceptions of the learning environment were associated with student outcomes.

Research specifically focusing on at-risk mathematics students and their perceptions of the learning environment includes a study of 136 junior high mathematics and English classes in Texas (Veldman & Sanford, 1984). Results of this study suggested that differences in classroom environment have more impact on achievement and behaviour among lower-ability students than for higher-ability students. In another study with 90 sixth-grade and eighth-grade classrooms from 16 inner-city middle level schools, Padron, Waxman and Huang (1999) reported that effective learning environments can help non-resilient students to improve their classroom behaviour.

2.7 Summary of Literature Review

The main goal of my research was to investigate the effectiveness of an Algebra 1 intervention class, Success Lab, in terms of the learning environment and students' attitudes toward mathematics and academic efficacy. The literature reviewed in this chapter is relevant to important facets of my study. Section 2.2 reviewed the historical background of learning environments beginning with Lewin's (1936) studies, and then this was followed by consideration of learning environment instruments in Section 2.3 beginning with the LEI and CES (Moos, 1979; Walberg & Anderson, 1968).

The subsections of Section 2.3 highlighted the development of and use of specific learning environment research instruments beginning with the MCI (Fraser & O'Brien, 1985; Goh & Fraser, 1998; Majeed et al., 2002; Mink & Fraser, 2005). The development and use of the ICEQ (Asghar & Fraser, 1995; Fraser et al., 1983; Fraser et al., 1982; Rentoul & Fraser, 1979; Wierstra, 1984) was followed by reviews of studies using the CUCEI (Fraser & Treagust, 1986; Yarrow et al., 1997), and the QTI (Fraser, Aldridge, & Soerjaningsih, 2010; Lee et al., 2003; Telli et al., 2007; Wubbels, 1993).

Section 2.3 considered the development of the SLEI for research in science laboratory classrooms (Fraser et al., 1992; Fraser & Lee, 2009; Henderson et al., 2000; Lightburn & Fraser, 2007). The CLES was developed about the same time as the SLEI for use in constructivist science or mathematics classrooms (Aldridge & Fraser, 2000; Peiro & Fraser, 2009; P. C. Taylor et al., 1997). Section 2.3 concluded with an in-depth review of the development and use of the WIHIC (Fraser, 2002; Fraser et al., 1996), the learning environment instrument which I chose for my study, and its implementation in studies in a variety of languages (Aldridge et al., 2009; Soto-Rodriguez & Fraser, 2004), instructional settings and grade levels (Allen & Fraser, 2007; Dorman, 2003; MacDowell, 2005; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; Pickett & Fraser, 2009; B. A. Taylor, 2004). It is important to understand the history of the development of these instruments in that it illustrates how they have developed and changed as society has recognized the important influence of the classroom learning environment on student outcomes.

An in-depth review of studies involving the historical background and development of the attitudes toward mathematics and academic-efficacy instruments used in my study (ATMI and PALS) was included to show the importance of their place in international educational research and the variety of educational settings in which they have been used. Section 2.4 focused on the development of instruments for assessing mathematics attitudes (Aiken, 1974; Dutton & Blum, 1968; Fennema & Sherman, 1976; Remmers, 1960; Sandman, 1980), including the most recent additions of the TOMRA (Ogbuehi & Fraser, 2007) and the instrument which I used, the ATMI (Tapia & Marsh, 2004). A review of studies using the ATMI was included to highlight past studies of associations between the learning environment and student outcomes including attitudes toward mathematics (Ke & Grabowski, 2007; Kolodzy, 2007; Moldavan, 2007; Schroeder, 2007).
Academic efficacy research was reviewed in Section 2.5. There is a long history of studies of correlations between students' self-efficacy and outcomes in mathematics including future career choice (Bandura & Schunk, 1981; Hackett & Betz, 1989;

Pajares & Miller, 1994). Over the past 30 years, self-efficacy scales have been revised and refined to meet specific needs but mainly have been used in science classes (Dorman et al., 2008; Fisher et al., 1996; McCoach & Siegle, 2003). The instrument chosen for this study was the Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 2000) which was developed in the early 1990s through a federally funded grant to study goal orientation theory with elementary and middle schools (Maehr & Midgley, 1996). Recent studies were discussed in this section including international studies (Mu et al., 1997; Smith et al., 2002) and studies in the United States with a variety of grade levels of students (Anderman & Johnston, 1998; Friedel et al., 2002; Linnenbrink, 2005).

Fraser (1998a) identified important lines of past research in learning environments, with two of those lines being important in my study: the evaluation of innovative educational programs and investigations of outcome-environment associations. A review of studies in these two areas was provided in Section 2.6.

Chapter 2 provided a comprehensive review of literature on the history of and important studies of learning environments, attitudes toward mathematics, and academic efficacy. This literature review was included to show the importance of the instruments used in my study in international educational research and in the variety of educational settings in which they have been used. Researchers can have more confidence in my study by understanding the similarities and differences between it and past research. My study has a unique place in the literature of learning environments because of the use of the three instruments (WIHIC, ATMI, and PALS) in evaluating a high school Algebra 1 intervention class in a low-income area of California.

In the following chapter, the research methodology utilised in this study is presented.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

The level of confidence that a reader can have in a study depends not only on the validity and reliability of the instruments used but, more so, on the research methodology employed. It is through this lens that this chapter is written.

The primary goal of my study was to determine the effectiveness of an intervention class, Success Lab, on Algebra 1 students in terms of learning environment, attitudes toward mathematics, and academic efficacy through the use of a questionnaire. This study was of interest to me because Success Lab was a class with which I was very involved while working for the Tulare Joint Union High School District. Surprisingly, after eight years of implementation, no studies of its effectiveness had been undertaken.

Chapter 2 provided a literature review of the history of and importance of learning environments in education (Aldridge & Fraser, 2000; Fraser, 1998a, 1998b). The history of research on students' attitudes toward mathematics (Aiken, 1974; Dutton & Blum, 1968; Fennema & Sherman, 1976; Schroeder, 2007; Stokes, 2008; Tapia, 1996) and academic efficacy in mathematics students (Bandura & Schunk, 1981; Midgley et al., 1998; Pajares & Miller, 1994; Smith et al., 2002) was also included in the previous chapter. This literature review suggested that my study had value and could add to the literature connecting learning environment to student attitudes toward mathematics and academic efficacy.

Chapter 3 explains the methodology used in this study. Section 3.2 provides details of the data sources, the sample and the procedures for data collection. The instruments used, as well as modifications needed for this study, are discussed in Section 3.3. The procedures for collection, preparation and analyses of the quantitative data comprise Section 3.4. The chapter concludes with remarks regarding the limitations of my study (Section 3.5), as well as a summarization of the methodology (Section 3.6).

3.2 Data Sources

A pretest-posttest quantitative methodology was used to collect the data for this study. Questionnaires were administered to 20 classes of ninth grade Algebra 1 classes at three comprehensive public high schools from one school district in Tulare, California during the 2008–2009 school year. The district is typical of a high school district in Central California with a large Hispanic population and low socioeconomic status (see Table 3.1). Two of the participating schools are four-year high schools. The third school, Mission Oak, was in its first year of operation and enrolled students only in the first two years of high school.

Table 3.1 Demographic Information for the High Schools in the Study

Demographic Information	School 1	School 2	School 3
School Performance (Program Intervention)	NA (first year opened)	No	Yes Year 1
Academic Performance Index	NA	724	711
Statewide Rank (1–10)	NA	6	5
Adequate Progress for all Subgroups	NA	No	No
Enrollment			
Total	715	1350	1719
Ninth Grade Algebra 1	9 classes (235 students)	15 classes (364 students)	16 classes (355 students)
Sample Size	9 classes (181 students)	4 classes (75 students)	7 classes (127 students)
% of Ninth Grade Algebra 1 students participating	77%	21%	36%
Ethnic Distribution			
Hispanic or Latino	64%	61%	63%
Asian-American	1%	1%	2%
African-American	3%	5%	7%
White	28%	31%	26%
Other	4%	2%	2%
English Language Fluency			
English Learner	21%	11%	16%
Socioeconomic Distribution			
Disadvantaged (Free/Reduced-Price Meals)	61%	46%	59%

After presenting the research proposal to the district superintendent and the three high school principals and receiving permission to proceed, I discussed my plan with each of the mathematics department heads at the schools. These department heads agreed to discuss my proposal at their department meeting. I was given permission to send an email message to the ninth grade Algebra 1 teachers. Of the 19 teachers contacted, 12 teachers agreed to their classes participating. A total of 20 ninth grade Algebra 1 classes (out of a possible 40 classes) were surveyed initially to provide the pretest data. Administration schedules were worked out in conjunction with the classroom teachers. Approximately two months later, the surveys were readministered in each classroom in order to provide posttest data.

Of the 383 students who completed the pretest and 361 students who completed the posttest, only 313 students completed both. Incomplete questionnaires were discarded. From the 313 students, I matched 56 intervention students with 56 non-intervention students using the students' personal data provided by the district, namely, students' previous scores on the California Standards Test (CST) in mathematics (either General Mathematics or Algebra 1) and previous results for the CST English Language Arts. If students did not have that information listed, results for their two benchmark examinations for that semester were compared. Next, gender and school attended were examined. Students' family economic status and English Language Proficiency were also taken into account. Appendix B contains 56 matched pairs and their corresponding data used for matching.

3.3 Instruments and Modifications

Gottfried (1985) says that research shows that students who value and enjoy mathematics have a higher level of achievement. It was my goal in this study to determine if there are associations between the learning environment and students' perceptions of attitudes toward mathematics and academic efficacy. A questionnaire consisting of parts of three previously-validated and reliable instruments was used. Four scales from the What Is Happening In this Class? (WIHIC) questionnaire (Fraser et al., 1996) were used to assess perceptions of the learning environment. Two scales from the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004) were used to monitor changes in attitudes toward mathematics, while academic efficacy was assessed by one scale from the Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 1996; Midgley, Maehr, Hruda, et al., 2000). Each part of the modified instrument made use of a five-point Likert scale with responses of Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. Appendix C contains the survey instrument used.

Within the first three weeks of school, the questionnaire was administered in the ninth grade Algebra 1 classes in the three schools. Two months later, the questionnaires were readministered in order to permit investigation of changes in learning environment perceptions, attitudes toward mathematics and academic efficacy associated with student participation in the Success Lab class.

3.3.1 What Is Happening In this Class? (WIHIC) Survey

The WIHIC questionnaire was chosen because it was recently developed and has been validated in many countries for a variety of subjects and grade levels. Only four of a possible seven scales from the WIHIC were used. Each of the scales had eight questions. The four scales (Teacher Support, Involvement, Task Orientation and Equity) were considered to be the most relevant to the course under investigation.

For the purposes of the proposed study, the WIHIC scales consisted of items from the personal, actual form. The actual form assessed the current class in which the students were enrolled. The personal form was chosen over the class form to avoid confounding (Fraser & Tobin, 1991).

The WIHIC has a history of being valid and reliable (Aldridge & Fraser, 2000; Fisher et al., 1996). It has been validated in studies with samples from middle school and high school students in California (Azimioara & Fraser, 2007; Ogbuehi & Fraser, 2007; B. A. Taylor, 2004), and has been found to be valid and reliable when translated into Spanish (Adamski et al., 2005; Allen & Fraser, 2007; Peiro & Fraser, 2009; Soto-Rodriguez & Fraser, 2004) as well as other languages.

3.3.2 Attitudes Toward Mathematics Inventory (ATMI)

The Attitudes Toward Mathematics Inventory (ATMI) was chosen for several reasons. It was recently developed and its scope extends beyond mathematics anxiety. “Attitude scales must withstand factor analysis, tap important dimensions of attitudes, and require a minimum amount of time for administration” (Tapia & Marsh, 2004). The ATMI was designed to address these three requirements. Two of the four scales of the ATMI were chosen. The scales of Value and Enjoyment were most salient for my study. The other two scales, Self-confidence and Motivation, were not chosen because the academic-efficacy scale described below was included in my study. The ATMI has been validated and proven reliable with students at the junior high, high school and college levels (Aiken, 2002; Schroeder, 2007; Tapia, 1996; Tapia & Marsh, 2000, 2002, 2004).

3.3.3 Patterns of Adaptive Learning Scales (PALS)

The Patterns of Adaptive Learning Scales (PALS) was chosen as the instrument for assessing academic efficacy in this study (Midgley, Martin, Gheen et al., 2000). It has been used in high schools with the same level of socioeconomic status as the three schools in this study (Midgley, Martin, Gheen et al., 2000). The instrument was validated by confirmatory factor analysis for the scale chosen, Academic-Related Perceptions, Beliefs and Strategies. The other four scales (Personal Achievement Goal Orientations, Perception of Teacher’s Goals, Perception of Classroom Goal Structures, and Perceptions of Parents, Home, Life, and Neighbourhood) were not chosen for this study. PALS has been found valid and reliable in previous studies for English, mathematics and science courses, for females and males and for both high-ability and low-ability students (Anderman & Young, 1994; Midgley et al., 1998). Other studies using various versions of PALS with adolescents have shown the instrument to be valid and reliable with that level of student (Anderman & Johnston, 1998; Johnston et al., 1994; Urdan & Giancarlo, 2001).

3.3.4 Modifications to the Instruments

In addition to limiting the number of scales from each instrument, the revised instrument was translated into Spanish. Both the English and Spanish versions can be found in Appendix C. Table 3.1 shows that the largest demographic group is Hispanic in each of the schools participating in the study. English learners represent almost a quarter of the school population. Based on these statistics, all parent and student documents were offered bilingually. The translation into Spanish was provided by http://www.spanishdict.com/translation and back-translated by the Spanish Language teachers at Tulare Union High School. English language proficiency designations used in this study are: Limited English Proficient students whose primary language is not English and have limited comprehension and communication skills in English and could receive extra support in regular classrooms, such as materials in their primary language or the assistance of an aide who speaks their primary language; Fluent English Proficient students whose primary language is not English but are able to communicate in English at an average English-speaker level and are able to attend regular classrooms without additional language assistance; Redesignated Fluent English Proficient students who have previously been designated as Limited English Proficient but now are able to communicate fluently in English; and English Proficient students whose primary language is English.

All students were provided with an English version of the instrument. Students who indicated a need for the Spanish version had the choice of responding either to the English or Spanish version. While 51 students in the full sample (N = 313) were classified as Limited English Proficient and were provided with both versions, only four students chose to return the Spanish version during pretesting, while five students returned the Spanish version during posttesting. The remainder of the Limited English Proficient students were more comfortable using the Spanish version for translating items and indicating their responses on the English version.

3.4 Data Analyses

Data analyses were used to answer the following three research questions of my study:

1. Is it possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy?

2. How effective is Success Lab in terms of the learning environment and students' attitudes toward mathematics and academic efficacy?
3. Are there associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy?

The data collected from the first administration of the survey instrument were entered into a spreadsheet and checked for accuracy (n = 383). After the second administration and entering of data into the spreadsheet (n = 361), the data were sorted to find which students had taken both the pretest and posttest surveys. Any surveys that were not completed correctly, because of either unmarked answers or double marked answers, were deleted from the data set to produce 313 completed sets of data. In order to match pretest and posttest scores, students were asked to put their names on the surveys. They were assured that I was the only person to have access to their data. The inability to decipher names or the lack of names also necessitated the deletion of some surveys.

The Tulare Joint Union High School District Assistant Superintendent of Curriculum provided me with student information which included details necessary to match pairs of students to use for analyses (see Appendix B). To protect student confidentiality, all student data were kept on a separate data storage device in a locked filing cabinet drawer.

To answer Research Question 1 and to give credibility to my results, student responses to the instrument were analysed to determine its validity and reliability. Data collected from the sample of 313 students were used to investigate, for the modified learning environment and attitude and efficacy scales, the factor structure, reliability, and discriminant validity (Section 3.4.1). My survey instrument had five-point Likert scale responses consisting of Strongly Disagree (5), Disagree (4), Neutral (3), Agree (2) and Strongly Agree (1). In order to have the results make sense (higher numbers mean more positive responses), the scores were reversed before analyses were run except for Item 40 from the scale of Enjoyment ("Mathematics is dull and boring") which is negatively worded.

From the sample of 313 ninth grade Algebra 1 students, 56 matched pairs of students were identified in order to investigate Research Question 2 (see Appendix B). Matched paired-samples *t*-tests was utilized to explore differences between the 56 students concurrently enrolled in Algebra I and the intervention class, Success Lab, and a comparison group comprised of 56 non-intervention Algebra I students. Pretest and posttest scores were analysed to investigate the effectiveness of the Success Lab in terms of students' perceptions of the learning environment and students' attitudes toward mathematics and academic efficacy (Research Question 2) (Section 3.4.3).

The last objective of my study was to investigate associations between the learning environment and the outcomes of students' attitudes toward mathematics and academic efficacy. To investigate the bivariate association between each student outcome and each of the three learning environment scales, simple correlation analyses were run using the full sample of Algebra 1 students (N = 313). Additionally, multiple regression analysis was run to provide information about the joint influence of the set of correlated learning environment scales on each individual student outcome. Standardized regression weights were examined to determine which specific learning environment scales were independent predictors for each attitude and efficacy scale when the other learning environment scales were mutually controlled (Research Question 3) (Section 3.4.4).

3.4.1 Validity and Reliability of Questionnaires

The first goal of my study was to determine if it is possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy. The validity of a scale refers to the degree to which it measures what it is supposed to measure. Data from the sample of 313 ninth grade students were used for these analyses. The level of confidence which researchers can have in the results obtained from using any instrument is dependent on its validity and reliability.

Urdan (2001) says that, when researchers use multiple measures to represent a single underlying construct, they must perform some statistical analyses to determine how closely the items and the constructs are related. If the items (questions) for one construct (scale) really do measure that scale, then most students will answer all the items in the similar ways and this will be evident from the analyses. In each scale of the WIHIC, there are eight items. It is important to ask more than one question for each scale so that you have confidence that the questions are interpreted in similar ways. In other words, the students seem to understand what the questions are asking.

The statistical analysis used to determine which items are most strongly correlated was a principal axis factoring with varimax rotation and Kaiser normalization. Each instrument was subjected to analysis for pretest and posttest data separately. Factor loadings indicate the strength of the relationship between an item and a construct. The stronger that an item loads onto a factor or construct, the more that item defines the factor. A varimax rotation (orthogonal factor rotation) produces the maximum distinction between the factors. So, using rotation, the factor analysis works to create factors which are as separate, or unique, from each other as possible (Hinton, 2004).

A rotation method separates factors that are as different from each other as possible and helps you to interpret the factors by putting each variable primarily on one of the factors. My criteria for an item to be retained were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on all other scales. The removal of items not meeting these criteria improves the internal consistency and factorial validity of the instrument. Factor loadings, percentage of variance, and eigenvalues are reported in Chapter 4 separately for the WIHIC learning environment scales and the attitude and efficacy scales from the ATMI/PALS. By comparing the factor analysis results for this study to those from previous studies, credibility is enhanced.

Reliability indicates how well a group of items hang together. The reliability of a scale indicates how free from random error the results are. The degree to which the items that make up the scale are measuring the same underlying attribute is found by checking the internal consistency of the instrument. The measure used in this study was Cronbach's alpha coefficient, which provides an indication of the average correlation among all of the items that make up the scale. The magnitude of the alpha coefficient depends on the number of items and on the strength of the correlations among the items. Alpha coefficient values range from 0 to 1, with higher values indicating greater reliability (Nunnally & Bernstein, 1998).

3.4.2 *Effectiveness of Success Lab in Terms of Between-group Differences in Learning Environment Perceptions, Students' Attitudes Toward Mathematics, and Academic Efficacy*

After finding that the instruments were valid and reliable for the sample of 313 students, quantitative analyses were undertaken in order to determine how effective Success Lab was in terms of learning environment and students' attitudes toward mathematics and academic efficacy (Research Question 2). To avoid a systematic error such as confounding, 56 intervention students were matched with a similar set of Algebra 1 students. Hinton (2004) advises that systematic errors can be avoided by deliberately selecting participants so that they are matched on one or more confounding variables. Examples of confounding variables in this study were school attended, gender and English language proficiency. Appendix B contains the 56 pairs and their characteristics used in the matching process.

A matched paired-samples *t*-test (n = 56) was used with each of the WIHIC and attitude and efficacy scales to determine the statistical significance of between-group differences (Research Question 2). The average item mean for each scale on the pretest data was used to confirm how closely the intervention group and the non-intervention group were matched. Significance tests were conducted separately for pretest and posttest data to see if any changes in the between-group differences occurred during the time when the students experienced the intervention.

Effect sizes were calculated for each scale to indicate the magnitude of the difference between the two groups. Effect size (d) is the difference between the means of the two groups divided by the pooled standard deviation. It expresses the difference between means in standard deviation units. Effect sizes have been described as small (d = 0.2), medium (d = 0.5), or large (d = 0.8) (J. Cohen, 1988; Hinton, 2004). Effect size is independent of sample size, which is good because sample size can influence significance testing results. Hinton (2004) says that, by setting a significance level appropriately, we can decide if there is a difference between our samples that has been caused by random errors.

Finding a statistically significant difference where one does not exist (Type 1 error) can occur with the use of multiple *t*-tests (as in my study). When determining statistical significance, therefore, a modified Bonferroni correction was made in order to reduce the number of Type I errors (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004).

The number of *t*-tests performed is dependent on the number of variables in a study because each *t*-test examines only one pair of variables (one dependent and one independent) at a time (Hinton, 2004). In my study, the one independent variable was the instructional group (intervention students or non-intervention students), but there were six dependent variables: Teacher Support, Involvement, Task Orientation, Value, Enjoyment and Academic Efficacy. With one dependent variable (e.g. Teacher Support), one *t*-test is performed. With an alpha level of $\alpha = 0.05$, there is a probability of 0.05 of making a Type 1 error (or a probability of 0.95 of not making a Type I error). With two dependent variables (e.g. Teacher Support and Involvement), two *t*-tests (each at $\alpha = 0.05$) are performed and the probability of making a Type I error is calculated as $2 \times 0.05 = 0.1$, twice the chance as for only one *t*-test (Hinton, 2004).

In my study, a modified Bonferroni correction (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004) was used to adjust the *p*-values from the significance testing to reduce the chance of Type I errors. The modified Bonferroni correction involves ranking the probabilities obtained from significance testing (*p*-values) from smallest to largest (most significant to least significant). The smallest *p*-value is multiplied by the total number of tests to be conducted, $n = 6$ in my study, and compared to α (0.01 or 0.05). If this new *p*-value is less than α, it is considered statistically significant and the next smallest *p*-value is then multiplied by $(n - 1)$ and compared to the desired α. This pattern continues by multiplying each successive *p*-value by the next $(n - k)$ until a statistically nonsignificant result is obtained, guaranteeing that the remaining *p*-values are also nonsignificant (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004). Section 4.3 provides results for effect sizes and significance tests conducted for a comparison of the two instructional groups.

3.4.3 Associations Between Learning Environment and Student Outcomes of Attitudes Toward Mathematics and Academic Efficacy

Simple correlation and multiple regression analyses were run using the full sample of ninth grade Algebra 1 students (N = 313) to investigate associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy (Research Question 3). Simple correlations (r) reveal the bivariate association between each student outcome and each of the three learning environment scales. Multiple regression analysis provides information about the joint influence of a set of correlated learning environment scales on each individual student outcome and reduces the Type I error rate commonly associated with simple correlation analysis. Section 4.4 reports the results of the simple correlation analysis (r) between each learning environment scale and each student outcome, as well as the multiple correlation (R) between the set of three learning environment scales and each attitude and efficacy scale for this study. Standardized regression weights were examined to determine which specific learning environment scale accounted for most of the variance in the attitude and efficacy scales. The regression coefficient (β) indicates the strength of the association between each attitude and efficacy scale and each learning environment scale when the other two learning environment scales were mutually controlled.

3.5 Limitations

Limitations, biases, and invalidity are inherent in any research involving human subjects. Cohen, Manion, and Morrison (2000) identify four stages when biases and invalidity can be introduced into a research project: research design, data gathering, data analysis, and data reporting. This section discusses each stage of research and addresses my attempts to minimize biases and invalidity.

For the first stage of research, research design, Cohen and associates (2000) describe issues which need to be addressed. To avoid areas of bias and invalidity, they offer suggestions that can alleviate concerns in this area. An appropriate time frame, adequate resources and appropriate instruments are three areas that should be carefully thought out.

In my study, while the time frame was sufficient (18 weeks), a problem with attendance during the posttesting session occurred. From November to February, the central valley of California is subject to dense fog. In Tulare, a 'winter schedule' goes into effect and there are times that school busses are delayed or cancelled. Unfortunately, this became an issue with the posttesting in December. Fewer students were able to be surveyed because of the weather conditions.

To avoid any issues with adequate resources, I took extra copies of the surveys in English and Spanish, as well as writing utensils, with me to each classroom. Keeping in mind the age of the participants, I had extra copies of the surveys photocopied.

My literature review of instruments used to measure learning environments, attitudes toward mathematics and academic efficacy was extensive (see Chapter 2). During this process, I kept in mind the level of students with whom I would be working, as well as the demographics of the school district, so that I could choose instruments which were appropriate in length as well as language.

The second area of concern for Cohen and associates (2000) is data gathering. To avoid any bias or validity issues during data gathering, I chose to be the only person administering the surveys. While several teachers offered to help with this task, it was not in the best interest of this study for them to do so. Because the learning environment instrument includes questions regarding the teacher, I wanted the data to be free from any invalid perceptions due to students' fear of their teacher seeing their answers.

Data analysis is the third area of concern in terms of data management and data interpretation. I chose to enter the data into a spreadsheet myself, keeping checks on any discrepancies along the way. Totals were included at the end of each student's data entry so that any obvious errors in data entry would be noticed. By being in charge of the data management, I kept biases and invalidity to a minimum.

The other concern in this area, data interpretation, was alleviated by validity testing of the instruments and being careful not to make any subjective statements based on the data. The analyses run were straightforward and appropriate to the study. The use of the Bonferonni procedure minimized Type I errors as discussed earlier in Section 3.4.2.

One limitation of this study is in the area of data interpretation. Any conclusions made from these data will only be strictly applicable to the efficacy of the intervention class, Success Lab, at the three schools in this specific school district and to the students in this study. Generalisations based on the results of this study should only be made to other intervention programs, other grade levels, or other school districts with considerable caution.

Another area of concern for Cohen and associates (2000) is bias introduced into the study from the relationship of the researcher to the subjects of the study. While it is true that I was very involved with the teachers and courses, I conducted my research after I retired from employment in the district. None of the students were associated with me in any way and the teacher's role in the collection of data was kept to a minimum. A bias introduced by my association with the district might be in terms of which classes were chosen to be surveyed. Teachers who knew me and/or had worked with me were more willing to allow their class to participate.

A further limitation is that there are other intervention programs which are used to support algebra. My study evaluated the extended-time model intervention that was being used at these specific schools. Because other schools in the area use different programs, we cannot say whether this model would be better or worse for improving the learning environment or students' attitudes toward mathematics and academic efficacy. A further study is needed to investigate the relative effectiveness of different intervention models.

Limitations, biases and issues of validity are part of research. The validity and reliability of data and interpretations from the analyses used depend on the degree of caution taken to minimize these.

3.6 Summary

Chapter 3 focused on the research methodology used in my study. The sample, instruments, data collection and data analyses were discussed. Because the main goal of this study was to determine the effectiveness of the intervention class, Success Lab, the sample of 313 ninth grade Algebra 1 students from 20 classes at the three comprehensive high schools in Tulare, California was large enough to provide reasonably dependable results for this study.

Based on a literature review of instruments measuring learning environments, attitudes toward mathematics, and academic efficacy, appropriate scales were chosen from three previously-validated instruments. Because my sample was from a demographic group which had not previously been studied (high Hispanic, low socio-economic students), reliability and validity analyses needed to be conducted.

The effectiveness of the intervention class, Success Lab, was investigated using 56 matched pairs from the total sample of 313 ninth grade students. A matched paired-samples *t*-test provided a basis for comparing the intervention group and the non-intervention group. A modified Bonferroni correction was used to reduce the Type I error rate when investigating differences between the groups in terms of pretest and postest data for learning environment, attitudes and efficacy scales. Effect sizes were calculated for each scale to indicate the magnitude of the differences between the two instructional groups in standard deviation units.

Associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy were analysed using simple correlation and multiple regression analyses. Regression coefficients helped with identifying which specific learning environment scale accounted for most of the variance in the attitude and efficacy scales when the other environment scales were mutually controlled.

The next chapter reports the results of the data analyses described in this chapter.

Chapter 4

ANALYSES AND RESULTS

4.1 Introduction

The main objective of my study was to evaluate the effectiveness of Success Lab, an Algebra 1 intervention class, in terms of learning environment and students' attitudes toward mathematics and academic efficacy. Data were gathered from ninth grade Algebra 1 (N = 313) students from 20 algebra classes at three comprehensive high schools in the Tulare Joint Union High School in central California using a questionnaire consisting of parts of three previously-validated and reliable instruments. The instrument was offered in English and Spanish to accommodate the language needs of students.

As reported in Chapter 2, a pretest/posttest design was used in collecting data with an instrument comprised of four scales from the What Is Happening In this Class? (WIHIC) (Fraser et al., 1996) learning environment questionnaire (Teacher Support, Involvement, Task Orientation and Equity), two scales from Attitudes Toward Mathematics Inventory (ATMI) (Tapia, 1996) (Value and Enjoyment), and one academic-efficacy scale from the Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 1996). Each part of the modified instrument used a five-point Likert response scale with responses of Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree.

This chapter is devoted to describing the data analyses and discussing the findings in order to answer the following three research questions of my study:

1. Is it possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy?
2. How effective is Success Lab in terms of the learning environment and students' attitudes toward mathematics and academic efficacy?

3. Are there associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy?

In order to answer Research Question 1 and to give credibility to my results, student responses to the instrument were analysed to determine its validity and reliability. Data collected from the sample of 313 students were used to investigate, for each modified learning environment and attitude and efficacy scale, the factor structure, reliability, and discriminant validity. The results reported in Section 4.2 below provide evidence of the validity of these instruments in assessing the learning environment and student attitudes toward mathematics and academic efficacy when used in high school Algebra 1 classrooms in Tulare, California.

From the sample of 313 ninth grade Algebra 1 students, 56 matched pairs of students were identified in order to investigate Research Question 2 (see Chapter 3 for more details). Paired-samples *t*-tests (with a modified Bonferroni correction) were utilized to explore differences between 56 students concurrently enrolled in Algebra I and the intervention class, Success Lab, and a comparison group comprised of 56 non-intervention Algebra I students. Changes between pretest and posttest scores experienced by the two groups were used to investigate the effectiveness of Success Lab in terms of students' perceptions of the learning environment, attitudes toward mathematics and academic efficacy (Research Question 2). Results of the paired-samples *t*-tests are provided in Section 4.3.

The last objective of my study was to investigate associations between the learning environment and the outcomes of attitudes toward mathematics and academic efficacy. Simple correlation and multiple regression analyses were run to investigate these associations and are discussed in Section 4.4 (Research Question 3).

The What Is Happening In this Class? (WIHIC) was chosen as the learning environment instrument because it incorporates important aspects of today's classroom: cooperation and equity (Fraser, 1998a). It has a history of being valid and reliable in English in many countries including: Australia (Dorman, 2003); India (Koul & Fisher, 2005); Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008);

and the United States (den Brok et al., 2006; Ogbuehi & Fraser, 2007; Pickett & Fraser, 2010; Wolf & Fraser, 2008). Cross-national studies with the WIHIC include comparisons between students in: Australia and Taiwan (Aldridge & Fraser, 2000); Australia and Canada (Zandvliet & Fraser, 2005); and Australia and Indonesia (Fraser, Aldridge, & Adolphe, 2010) .

The reliability and validity of WIHIC has been confirmed when translated into languages other than English including: Arabic (MacLeod & Fraser, 2010); Chinese (Aldridge & Fraser, 2000; Chua, Wong, & Chen, 2001; Yang et al., 2002); Indonesian (Fraser, Aldridge, & Adolphe, 2010; Margianti et al., 2004); Korean (Kim, Fisher, & Fraser, 1999); IsiZulu (Aldridge et al., 2009); and Spanish (Adamski et al., 2005; Allen & Fraser, 2007; Peiro & Fraser, 2009; Soto-Rodriguez & Fraser, 2004). These studies are important to me because my modified survey instrument was also translated into Spanish and offered concurrently with the English version for students who felt more comfortable responding in Spanish. Chapter 2 provides more information about the development, characteristics and validity of the original WIHIC. Complete details about modifications made to the WIHIC for this study are discussed in Chapter 3.

As reported in Chapter 3, modified versions of the Attitudes Toward Mathematics Inventory (ATMI) and Patterns of Adaptive Learning Scales (PALS) were used to measure the outcomes of students' attitudes toward mathematics and academic efficacy. Two scales from the ATMI were used to measure students' attitudes toward mathematics. The ATMI has been found to be valid and reliable with students at the junior high, high school and college level (Schroeder, 2007; Tapia, 1996; Tapia & Marsh, 2000, 2002, 2004).

One scale from Patterns of Adaptive Learning Scales (PALS) was used to measure academic efficacy. PALS was developed and used in a longitudinal study that followed students from 5^{th} grade through 9^{th} grade (Midgley, 2002) and explored their perceptions of goal orientation, including academic efficacy. Other studies have been conducted using various versions of PALS with adolescents (Anderman & Johnston, 1998; Johnston et al., 1994; Urdan & Giancarlo, 2001). Prior research indicates that the scales are valid and reliable for English, mathematics and science, for females and males, and for both high-ability and low-ability students (Anderman & Young, 1994; Midgley et al., 1998). Refer to Chapter 2 for further information about the ATMI and PALS, including their conceptualization, characteristics and validity.

4.2 Validity and Reliability of the Learning Environment and Attitude and Efficacy Scales

The first goal of my study was to determine if it is possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy. Quantitative data from the sample of 313 ninth grade students were used for these analyses. The level of confidence that researchers can have in the results obtained from using any instrument is dependent on its validity and reliability.

The validity of a scale refers to the degree to which it measures what it is supposed to measure. Factor analysis was used in my study to reduce the large number of related questionnaire items to a smaller, more manageable set of factors that can then be further analysed. By comparing the factor analysis results of this study to previous research, credibility is enhanced.

The reliability of a scale indicates how free from random error the results will be. The degree to which the items that make up the scale are measuring the same underlying attribute can be checked by ascertaining the internal consistency of the instrument. The measure used in this study was Cronbach's alpha coefficient, which provides an indication of the average correlation among all of items that make up the scale. Values range from 0 to 1, with higher values indicating greater reliability (Nunnally & Bernstein, 1998).

4.2.1 Validity and Reliability of WIHIC

Data collected with the four modified WIHIC scales (Teacher Support, Investigation, Task Orientation, and Equity) were subjected to separate factor analyses (principal axis factoring with varimax rotation and Kaiser normalization). Analyses were conducted separately for pretest and posttest data. The criteria for the retention of any item were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on all other scales. The application of those criteria led to the complete deletion of the original Equity scale and three Involvement items (namely, Item 11: The teacher asks me questions; Item 15: Students discuss with me how to go about solving problems; and Item 16: I am asked to explain how I solve problems). Removal of these items improved the internal consistency and factorial validity of the WIHIC. Table 4.1 reports the factor analysis results. For the remaining 21 items, Table 4.1 shows that every item had a loading of at least 0.40 on its own scale and less than 0.40 on each of the other two scales. This pattern existed for both pretest and posttest data.

The percentage of variance accounted for by different WIHIC scales ranged from 8.49% to 37.51% for pretest data and from 7.23% to 44.18% for posttest data (see Table 4.1). The total variance was 57.61% for pretest data and 63.17% for posttest data for the remaining three scales of Teacher Support, Involvement, and Task Orientation. The learning environment scale of Teacher Support accounted for most of the total variance (37.51% for pretest data and 44.18% for posttest data). Eigenvalues associated with different factors ranged from 2.04 to 9.00 for pretest data and from 1.74 to 10.60 for posttest data.

When the Cronbach alpha reliability coefficient was used as an index of scale internal consistency, the reliability was high for all scales of the modified WIHIC learning environment questionnaire for both the pretest and posttest. Using the individual as the unit of analysis, Cronbach alpha coefficients ranged from 0.81 (Task Orientation) to 0.90 (Teacher Support) for the pretest and from 0.85 (Task Orientation) to 0.92 (Teacher Support) for the posttest.

My results are comparable to those of previous studies that showed good factorial validity and internal consistency reliability. Recent studies with the WIHIC have included all levels of mathematics and science students including: primary and secondary students in Queensland and Western Australia (Dorman, 2003); and secondary students in Australia (Kilgour, 2009), Singapore (Chionh & Fraser, 2009; Chua et al., 2009), Australia and Indonesia (Fraser et al., 2010), Australia and Canada (Zandvliet & Fraser, 2005) and the United States (Hoang, 2008). Other recent studies included samples of middle/secondary school students in the United States (Azimioara & Fraser, 2007; Biggs, 2009; den Brok et al., 2006; Ogbuehi & Fraser, 2007; B. A. Taylor, 2004; Wolf & Fraser, 2008), as well as university students in Indonesia (Margianti et al., 2004) and United Arab Emirates (MacLeod & Fraser, 2010). Overall, the results in Table 4.1 support the *a priori* structure and internal consistency reliability of the modified WIHIC.

Table 4.1 Factor Analysis Results and Reliability for Learning Environment Scales for Pretest and Posttest

Item	Factor Loadings					
	Teacher Support		Involvement		Task Orientation	
	Pre	Post	Pre	Post	Pre	Post
TS 1	0.72	0.68				
TS 2	0.66	0.79				
TS 3	0.78	0.76				
TS 4	0.69	0.66				
TS 5	0.63	0.70				
TS 6	0.74	0.76				
TS 7	0.68	0.68				
TS 8	0.57	0.56				
INV 9			0.76	0.76		
INV 10			0.80	0.78		
INV 12			0.59	0.59		
INV 13			0.57	0.55		
INV 14			0.50	0.55		
TO 17					0.70	0.70
TO 18					0.65	0.69
TO 19					0.67	0.73
TO 20					0.66	0.76
TO 21					0.73	0.75
TO 22					0.65	0.61
TO 23					0.64	0.71
TO 24					0.67	0.76
% Variance	37.51	44.18	8.49	7.23	11.61	11.76
Eigenvalue	9.00	10.60	2.04	1.74	2.79	2.82
α Reliability	0.90	0.92	0.89	0.91	0.81	0.85

Sample of 313 students in 20 classes.
Factor loadings less than 0.40 have been omitted from the table.
Principal axis factoring with varimax rotation and Kaiser normalization.
Items INV11, INV15, INV16 were omitted.

4.2.2 Validity and Reliability of Attitude and Efficacy Scales

Data collected with the two attitude scales from the ATMI (Value and Enjoyment) and one academic-efficacy scale from PALS (Academic Efficacy) also were subjected to separate factor analyses (principal axis factoring with varimax rotation and Kaiser normalization). Analyses were conducted separately for pretest and posttest data. The criteria for the retention of any item again were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on the other two scales. These criteria led to improved internal consistency and factorial validity. This process led to elimination of two Value items (Item 38: I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in mathematics and Item 39: I am comfortable answering questions in math class) and one Enjoyment item (Item 40: Mathematics is dull and boring). Only factor loadings of 0.40 or higher are reported in Table 4.2.

Table 4.2 Factor Analysis Results and Reliability for Attitude and Academic Efficacy Questionnaire for Pretest and Posttest

Item	Factor Loadings					
	Value		Enjoyment		Academic Efficacy	
	Pre	Post	Pre	Post	Pre	Post
VAL 33	0.70	0.69				
VAL 34	0.66	0.70				
VAL35	0.66	0.79				
VAL 36	0.69	0.80				
VAL 37	0.71	0.77				
ENJ 41			0.56	0.62		
ENJ 42			0.54	0.53		
ENJ 43			0.72	0.72		
ENJ 44			0.72	0.76		
ENJ 45			0.67	0.52		
ENJ 46			0.51	0.48		
EFF 47					0.57	0.66
EFF 48					0.52	0.67
EFF 49					0.68	0.80
EFF 50					0.78	0.74
EFF 51					0.69	0.71
% Variance	47.99	52.49	9.20	8.81	7.96	9.01
Eigenvalue	7.68	8.40	1.47	1.41	1.27	1.44
α Reliability	0.88	0.92	0.85	0.86	0.86	0.90

Sample of 313 students from 20 classes.
Factor loadings less than 0.40 have been omitted from the table.
Principal axis factoring with varimax rotation and Kaiser normalization.
Items VAL38, VAL39 and ENJ40 were omitted.

The percentage variance and the eigenvalue for each scale are shown at the bottom of Table 4.2. The percentage of total variance for different attitude and efficacy scales ranged from 7.96% to 47.99% for pretest data and from 8.81% to 52.49% for posttest data. Eigenvalues associated with each factor ranged from 1.27 to 7.68 for pretest data and from 1.41 to 8.40 for posttest data. The total variance was 65.15% for pretest data and 70.31% for posttest data for the three attitude and efficacy scales of Value, Enjoyment, and Academic Efficacy. The attitude scale of Value accounted for most of the total variance (47.99% for pretest data and 52.49% for posttest data).

The Cronbach alpha reliability coefficient was high for all scales of the modified attitude and efficacy questionnaire for both the pretest and posttest. Using the individual as the unit of analysis, Cronbach alpha coefficients ranged from 0.85 (Academic Efficacy) to 0.88 (Value) for the pretest and from 0.86 (Enjoyment) to 0.92 (Value) for the posttest.

Similar indices of internal consistency were found when the ATMI was used with American middle-school mathematics students (Stokes, 2008; Tapia, 1996) and high school Algebra 1 students (Schroeder, 2007). These results were replicated with university students (Moldavan, 2007; Tapia & Marsh, 2000; 2002) in the United States. Midgley et al. (1998) reported similar results when using PALS with middle-school students in the United States, and results from an Australian study of secondary mathematics students (Smith et al., 2002) were also consistent with my results. Overall, the results support the factor structure and internal consistency reliability of the three-scale, 16-item version of the attitude and efficacy questionnaire.

4.3 Effectiveness of Success Lab

Having found the instruments to be valid and reliable, Research Question 2 was then investigated. Quantitative analyses were undertaken in order to determine how effective Success Lab was in terms of learning environment and students' attitudes toward mathematics and academic efficacy. The Algebra 1 classes have larger class sizes than the Success Labs and the students in Algebra 1 are more varied in characteristics such as socioeconomic status, previous algebra experience, and primary home language. Therefore, to avoid a systematic error such as confounding, 56 intervention students were matched on socio-economic status, previous algebra experience, and primary home language. Hinton (2004) advises that systematic errors can be avoided by deliberately selecting participants so that they are matched on one or more confounding variables. Chapter 3 provides more information on the matching process used in my study.

4.3.1 Methods of Analysis: t-tests with Modified Bonferroni Correction and Effect Sizes

To investigate whether differences in terms of scores on the WIHIC and attitude and efficacy scales (Research Question 2) existed between students in Success Lab and the comparison group of students not receiving the intervention, a paired-samples *t*-test (n = 56) was used with each scale to determine the statistical significance of between-group differences. These significance tests were conducted separately for pretest and posttest data to see if any changes in the between-group differences occurred during the intervention (Figure 4.1 and Figure 4.2). Also, scale scores for the pretest data were used to confirm how successful the process of matching of the intervention group and the non-intervention group had been.

Conducting multiple *t*-tests can produce Type I errors (finding a statistically significant difference where one does not exist). Therefore, in order to reduce Type I errors, I used a modified Bonferroni correction (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004) when determining statistical significance. A more thorough explanation of the modified Bonferroni correction was provided previously in Section 3.4.2.

The number of dependent variables (scales) determines the number of tests to be performed because each *t*-test examines the effect of only one pair of variables (one dependent and one independent) at a time (Hinton, 2004). As additional *t*-tests are performed, the probability of making a Type I error increases. In my study, a modified Bonferroni correction (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004) was used to adjust the probabilities obtained from significance testing (p-values) in order to reduce any Type I errors that might have occurred.

The modified Bonferroni correction involves the following method. After ranking the probabilities obtained from significance testing (p-values) from smallest to largest (most significant to least significant), the p-values are recalculated based on the number of tests to be performed (n) (B. A. Taylor, 2004). The smallest p-value is multiplied by total number of tests to be conducted, $n = 6$ in my study, and compared to α (0.01 or 0.05). If this new p-value is less than α, it is statistically significant and the next smallest p-value is then multiplied by $(n - 1)$ and compared to the desired α. This pattern continues by multiplying each successive p-value by the next $(n - k)$ until a statistically non-significant result is obtained, guaranteeing the remaining p-values are also nonsignificant (Holland & Copenhaver, 1988; Jaccard & Wan, 1996; B. A. Taylor, 2004).

Neill (2008) advises that "One of the most common questions driving evaluation of intervention programs is "did we get an effect?". However, very often, the question could be more usefully phrased as "how *much* effect did this program have?" Paired-samples t-tests were conducted to answer the "did we get an effect?" question. To answer the "how much effect did the program get?" question, effect sizes were used.

Effect size (d) indicates the magnitude of a difference. The effect size was calculated in my study by dividing the difference between the means of the two groups by the pooled standard deviation and is expressed in standard deviation units (J. Cohen, 1988). Jacob Cohen (1988) describes an effect size as small, medium and large. Small ($d = 0.2$), medium ($d = 0.5$), and large effects ($d = 0.8$) are used as a guide to evaluate the magnitude of a statistically significant difference (Hinton, 2004). Effect size is independent of sample size, which is useful because sample size can influence significance testing results. Hinton (2004) continues to say that we cannot control for random errors but, by setting a significance level appropriately, we can decide if there is a difference between samples caused by random errors.

4.3.2 *Between-group Differences in Learning Environment Perceptions, Students' Attitudes Toward Mathematics, and Academic Efficacy*

Table 4.3 reports the average item mean and average item standard deviation for each learning environment and attitude and efficacy scale separately for pretest and posttest and separately for the intervention and non-intervention groups. The average item mean is the scale mean divided by the number of items in the scale and was used to enable meaningful comparison of average scores on scales containing different numbers of items. A comparison of the differences in terms of mean scores between the two groups can be seen in Figure 4.1 and 4.2 for pretest and posttest data, respectively.

In my study, I compared the intervention group and the non-intervention group using matched pairs of students (n = 56) for each of the six different scales assessing learning environment and students' attitudes toward mathematics and academic efficacy (Teacher Support, Involvement, Task Orientation, Value, Enjoyment, and Academic Efficacy). As described in Section 4.3.1, my comparisons of the two instructional groups were conducted separately for pretest and posttest data, involved t-tests to ascertain the statistical significance of differences, and included effect sizes to estimate the magnitude of these differences. Table 4.3 shows, separately for pretest and posttest data, the t-value and effect size for the between-group difference for each of the six learning environment and attitude and efficacy scales.

Table 4.3 also reports the probability (p) or statistical significance associated with the t-test conducted for the between-group differences on each of the six scales. This table provides the p-values and statistical significance both before and after the application of the modified Bonferroni correction, described in Section 4.3.1, which was used to reduce the likelihood of Type I errors. Statistically significant between-group differences for the posttest, with α = 0.05 prior to applying the modified Bonferroni correction, occurred for the scales of Involvement (p = 0.002), Teacher Support and Task Orientation (p = 0.004 for each), and Value (p = 0.042). After performing the modified Bonferroni correction, statistically significant between-group differences remained only for Involvement (p = 0.012), Teacher Support (p = 0.020), and Task Orientation (p = 0.016), with α = 0.05 (see Table 4.3).

Table 4.3 Average Item Mean, Average Item Standard Deviation and Difference (Effect Size and *t*-Test Results Using Modified Bonferroni Correction) Between Intervention and Non-Intervention Students in Learning Environment and Attitude and Efficacy Scores for Pretest and Posttest

Scale	Administration	Average Item Mean		Average Item Standard Deviation		Difference			
		Intervention	Non-Intervention	Intervention	Non-Intervention	Effect Size	*t*	*p* before Correction	*p* after Correction
Learning Environment									
Teacher Support	Pre	3.43	3.55	0.72	0.86	-0.14	-0.87		
	Post	3.61	3.13	0.74	1.05	0.51	2.97	0.004**	0.020*
Involvement	Pre	3.18	3.15	0.88	0.86	0.04	0.22		
	Post	3.43	2.90	0.81	1.02	0.57	3.32	0.002**	0.012**
Task Orientation	Pre	4.10	4.03	0.64	0.56	0.16	0.64		
	Post	4.15	3.79	0.57	0.78	0.54	2.97	0.004**	0.016*
Attitude/Efficacy									
Value	Pre	3.88	3.86	0.96	0.84	0.02	0.13		
	Post	3.77	3.42	0.81	1.15	0.34	2.08	0.042*	
Enjoyment	Pre	3.07	3.06	1.00	0.92	0.01	0.07		
	Post	3.11	2.87	0.92	0.91	0.26	1.61		
Academic Efficacy	Pre	3.80	3.74	0.83	0.82	0.07	0.37		
	Post	3.78	3.62	0.91	0.84	0.18	1.09		

n = 56 matched pairs
* $p < 0.05$, ** $p < 0.01$
The effect size is the between-group difference in means divided by the pooled standard deviation.
Only p values less than 0.05 are included

Table 4.3 shows that, at the time of the pretest, differences between the intervention group and the non-intervention group were small in magnitude (ranging from only 0.01 to 0.16 standard deviations for different scales) and statistically nonsignificant for every learning environment and attitude and efficacy scale. This pattern is to be expected and supports the effectiveness of the process of matching students in the two instructional groups according to socioeconomic status, previous algebra experience, and primary home language.

At the time of posttesting, however, Table 4.3 shows that differences between the intervention group and the non-intervention group were statistically significant for three of the six scales even after the modified Bonferroni correction was applied. The three scales for which between-group differences were statistically significant were Teacher Support, Involvement, and Task Orientation. Also the between-group difference was sizeable in magnitude for each of these three learning environment scales (with effect sizes of over half a standard deviation, which indicate a medium effect). Cohen (1988) explains that medium effects are 'visible to the naked eye', meaning that it is clear that there is a difference. For these three scales, intervention students perceived more Teacher Support, more Involvement and more Task Orientation in their algebra class than did the non-intervention students at the time of posttesting.

Table 4.3 also shows that, for each of the three attitude and efficacy scales at the time of posttesting, the differences between the intervention group and the non-intervention group were statistically nonsignificant (after application of the Bonferonni correction) and were associated with relatively small effect sizes ranging from only 0.18 to 0.34 standard deviations. However, the between-group differences were still positive for all attitude and efficacy scales, suggesting that intervention students had somewhat more positive attitudes toward mathematics and academic efficacy than the non-intervention group.

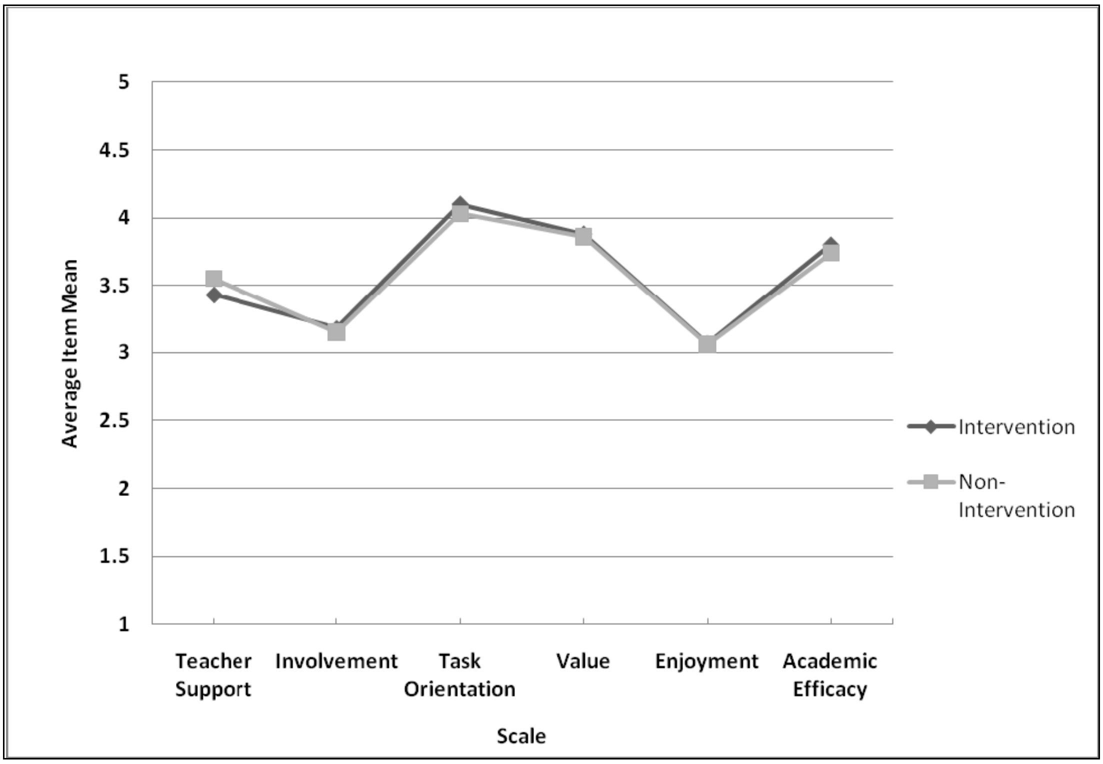

Figure 4.1 Pretest: Differences between the Intervention Group and Non-Intervention Group on Learning Environment and Attitude and Efficacy Scales (*n* = 56 matched pairs)

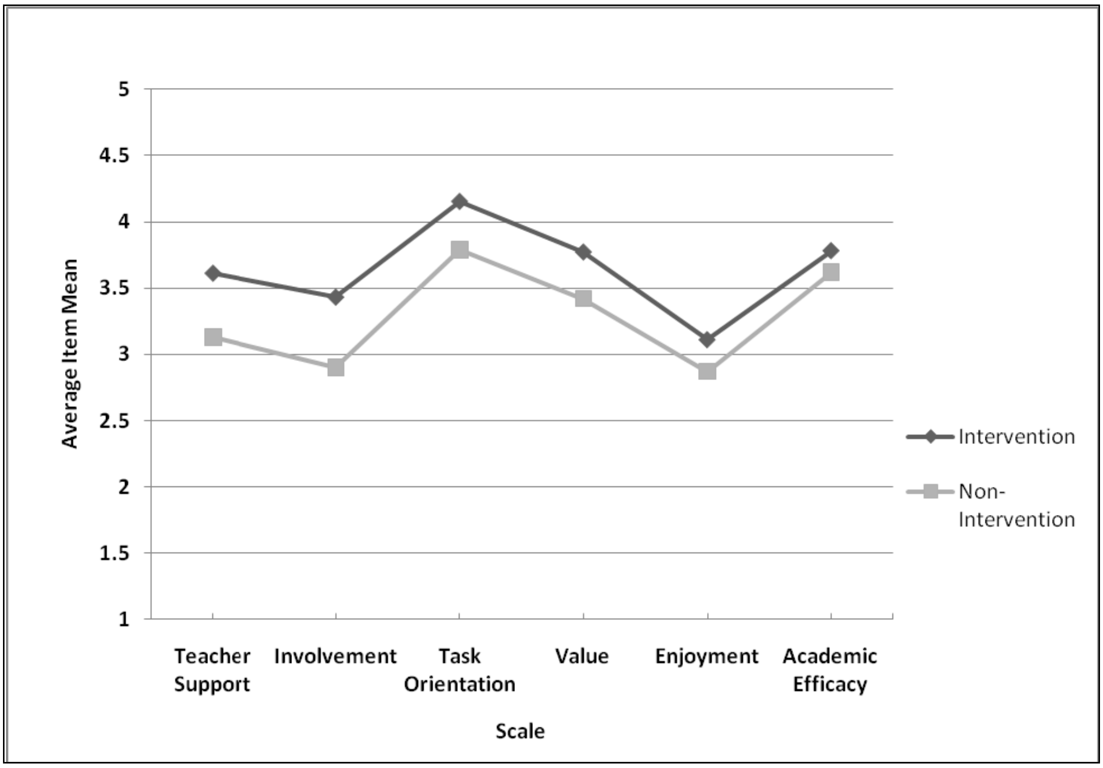

Figure 4.2 Posttest: Differences between the Intervention Group and Non-Intervention Group on Learning Environment and Attitude and Efficacy Scales (*n* = 56 matched pairs)

Figure 4.1 depicts differences between the intervention group and the non-intervention group in terms of mean scores for each WIHIC scale and modified attitude and efficacy scale at the time of pretesting, whereas Figure 4.2 depicts between-group differences for the same scales for the posttest. Figure 4.1 graphically highlights the small magnitude of the difference between the two groups for the pretest data for every scale. The most noticeable difference in pretest average item mean scores between the intervention group and the non-intervention group was for the scale of Teacher Support, with the non-intervention group's perceptions being slightly more positive. The average item mean scores for the other five scales appear so similar for the two groups that it is hard to distinguish between them on the graph. The small magnitude of the differences between the two groups for the pretest data confirm the success of the matching of the 56 pairs of students used in this study.

In contrast to Figure 4.1, Figure 4.2 clearly shows a widening gap between the perceptions of the intervention group and the non-intervention group on every WIHIC and attitude and efficacy scale on the posttest. The largest differences between groups in posttest perceptions occurred for the learning environment scales, with Teacher Support showing the greatest amount of difference. Smaller between-group differences are evident for the two attitude and efficacy scales, with the smallest gap between occurring for of academic efficacy. It is evident that the intervention students had more positive learning environments perceptions and somewhat more positive attitudes toward mathematics and academic efficacy on the posttest than did the non-intervention group.

4.4 Associations between Learning Environment and Student Outcomes of Attitudes toward Mathematics and Academic Efficacy

My last research question involves associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy. Table 4.4 shows the results when simple correlation and multiple regression analyses were run using the full sample of ninth grade Algebra 1 students (N = 313). Simple correlations (r) were used to reveal the bivariate association between each student outcome and each of the three learning environment scales. The results of the simple correlation analysis shown in Table 4.4 suggest a positive and statistically significant

($p < 0.01$) correlation between each student attitude and efficacy scale (Value, Enjoyment and Academic Efficacy) and each of the three learning environment scales (Teacher Support, Involvement, and Task Orientation) for both the pretest and posttest data.

Multiple regression analysis was used to provide information about the joint influence of the set of correlated learning environment scales on each student attitude and efficacy scale and reduces the Type I error rate commonly associated with simple correlation analysis. The bottom of Table 4.4 shows that the multiple correlation (R) between the set of three learning environment scales and an attitude and efficacy scale (Value, Enjoyment and Academic Efficacy) was statistically significant ($p < 0.01$) for both the pretest and posttest data with values ranging from 0.58 to 0.73.

To determine which specific learning environment scale accounted for most of the variance in the attitude and efficacy scales, standardized regression weights were examined. The regression coefficient (β) indicates the strength of the association between each attitude and efficacy scale and each learning environment scale when the other two learning environment scales were mutually controlled. Table 4.4 shows that significant independent predictors of the Value scale were Teacher Support and Task Orientation for the pretest data and Involvement and Task Orientation for the posttest data. All three learning environment scales were statistically significant independent predictors of Enjoyment for both pretest and posttest data. For Academic Efficacy, all three learning environment scales were significant independent predictors for pretest data and the two learning environment scales of Involvement and Task Orientation were significant independent predictors for the posttest data.

The positive outcome-environment associations found in my study replicate much past research (e.g. Fraser, 2007; Goh & Fraser, 1998). The positive, statistically significant associations between Value and each learning environment scale indicate that students valued mathematics more when the teacher was helpful and took an interest in students (Teacher Support). My study replicates the findings of Hoang

(2008) and Madu and Fraser (2009) for associations between Value and each learning environment scale of Involvement and Task Orientation.

In my study, Enjoyment was positively and significantly associated with each of the learning environment scales when all the other learning environment scales are mutually controlled. These results replicate previous studies (Hoang, 2008; Madu & Fraser, 2009).

Table 4.4 Simple Correlation and Multiple Regression Analyses for Associations between Student Outcomes and Learning Environment for Pretest and Posttest Data

Environment Scale	Admini-stration	Outcome-Environment Association					
		Value		Enjoyment		Academic Efficacy	
		r	β	*r*	β	*r*	β
Teacher Support	Pre	0.41**	0.14**	0.48**	0.25**	0.39**	0.11*
	Post	0.42**	0.09	0.47**	0.21**	0.48**	0.07
Involvement	Pre	0.34**	0.03	0.45**	0.22**	0.41**	0.15**
	Post	0.44**	0.12*	0.47**	0.21**	0.58**	0.30**
Task Orientation	Pre	0.68**	0.61**	0.51**	0.31**	0.63**	0.52**
	Post	0.64**	0.54**	0.49**	0.28**	0.67**	0.49**
Multiple Correlation, *R*	Pre		0.69**		0.61**		0.65**
	Post		0.66**		0.58**		0.73**

Sample of 313 students in 20 classes.
$*p < 0.05$, $**p < 0.01$

Taylor (2004) found that both Involvement and Task Orientation were positively and significantly associated with Enjoyment, but the association between Enjoyment and Teacher Support was negative, indicating a decrease in Enjoyment as Teacher Support increased. Azimioara and Fraser (2007) and Biggs (2009) found positive and significant correlations between both Teacher Support and Task Orientation with Enjoyment. Gottfried (1985) suggests that these results are important because research shows that students who value and enjoy mathematics often have a higher level of achievement (Schroeder, 2007). In addition, Bembenutty and Karabenick (1998) found that a high degree of self-efficacy is linked with high academic performance (Schroeder, 2007). These results suggest that, even though students might come into a class poorly motivated and with poor attitudes or low interest in mathematics, teachers can still have a positive influence by paying attention to the classroom learning environment (Ma & Xu, 2004).

My study showed independent, positive, and statistically significant associations between Academic Efficacy and each of the three learning environment scales. This replicates previous studies that also showed an increase in students' beliefs regarding their ability to do mathematics as teacher support, student involvement, and students' ability to stay on task increases (Dorman, 2001; Dorman, Adams, & Ferguson, 2003).

4.5 Summary and Conclusions

This chapter reported the analyses and results for my study's three research questions which focused on: the validity and reliability of the instruments used; the effectiveness of the Success Lab intervention in terms of algebra students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy; and associations between learning environment and attitudes toward mathematics and academic efficacy.

A sample of 313 ninth grade Algebra 1 students from 20 classrooms at three high schools in the Tulare Joint Union High School District provided quantitative data using a pretest/posttest design. 56 students concurrently enrolled in Algebra 1 and the intervention class, Success Lab, were matched to a comparison group comprised of 56 non-intervention Algebra 1 students in order to investigate the effectiveness of the Success Lab class. Quantitative data were collected using selected scales from the What Is Happening In this Class? learning environment instrument, the Attitudes Toward Mathematics Inventory, and a scale assessing academic efficacy (the Patterns of Adaptive Learning Scales). The instrument was offered in English and Spanish to accommodate students' language needs.

Factor and reliability analyses were performed for each instrument to identify the level of confidence that researchers can have in the results in this study (Table 4.1 and Table 4.2). A paired-samples *t*-test was used with each scale to determine the statistical significance of between-group differences. These significance tests were conducted separately for pretest and posttest data. Because conducting multiple *t*-tests can produce Type I errors, I used a modified Bonferroni correction to the *p*-values obtained from the significance tests also. Effect sizes were calculated to describe the magnitude of differences between the two instructional groups (Table 4.3). Simple correlation and multiple regression analyses were used in order to investigate associations between learning environment and attitude and efficacy scales (Table 4.4).

Factor analysis (principal axis factoring with varimax rotation and Kaiser normalization) performed with data for the learning environment scales showed that three of the original four scales should be kept for further analyses. Those three scales accounted for 57.61% of the total variation for the pretest data and 63.17% of the total variation for the posttest data. Only items with factor loadings of least 0.40 on their own scale and less than 0.40 on all other scales were retained. The Cronbach alpha reliability coefficient exceeded 0.80 for every learning environment scale for both the pretest and posttest.

Factor analysis of data for the three attitude and efficacy scales of the ATMI/PALS revealed results consistent with previous uses of these instruments. Those three scales accounted for 65.15% of the total variation for pretest data and 70.31% of the total variation for posttest data. Only items with factor loadings of least 0.40 on their own scale and less than 0.40 on all other scales were retained. Cronbach alpha reliability coefficients all exceeded 0.85 for each attitude and efficacy scale for both pretest and posttest data.

After determining that the instruments were valid and reliable when used with my sample of ninth grade Algebra 1 students in central California, the effectiveness of Success Lab was investigated (Research Question 2) using 56 matched pairs of students from the intervention group and students from the non-intervention group. The criteria were students' perceptions of their learning environment and attitudes toward mathematics and academic efficacy. A comparison of the two instructional groups showed very little differences for pretest data, thus confirming the close matching of the student pairs (Figure 4.1). However, when comparing average item means for posttest data for the intervention group and the non-intervention group, a statistically significant difference in students' perceptions of their learning environment was found, with the intervention students reporting more positive perceptions (Figure 4.2). These differences were sizeable in magnitude (with effect sizes over half a standard deviation indicating a medium effect) for each learning environment scale. Posttest differences between the intervention group and the non-intervention group were statistically nonsignificant for the three attitude and efficacy scales (after application of the modified Bonferroni correction) and were associated with relatively small effect sizes ranging from 0.18 to 0.34 standard deviations.

The statistical significance of between-group differences found using multiple paired-samples *t*-tests was adjusted using a modified Bonferroni correction to eliminate any Type I errors that might have been created. After applying the modified Bonferroni correction, only the between-group differences in students' perceptions of their learning environment remained statistically significant. Based on these comparisons, Success Lab had a positive effect for students' perceptions of the learning environment in Algebra 1, but not for the three attitude and efficacy scales. Nevertheless, students participating in the intervention class, Success Lab, had somewhat more positive scores for attitudes toward mathematics and academic efficacy than the non-intervention group.

The final goal of my study was to explore associations between the nature of the learning environment and attitudes toward mathematics and academic efficacy. For both pretest and posttest data, simple correlation analysis revealed positive and statistically significant correlations between each student attitude and efficacy scale and each of the three learning environment scales. Multiple regression analysis showed that the multiple correlation between the set of three learning environment scales and each attitude and efficacy scale separately was statistically significant for both the pretest and posttest data.

To determine which specific learning environment scale accounted for most of the variance for the attitude and efficacy scales, standardized regression coefficients were examined. Teacher Support and Task Orientation were significant independent predictors of Value for the pretest data and Involvement and Task Orientation were significant independent predictors of Value for the posttest data. All three learning environment scales were significant independent predictors of Enjoyment for both the pretest and posttest data, but only for pretest data for Academic Efficacy. Posttest analysis showed that Involvement and Task Orientation were significant independent predictors of Academic Efficacy. These findings replicate past studies showing the influence of the learning environment on the student outcomes of attitudes toward mathematics and academic efficacy (Allen & Fraser, 2007; Biggs, 2009; Chionh & Fraser, 2009; Fraser et al., 2010; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008).

The findings of my study can be used to answer each of my research questions. My instrument was found to be valid and reliable for measuring Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy (Research Question 1). Relative to a comparison group, Success Lab was found to be more effective in terms of the learning environment, but not students' attitudes toward mathematics and academic efficacy (Research Question 2). Positive associations were found between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy (Research Question 3).

Chapter 5

DISCUSSION AND CONCLUSION

5.1 Introduction

> Students' success in mathematics depends on the teacher more than on any other factor. Teachers must strive to create an environment that enhances the mathematical understanding of all students. All students need a solid foundation in mathematics, and all are capable of learning challenging mathematical content, although individual differences in educational outcomes are inevitable. Students must recognize that learning and progressing in mathematics result from dedication and determination. (Curriculum Development and Supplemental Materials Commission (California), 2005, p. 241)

Some students who need remediation perceive their low performance to be unchangeable, expect to fail in the future, and give up readily when confronted with difficult tasks (Chapman, 1988). A teacher's responsibility is to present mathematics in ways that allow students to experience the excitement and joy of doing mathematics and to attain mathematics proficiency (Curriculum Development and Supplemental Materials Commission (California), 2005). Students also have a responsibility for improving their success in mathematics. Students can start by participating actively in classroom instruction, supporting one another and cooperating with their teachers. In addition, students must persist when the mathematics content becomes challenging. With these responsibilities in mind, educators should pay attention to the quality of the learning environment. Research convincingly shows that attention to classroom environment is likely to pay off in terms of improving student outcomes (Chionh & Fraser, 2009; Ma & Xu, 2004).

This chapter provides a summary of the thesis (Section 5.2) and a discussion of the major findings (Section 5.3), limitations and biases (Section 5.4), implications (Section 5.5) of my research study. Recommendations for future research are discussed in Section 5.6.

5.2 Summary of Thesis

To evaluate the effectiveness of the Success Lab intervention class, three questions framed my study:

1. Is it possible to develop valid and reliable measures of Algebra 1 students' perceptions of the learning environment, attitudes toward mathematics, and academic efficacy?
2. How effective is Success Lab in terms of the learning environment and students' attitudes toward mathematics and academic efficacy?
3. Are there associations between the learning environment and the student outcomes of attitudes toward mathematics and academic efficacy?

Chapter 1 gave a concise statement of the main goal of my study, namely, "How effective is Success Lab in terms of the learning environment and students' attitudes toward mathematics and academic efficacy?" Chapter 1 also provided the rationale, background, and purposes of this study.

Chapter 2 provided a review of literature regarding the main areas of study for my research: classroom learning environments, attitudes toward mathematics, and academic efficacy. A historical background of the learning environment field, beginning with Lewin in 1936 and following through the next 70 years of evolution of that field, was presented in Section 2.2.

Section 2.3 discussed the development of learning environment assessment instruments, beginning with the Classroom Environment Scale (CES) developed by Moos (Moos & Trickett, 1974) and the Learning Environment Inventory (LEI) developed by Walberg (Walberg & Anderson, 1968) and concluding with Section 2.3.8 on the development, validation and utilization of the learning environment instrument chosen for my study, namely, the What Is Happening In this Class? (WIHIC) (Fraser et al., 1996).

Section 2.4 reviewed literature describing the field of attitudes toward mathematics and Section 2.5 focused on the literature describing the field of academic efficacy. Chapter 2 concluded with a discussion of past lines of research involving learning environment questionnaires (Section 2.6). In this last section, studies involving two lines of research that specifically pertained to my study were reviewed, namely, the evaluation of educational innovations and associations between learning environments and student outcomes.

Chapter 3 described the methodology used in answering the research questions of my study. Section 3.2 provided details of the sources of my data, demographic information about my sample, and the methods of data collection. Quantitative data were collected from 313 students in three high schools in Central California to validate the instrument used. These students were in 20 ninth grade Algebra 1 classes. Two subgroups of students were compared in this study (intervention and non-intervention groups). The non-intervention group only took Algebra 1. The intervention group took both Algebra 1 and the intervention class, Success Lab. Fifty-six matched pairs were chosen from these two groups and their scores were compared to evaluate the effectiveness of the Success Lab class in terms of learning environment, attitudes toward mathematics, and academic efficacy.

Section 3.3 discussed the selection and modification of the instruments used in my study. Four scales from the WIHIC learning environment instrument were selected to measure students' perceptions of Teacher Support, Involvement, Task Orientation, and Equity.

The instrument used to measure attitudes toward mathematics was the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004). Two of the four scales of the ATMI were chosen as being the most salient to my study: Value and Enjoyment.

The Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 1998) was chosen to measure students' academic efficacy in the area of mathematics. The scale chosen from this instrument was Academic-Related Perceptions, Beliefs and Strategies (referred to as Academic Efficacy in this study).

The final instrument, which combines scales from each of the three questionnaires, was translated into Spanish and then back-translated by the Spanish Department teachers at one of the participating high schools. This version was made available to any students who felt more comfortable with Spanish.

After the questionnaire scales were chosen and the data were collected, statistical analyses were undertaken with the data to answer the research questions in my study. Section 3.4 gave details on what analyses were used to answer each question.

To answer Research Question 1 concerning the validity of scales, student responses to the instrument were analysed to check the factor structure using principal axis factoring with varimax rotation and Kaiser normalization. Internal consistency reliability of each scale was determined by using the Cronbach alpha coefficient.

Matched paired-samples t-tests were utilized to explore differences between the 56 students concurrently enrolled in Algebra 1 and the intervention class, Success Lab, and a comparison group comprised of non-intervention Algebra 1 students in order to answer Question 2, concerning the effectiveness of Success Lab. Pretest and posttest scores were analysed to investigate the effectiveness of Success Lab in terms of students' perceptions of attitudes toward mathematics and academic efficacy.

Research Question 3 concerned associations between each student outcome and each of the three learning environment scales. Simple correlation analyses were undertaken using the full sample of Algebra 1 students (N = 313) to provide information about the bivariate association between each student attitude and efficacy scale and each learning environment scale. Multiple regression analysis was undertaken to provide information about the joint influence of the set of correlated learning environment scales on each individual student outcome. Standardized regression weights were examined to determine which specific learning environment scales were independent predictors of each attitude and efficacy scale when the other learning environment scales were mutually controlled.

All of the results for the statistical analyses were reported in Chapter 4. The major findings are summarized and discussed in Section 5.3 below.

5.3 Major Findings of the Study

My study's major findings are arranged below into three groups related to (1) the validity and reliability of the instruments used, (2) the effectiveness of the Success

Lab intervention in terms of algebra students' perceptions of their learning environment, attitudes toward mathematics, and academic efficacy, and (3) associations between learning environment scales and scales assessing attitudes toward mathematics and academic efficacy.

A sample of 313 ninth grade Algebra 1 students from 20 classrooms at three high schools in the Tulare Joint Union High School District was used to collect quantitative data using a pretest/posttest design. Fifty-six students concurrently enrolled in Algebra 1 and the intervention class, Success Lab, were matched to a comparison group comprised of non-intervention Algebra 1 students to investigate the effectiveness of the Success Lab class. Quantitative data were collected using selected scales from the What Is Happening In this Class? learning environment instrument, the Attitudes Toward Mathematics Inventory, and the Patterns of Adaptive Learning Scales. The instrument was offered in English and Spanish to accommodate students' language needs.

5.3.1 Findings for the Validity and Reliability of the Learning Environment Scales Based on the WIHIC and the Attitude and Efficacy Scales from the ATMI and PALS

Data gathered from the full sample of 313 ninth grade Algebra 1 students were used to analyse the quantitative data to determine the validity and reliability of the instrument used. Separate factor analyses were conducted for the learning environment instrument, the WIHIC, and for the attitude and efficacy instrument that contained scales from the ATMI and PALS.

5.3.1.1 Findings for the Validity and Reliability of the Learning Environment Scales

Finding 1: The *a priori* factor structure for the modified questionnaire containing four WIHIC scales (Teacher Support, Investigation, Task Orientation, and Equity) was checked using principal axis factoring with varimax rotation and Kaiser normalization. The original Equity scale and three Involvement items were eliminated when it was found that they did not meet the criteria for retention. For the remaining 21 items, every item had a loading of at least 0.40 on its own scale and less than 0.40 on each of the other two scales. This pattern existed for both pretest and posttest data. The total variance was 57.61% for pretest data and 63.17% for posttest data for the remaining three WIHIC scales.

Finding 2: The Cronbach alpha reliability coefficient, used as an index of scale internal consistency, was high for all retained scales of the modified WIHIC learning environment questionnaire for both the pretest and posttest. Using the individual as the unit of analysis, Cronbach alpha coefficients ranged from 0.81 (Task Orientation) to 0.90 (Teacher Support) for the pretest and from 0.85 (Task Orientation) to 0.92 (Teacher Support) for the posttest.

The findings for the validity and reliability of the modified WIHIC are comparable to those of previous studies that showed good factorial validity and internal consistency reliability with samples ranging from elementary school students to university students. Using samples of elementary school students, the WIHIC has been validated in various countries including the United States (Allen & Fraser, 2007; Pickett & Fraser, 2009) and South Africa (Aldridge et al., 2009). Also, the WIHIC has been validated using middle-school students in the United States (Biggs, 2009; den Brok et al., 2006; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008), Taiwan (Aldridge & Fraser, 2000; Aldridge et al., 1999), and Korea (Kim et al., 2000).

In cross-national studies involving large samples of secondary-school students, the WIHIC has been validated in Australia and Canada (Zandvliet & Fraser, 2005), in Australia and Indonesia (Fraser, Aldridge, & Adolphe, 2010) and in Australia, Canada and the United Kingdom (Dorman, 2003). Further validation studies involving secondary school students took place in the United States (Hoang, 2008), Turkey (Telli et al., 2009), Singapore (Chionh & Fraser, 2009; Chua et al., 2009), and Australia (Dorman, 2008; Kilgour, 2009).

Validation studies involving use of the WIHIC among higher-education students have taken place in Singapore (Khoo & Fraser, 2008), the United States (Martin-Dunlop & Fraser, 2008), Indonesia (Margianti et al., 2004), and Dubai (MacLeod & Fraser, 2010).

5.3.1.2 Validity and Reliability of Attitude and Efficacy Scales

Finding 3: Data collected with the two attitude scales from the ATMI (Value and Enjoyment) and one academic-efficacy scale from PALS (Academic Efficacy) also were subjected to separate factor analyses (principal axis factoring with varimax rotation and Kaiser normalization) and analyses were conducted separately for pretest and posttest data. This process led to elimination of two Value items and one Enjoyment item. Only items with factor loadings of at least 0.40 on its own scale and less than 0.40 on each of the other two scales were retained. The total variance was 65.15% for pretest data and 70.31% for posttest data for the attitude scales of Value, Enjoyment, and the Academic Efficacy scale.

Finding 4: The Cronbach alpha reliability coefficient was high for all scales of the modified questionnaire for both the pretest and posttest. Using the individual as the unit of analysis, Cronbach alpha coefficients ranged from 0.85 (Academic Efficacy) to 0.88 (Value) for the pretest and from 0.86 (Enjoyment) to 0.92 (Value) for the posttest.

The findings support the factor structure and internal consistency reliability of the three-scale, 16-item version of the attitude and efficacy questionnaire. Similar indices of internal consistency were found when the ATMI was used in recent studies using samples of students from elementary schools (Ke, 2008), middle schools (Kolodzy, 2007), secondary schools (Dart et al., 1999; Tapia & Marsh, 2004), and universities (G. E. Marsh, 2005; Moldavan, 2007).

Comparable results for internal consistency for PALS have been reported for samples from elementary schools (Linnenbrink, 2005; Midgley, 2002; Turner et al., 2002), middle schools (Anderman & Johnston, 1998; Middleton & Midgley, 1997), and secondary schools (Smith et al., 2002).

5.3.2 Findings for the Effectiveness of the Success Lab Intervention in Terms of Algebra Students' Perceptions of the Learning Environment, Attitudes Toward Mathematics, and Academic Efficacy

A paired-samples *t*-test (n = 56) was used with each learning environment or attitude and efficacy scale to determine the statistical significance of differences between the intervention group and the non-intervention group. These significance tests were conducted separately for pretest and posttest data to compare between-group differences.

Finding 5: At the time of the pretest, differences between the intervention group and the non-intervention group were small in magnitude (ranging from only 0.01 to 0.16 standard deviations for different scales) and statistically nonsignificant for every learning environment and attitude and efficacy scale, indicating that the matching of the pairs was successful.

Posttest differences between the intervention group and the non-intervention group for the three learning environment scales were statistically significant even after the modified Bonferroni correction was applied. Also the between-group differences were sizeable in magnitude for all three learning environment scales (with effect sizes of over half a standard deviation indicating a medium effect). The interpretation of these differences was that the students experiencing the intervention perceived more positive support from the teacher, were more involved in the algebra class, and perceived more task orientation after the intervention.

However, posttest differences between the intervention group and the non-intervention group were statistically nonsignificant for the three attitude and efficacy scales (after application of the modified Bonferroni correction) and were associated with relatively small effect sizes ranging from 0.18 to 0.34 standard deviations. Nevertheless, students participating in the intervention class, Success Lab, had somewhat more positive attitudes towards mathematics and academic efficacy than the non-intervention group.

5.3.3 Findings for Associations Between Learning Environments and Attitudes Toward Mathematics and Academic Efficacy

Finding 6: The results of the simple correlation analysis using the full sample of ninth grade Algebra 1 students (n = 313) suggest a positive and statistically significant ($p < 0.01$) correlation between each student outcome scale (Value, Enjoyment and Academic Efficacy) and each of the three learning environment scales (Teacher Support, Involvement, and Task Orientation) for both the pretest and posttest data.

Finding 7: The multiple correlation between the set of three learning environment scales and each outcome scale (Value, Enjoyment and Academic Efficacy) was statistically significant for both the pretest and posttest data with values ranging from 0.58 to 0.73.

Finding 8: Standardized regression weights indicated that significant independent predictors of the Value scale were Teacher Support and Task Orientation for the pretest data and Involvement and Task Orientation for the posttest data. All three learning environment scales were statistically significant independent predictors of Enjoyment for both pretest and posttest data. For Academic Efficacy, all three learning environment scales were significant independent predictors for pretest data and the two learning environment scales of Involvement and Task Orientation were significant independent predictors for the posttest data.

The positive outcome-environment associations found in my study replicate past research for associations between Value and each learning environment scale of Involvement and Task Orientation (Hoang, 2008; Madu & Fraser, 2009). The positive associations found in my study between Enjoyment and each of the learning environment scales replicate previous studies (Aldridge & Fraser, 2000; Fraser, Aldridge, & Adolphe, 2010; Fraser et al., 1995; Hoang, 2008; Ogbuehi & Fraser, 2007). My findings of independent, positive, and statistically significant associations between Academic Efficacy and each of the three learning environment scales replicates previous studies (Aldridge & Fraser, 2008; Dorman, 2001; Hoang, 2008).

The current emphasis on Algebra 1 in schools in California gives impetus to educators to research possible ways to help struggling mathematics students to be more involved in their mathematics class and have more confidence in their ability to succeed in mathematics. The findings of this study suggest that student attitudes toward mathematics and academic efficacy can be enhanced through the use of an additional class period that provides support for the students at risk of failure.

5.4 Limitations and Biases of the Study

In Section 3.5, a discussion of Cohen, Manion, and Morrison's (2000) four stages of the introduction of biases and invalidity into a research project were discussed. This section summarizes each stage of my research and my attempts to minimize biases and invalidity in those four areas of research design, data gathering, data analysis, and data reporting.

For the first stage of research, research design, Cohen and associates (2000) describe three areas that should be carefully thought out: an appropriate time frame, adequate resources and appropriate instruments. In my study, the time frame was sufficient (18 weeks) but, because of weather conditions, the posttesting yielded fewer student responses than planned. To avoid any issues with the adequacy of resources, additional copies of the survey instruments were available during the collecting of data. The appropriateness of the instruments was determined through my extensive literature review of instruments used to measure learning environments, attitudes toward mathematics and academic efficacy (see Chapter 2).

Data gathering is the second area of concern in research and this was discussed in Section 3.5. This concern was addressed by administering the surveys myself. Bias, invalidity issues, and students' fear of their teacher seeing their answers during data gathering were reduced by this choice.

Data management and data interpretation are the foci of the third area of concern. By entering the data into a spreadsheet myself, inaccuracies in data entry were reduced. Data interpretation was alleviated by validity testing the instruments and using data analyses that were straightforward and appropriate for the study. The use of the modified Bonferroni correction during data analysis minimized Type I errors as discussed earlier in Section 3.4.2.

There were several limitations with my study. One limitation was the lack of achievement data. The effectiveness of a program is most often viewed in light of increased academic achievement for those students participating in the program. I chose not to use achievement data because, during the time frame of my study, there were no common tests at each of the three schools that would generate achievement data to analyse. Instead, I based the effectiveness of Success Lab on positive changes in students' perceptions of the learning environment in Algebra 1, attitudes toward mathematics and academic efficacy. Research supports the claim that students with positive attitudes toward mathematics are more motivated to study, which often results in higher grades, and that students who develop a strong sense of efficacy have the ability to approach challenges better and have more intrinsic motivation (Aiken, 2002).

Another limitation of this study was in the area of data interpretation. Any conclusions made from these data are only strictly applicable to the intervention class, Success Lab, at the three schools in this specific school district and to the students in this study. Generalizations based on the results of this study should only be made to other intervention programs, other grade levels, or other school districts with considerable caution.

A third limitation was the lack of qualitative data to support and complement the findings of the data analyses from student responses to the questionnaire. Tobin and Fraser (1998) advise that, through the combined use of quantitative learning environment data and qualitative information (e.g. student interviews and classroom observations), greater credibility can be placed in findings because they emerge from data obtained using a range of data-collection methods.

Another area of concern is bias introduced into the study from the relationship of the researcher to the subjects of the study. While it is true that I had a personal involvement with the district, the teachers and courses, I conducted my research after I retired from employment in the district. By using ninth grade students, none of the students knew me. However, a bias might have been introduced in terms of which classes were chosen to be surveyed. Teachers who knew me and/or had worked with me were more willing to allow their classes to participate.

5.5 Significance and Implications of This Study

My study has made several contributions to the field of learning environments. In terms of using learning environment scales as criteria in evaluating the effectiveness of educational innovations, my study was the first to use learning environment dimensions to evaluate the effectiveness of an algebra intervention program for grade 9 students who were at risk of failing mathematics. Algebra intervention classes are increasing in popularity and this study provides educators with a model that may help at-risk students.

The second area of contribution is the choice of the specific instruments for evaluating associations between the learning environment and student outcomes. For the first time, the WIHIC, attitudes toward mathematics scales from the ATMI, and an academic-efficacy scale from PALS were used to determine outcome-environment associations for secondary-school mathematics students. The results of the factor analysis of these instruments provide evidence that they are appropriate for their use in secondary-school level mathematics classes in central California, and their validity and reliability in measuring the areas for which they were chosen to investigate.

Practical implications from findings from this study focus on (a) the effectiveness of Success Lab in terms of algebra students' perceptions of their learning environment, attitudes toward mathematics, and academic efficacy and (b) associations between learning environments and attitudes toward mathematics and academic efficacy.

Implications for Improving Students' Perceptions of their Learning Environment, Attitudes Toward Mathematics and Academic Efficacy

Paired-samples *t*-tests (Section 5.3.2, Finding 5) revealed that students who participated in Success Lab perceived more teacher support in Algebra 1, were more involved in the Algebra 1 class, and were more likely to stay on task than students who did not participate in Success Lab. Also, students enrolled in the intervention class, Success Lab, were found to have somewhat more positive attitudes toward mathematics and academic efficacy than the non-intervention group. This finding provides evidence that an additional support class for grade 9 Algebra 1 students is effective in improving the interpersonal relationship between them and their teacher and their participation in the Algebra 1 class.

Implications from Associations between the Learning Environment and Attitudes Toward Mathematics and Academic Efficacy

Simple correlation analysis (Section 5.3.3, Finding 6) and the multiple regression analysis (Section 5.3.3, Finding 7) provided evidence of positive associations between learning environment scales and the student outcomes of attitudes toward mathematics and academic efficacy. These results support the beliefs that some educators have regarding the influence of the learning environment on how students respond to their mathematics class.

Standardized regression weights (Section 5.3.3, Finding 8) revealed that the learning environment scales of Teacher Support, Task Orientation and Involvement were each independent predictors of student attitude scales of Enjoyment and Value, as well as academic efficacy. Based on this finding, teachers can feel confident that, even though students might come to a class poorly motivated, with poor attitudes or low interest in mathematics, the support that a teacher gives to the student, the amount of involvement that the student has in the class, and the student's ability to stay on task can be related to their attitudes toward mathematics and academic efficacy.

My study revealed that how a teacher relates to a student and the extent to which a student feels that it is important to complete planned activities and stay on the subject matter were predictors of a student's enjoyment of mathematics and a student's belief that he or she can successfully accomplish course outcomes and pass the course. My findings are relevant to researchers and educators looking for ways to improve students' attitudes toward mathematics and academic efficacy through changing the classroom environment.

5.6 Suggestions for Future Research

For every research study completed, there are avenues for future research that grow from it. A further study is needed into the effectiveness of different intervention models used to support algebra. The intervention in my study, extended time, is only one type of intervention. A study of different intervention models would be helpful in determining the most effective method of supporting the at-risk mathematics student in Algebra 1.

Further studies could be conducted into the long-lasting effects of an intervention program in areas such as: success in future mathematics courses, mathematics courses taken in high school; and success on the California High School Exit Examination (CAHSEE).

In future research, student achievement should be included because it is the criterion most pertinent when a school district measures the effectiveness of a new program. It would be advisable to use a common pretest/posttest of mathematics concepts across the sample being studied so that changes over the period of the study could be compared.

Qualitative data should be collected in any future research involving the effectiveness of an intervention program in mathematics. Student and teacher interviews, as well as classroom observations, would be likely to give insight into patterns that emerge from the quantitative data and to add credibility to the findings.

5.7 Concluding Remarks

All students in California must pass Algebra 1 in order to graduate from high school. It is the responsibility of the teachers to offer a classroom environment that is conducive to achievement for all students. Some students come to high school with negative attitudes toward mathematics. The experiences that they have had in middle school or earlier have made them unsure of themselves and caused them to feel that they cannot reach the expectations that have been set out for them. Many efforts are made to help those at-risk students to be successful in mathematics. From my study, I have learned that the classroom learning environment can have an effect on how students feel about mathematics and their academic efficacy.

Students with positive attitudes toward mathematics are more motivated to study, which often results in higher grades, which reinforces their positive attitudes toward mathematics. Students who develop a strong sense of efficacy have the ability to approach challenges better and they have more intrinsic motivation (Aiken, 2002). Through my research, I have learned that an intervention class for Algebra 1 can lead to improvements in students' perceptions of the learning environment of their Algebra 1 class. Students' attitudes toward mathematics and academic efficacy, however, were only affected to a small extent by participation in the intervention class. Teachers can benefit from my study's findings by understanding which types of teaching behaviours are associated with improved perceptions, attitudes and beliefs, thereby helping their students become more successful in Algebra 1.

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APPENDIX A

INFORMATION SHEETS AND CONSENT DOCUMENTS

Curtin University of Technology
Science and Mathematics
Education Centre

Student Participant Information Sheet

My name is Kathleen Landon. I am currently completing a piece of my research for my PhD in Mathematics Education at Curtin University of Technology.

Purpose of Research
I am investigating how the Success Lab classroom learning environment affects students' attitudes toward mathematics, and students' academic efficacy (belief in their ability to succeed and persevere).

Your Role
I would like to find out if being in Success Lab makes a difference in how you feel about mathematics and your ability to be successful in algebra.

I will ask you to fill out a survey in a couple of weeks and then again at the end of the semester. The survey will be given at the beginning or at the end of the class period so that your lessons will not be interrupted. The survey should take about twenty minutes. I may observe your Success Lab or Algebra 1 classroom or ask you to be part of a group of students that will meet with me to confidentially discuss the survey.

Consent to Participate
Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your grade in this class or my responsibilities. By completing and returning the survey, you have agreed to participate and allow me to use your data in this research.

Confidentiality
The information you provide will be kept separate from your personal details, and only I will have access to this. The interview transcript will not have your name or any identifying information on it and in adherence to university policy, the data will be kept in a locked cabinet for five years, before it is destroyed. You may choose a pseudonym for me to use if you would like.

Further Information
This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval number ________). If you would like further information about the study, please feel free to contact me at 564-3772 or by email: klandon@clearwire.net.
Alternatively you can contact my supervisor. (_________________)

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

Curtin University of Technology
Science and Mathematics
Education Centre

Curtin University of Technology

Estudiante Participante
Hoja de Información

Mi nombre es Kathleen Landon. Actualmente estoy terminando un pedazo de mi investigación para mi doctorado en Educación Matemática en la Universidad Curtin de Tecnología.

Objeto de Investigación

Estoy investigando la forma en que el éxito Laboratorio aprendizaje en el aula medio ambiente afecta a los estudiantes la actitud hacia las matemáticas, y los estudiantes auto-eficacia (la creencia en su capacidad para lograr el éxito y perseverar)..

Su Papel

Me gustaría saber si está en el éxito de Laboratorio marca una diferencia en cómo se siente acerca de las matemáticas y su capacidad para tener éxito en álgebra.

Yo le pedirá que llene una encuesta en un par de semanas y luego de nuevo al final del semestre. La encuesta se dará al comienzo o al final del período de clase para que sus lecciones no se interrumpa. La encuesta debe tener unos veinte minutos. Se me permite observar su éxito o Laboratorio de Álgebra 1 aula o pedirle a ser parte de un grupo de estudiantes que se reúna conmigo para hablar confidencialmente la encuesta.

El Consentimiento para Participar

Su participación en la investigación es totalmente voluntaria. Usted tiene el derecho a retirar en cualquier momento sin que ello afecte a su grado en esta categoría o mis responsabilidades. Al devolver la encuesta, que han aceptado participar y me permite utilizar sus datos en esta investigación.

Confidencialidad

La información que usted proporcione será manejada de manera independiente de sus datos personales, y sólo voy a tener acceso a este. En la adhesión a la política de la universidad, la información se mantendrá en un armario bajo llave por un período de cinco años, antes de que sea destruido. Usted puede elegir un seudónimo para mí a utilizar si quisiera.

Más información

Esta investigación ha sido revisado y aprobado por Curtin University of Technology Humanos, Comité de Ética de Investigación (número de autorización ________). Si desea más información sobre el estudio, no dude en ponerse en contacto conmigo al 564-3772 o por e-mail: klandon@clearwire.net.
Alternativamente puede ponerse en contacto con mi supervisor. (_________________)

Muchas gracias por su participación en esta investigación, su participación es muy apreciada.

Request for Student Permission to Participate in a Research Study

Student Name ________________________________ Teacher___________________

I am the parent/legal guardian of the student named above. I have received and read your letter regarding the research survey that my student will be asked to take and understand that if I have any questions or concerns I can contact the school principal.

After reading the information regarding the research project, I **do not** give my permission to include my student as he or she participates in a class conducted at

____ .
(Name of School)

If you object to your student's participation in this research project, please return this signed form to the teacher who will forward it to the researcher.

Signature of Parent or Guardian ____

Date_______________________________

Solicitud de estudiantes Permiso para participar en un estudio de investigación

Estudiantes Nombre ___________________________ Teacher___________________

Yo soy el padre/tutor legal del estudiante antes mencionadas. He recibido y leer su carta con respecto a la encuesta de investigación que mi alumno se le preguntó a tomar y comprender que si tengo preguntas o dudas puedo contactar a la escuela principal.

Después de leer la información sobre el proyecto de investigación, me **no** dar mi permiso para incluir mi estudiante como él o ella participa en una clase llevó a cabo en

____).
(nombre de la escuela

Si estudiante objeto a su participación en este proyecto de investigación, por favor regresar este firmado al maestro candidato que lo remitirá al investigador.

Firma del Padre o Guardian ____

Date_______________________________

Curtin University of Technology
Science and Mathematics Education Centre

Teacher Information Sheet

My name is Kathleen Landon. I am currently completing a piece of my research for my PhD in Mathematics Education at Curtin University of Technology.

Purpose of Research
I am investigating how the classroom learning environment of Success Lab affects students' attitude towards mathematics and students' academic efficacy. This will be done by comparing pretest and posttest surveys from the Algebra 1 classes. Only data from ninth graders will be used in this study.

Your Role
I will ask your students to fill out a survey at your convenience but within the first 3 weeks of school. Your class will need about twenty minutes to complete the survey. I will meet with your class to explain the purpose of the study, the procedures that will be used, and guarantee their privacy and confidentiality and right to non-participation. I will then conduct the survey. The Algebra 1 survey will include the classroom learning environment scales of Teacher Support, Involvement, Task Orientation and Equity, student attitude scales of Value and Enjoyment and a scale on academic efficacy.

The surveys will be readministered during the last three weeks of the semester.

Consent to Participate
Your involvement in the research, as well as the students', is entirely voluntary. You have the right to withdraw at any stage and your students have the right to withdraw at any stage without it affecting their grade in this class. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your students in this research. Student consent is given by completing and returning the survey in class. Only those students doing so will be included in the study. Some of the students surveyed will not be included as two groups will be chosen from the ninth grade Algebra 1 classes. The experimental group will be participating students in Success Lab and the control group will be participating students of similar academic characteristics that are only in Algebra 1

Confidentiality
The information your students provide will be kept separate from their personal details, and only I will have access to this. In adherence to university policy, the data will be kept in a locked cabinet for five years, before it is destroyed. A student may choose a pseudonym for me to use if he/she prefers.

Further Information
If you would like further information about the study, please feel free to contact me on 564-3772 or by email: klandon@clearwire.net.

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

Curtin University of Technology
Science and Mathematics
Education Centre

Request for Teacher Consent to Participate in the Research Study

Evaluation of Success Lab in Terms of Learning Environment, Attitudes Toward Mathematics and Academic Efficacy among High School Algebra Students

I ____ have read the information on the attached letter. Any questions I have asked have been answered to our/my satisfaction. I agree to participate in this research but understand that I can change my mind or stop at any time.

I understand that all information provided by me is treated as confidential.

I agree that research gathered for this study may be published provided names or any other identifying information is not used.

Participant Name
____

Participant Signature
____Date______________

Researcher: Kathleen Landon Kathleen Landon

Date______________

Curtin University of Technology
Science and Mathematics
Education Centre

Information sheet for Superintendent and Principal

Regarding the research:

Evaluation of Success Lab in Terms of Learning Environment, Attitudes Toward Mathematics and Academic Efficacy among High School Algebra Students

My name is Kathleen Landon. I am currently completing a piece of my research for my PhD in Mathematics Education at Curtin University of Technology.

Purpose of Research

I am investigating how the classroom learning environment of Success Lab affects students' attitude towards mathematics and academic efficacy. This will be done by comparing pretest and posttest surveys from the Algebra 1 classes. Only data from ninth graders will be used in this study.

What the teachers and students will be asked to do:

Within the first three weeks of school, I will explain my study to the Freshmen Algebra 1 teachers and ask for their consent to participate. Their students will complete a survey at their convenience within the first 3 weeks of school. Their class will need about twenty minutes to complete the survey at their convenience. I will meet with their class to explain the purpose of the study, the procedures that will be used, and guarantee their privacy and confidentiality and right to non-participation. I will then conduct the survey (printed in both English and Spanish). The Algebra 1 survey will include the classroom learning environment scales of Teacher Support, Involvement, Task Orientation and Equity, student attitude scales of Value and Enjoyment and a scale on academic efficacy.

Consent to Participate

Teacher and student involvement in the research is entirely voluntary. They have the right to withdraw at any stage without it affecting their job or grade in the class. I will meet with the classes to explain the purpose of the research study and explain what will occur.

Student consent is given by completing and returning the survey in class. Only those students doing so will be included in the study. Some of the students surveyed will not be included as two groups will be chosen from the ninth grade Algebra 1 classes. The experimental group will be participating students in Success Lab and the control group will be participating students of similar academic characteristics that are only in Algebra 1.

Confidentiality

The information students provide will be kept separate from their personal details, and only I will have access to this. In adherence to university policy, the data will be kept in a locked cabinet for five years, before it is destroyed. A student may choose a pseudonym for me to use if he/she prefers.

Risks

There are no risks identified for the participants but there are potential benefits to each school in terms of the effectiveness of the Success Lab program.

Further Information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval number ________). If you would like further information about the study, please feel free to contact me on 564-3772 or by email: klandon@clearwire.net.
Alternatively you can contact my supervisor. (_________________)

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

APPENDIX B

MATCHED PAIRS DATA

Matched Pairs Data

Pair	Group	school	SEX	Pretest %	Posttest %	EC	ELD	CST ELA Score	CST MATH Score	CST MATH TEST
Pair 1	Intervention	2	M	0	48	500		2	1	Algebra I
	Non-Intervention	2	M	37	22	500		2	1	Algebra I
Pair 2	Intervention	1	F	0	0	500	L	2	2	Algebra I
	Non-Intervention	1	M	0	82	500	L	2	2	Algebra I
Pair 3	Intervention	3	F	70	52	500	F	3	2	Algebra I
	Non-Intervention	3	F	70	42	500	F	3	2	Algebra I
Pair 4	Intervention	1	F	0	78	700		3	2	Algebra I
	Non-Intervention	1	F	0	76	700		3	2	Algebra I
Pair 5	Intervention	1	F	0	72	700		4	2	Algebra I
	Non-Intervention	1	F	0	72	700		4	2	Algebra I
Pair 6	Intervention	2	M	77	54	500	F	3	3	Algebra I
	Non-Intervention	1	M	0	0	500	F	2	3	Algebra I
Pair 7	Intervention	3	F	95	84	700		4	3	Algebra I
	Non-Intervention	1	F	0	67	700		4	3	Algebra I
Pair 8	Intervention	1	M	0	0	500	L	1	1	Gen Math
	Non-Intervention	2	M	35	44	700		1	1	Gen Math
Pair 9	Intervention	3	M	65	50	500	L	1	2	Gen Math
	Non-Intervention	3	M	24	26	500		1	1	Gen Math
Pair 10	Intervention	1	F	0	24	500		2	1	Gen Math
	Non-Intervention	3	F	70	12	500	L	2	1	Gen Math
Pair 11	Intervention	1	F	0	42	500	L	2	1	Gen Math
	Non-Intervention	2	F	54	54	700		1	2	Gen Math

Pair 12	Intervention	2	F	42	42	500	L	1	2	Gen Math
	Non-Intervention	1	F	0	60	500	L	1	2	Gen Math
Pair 13	Intervention	2	M	31	34	500	L	1	2	Gen Math
	Non-Intervention	3	M	49	36	500		2	2	Gen Math
Pair 14	Intervention	1	M	0	44	500		2	2	Gen Math
	Non-Intervention	3	M	59	92	500	L	2	2	Gen Math
Pair 15	Intervention	1	M	0	0	600		2	2	Gen Math
	Non-Intervention	3	M	59	38	500		2	2	Gen Math
Pair 16	Intervention	3	M	49	52	500	F	2	2	Gen Math
	Non-Intervention	1	M	0	50	700		2	2	Gen Math
Pair 17	Intervention	3	F	27	0	500	L	2	2	Gen Math
	Non-Intervention	1	F	0	45	400		2	2	Gen Math
Pair 18	Intervention	2	M	50	30	500		2	2	Gen Math
	Control	3	M	51	28	500	L	3	2	Gen Math
Pair 19	Intervention	2	F	27	34	700		2	2	Gen Math
	Control	3	F	32	32	600		2	2	Gen Math
Pair 20	Intervention	1	F	0	40	700		3	2	Gen Math
	Control	3	F	0	18	500		3	2	Gen Math
Pair 21	Intervention	1	F	0	33	500		3	2	Gen Math
	Control	2	F	56	34	500	R	3	2	Gen Math
Pair 22	Intervention	1	F	0	73	500	L	3	2	Gen Math
	Control	1	F	0	45	500	L	3	2	Gen Math
Pair 23	Intervention	3	F	32	20	600		4	2	Gen Math
	Control	3	F	78	62	500	R	4	2	Gen Math
Pair 24	Intervention	1	M	0	0	700		4	2	Gen Math
	Control	3	F	0	46	700		4	2	Gen Math

Pair 25	Intervention	2	M	0	26	600		2	3	Gen Math
	Control	3	M	43	46	500		2	3	Gen Math
Pair 26	Intervention	1	M	0	36	500	L	2	3	Gen Math
	Control	1	M	0	74	500		2	3	Gen Math
Pair 27	Intervention	3	M	57	34	500	L	1	4	Gen Math
	Control	3	M	54	36	500	L	2	4	Gen Math
Pair 28	Intervention	1	F	0	91	500	R	3	4	Gen Math
	Control	1	F	0	62	500	R	3	4	Gen Math
Pair 29	Intervention	1	F	0	46	999		NULL	NULL	NULL
	Control	1	F	0	78	500		NULL	NULL	NULL
Pair 30	Intervention	1	F	0	54	500		NULL	NULL	NULL
	Control	1	F	78	70	500		NULL	NULL	NULL
Pair 31	Intervention	1	F	0	0	500		NULL	NULL	NULL
	Control	1	F	0	0	700		NULL	NULL	NULL
Pair 32	Intervention	1	M	0	92	500	R	NULL	NULL	NULL
	Control	1	M	0	60	500	L	NULL	NULL	NULL
Pair 33	Intervention	1	M	0	91	500	L	NULL	NULL	NULL
	Control	1	M	0	24	500	L	NULL	NULL	NULL
Pair 34	Intervention	1	M	0	47	500	F	NULL	NULL	NULL
	Control	1	M	0	60	500	L	NULL	NULL	NULL
Pair 35	Intervention	1	F	0	42	500	L	NULL	NULL	NULL
	Control	1	F	0	44	500	L	NULL	NULL	NULL
Pair 36	Intervention	3	F	24	0	500		3	3	Gen Math
	Control	3	F	59	34	500	L	3	3	Gen Math
Pair 37	Intervention	1	F	0	0	500	L	3	3	Gen Math
	Control	1	F	0	51	700		3	3	Gen Math

Pair 38	Intervention	3	F	81	62	500	R	3	3	Gen Math
	Control	2	F	67	50	500	F	3	3	Gen Math
Pair 39	Intervention	1	F	64	53	500		3	3	Gen Math
	Control	1	F	50	34	700		3	3	Gen Math
Pair 40	Intervention	1	F	0	62	700		3	3	Gen Math
	Control	2	F	52	48	500	R	3	3	Gen Math
Pair 41	Intervention	1	M	0	77	500		2	3	Gen Math
	Control	3	M	59	36	500		2	3	Gen Math
Pair 42	Intervention	1	M	0	44	700	F	3	3	Gen Math
	Control	1	M	0	40	700		4	3	Gen Math
Pair 43	Intervention	3	F	76	48	500		5	3	Gen Math
	Control	3	F	0	38	500	F	4	3	Gen Math
Pair 44	Intervention	1	F	0	0	500	L	NULL	NULL	NULL
	Control	1	F	0	42	500	F	4	3	Gen Math
Pair 45	Intervention	1	F	0	40	700	F	4	4	Gen Math
	Control	3	M	78	44	700		4	4	Gen Math
Pair 46	Intervention	2	F	77	0	999		3	5	Gen Math
	Control	1	M	0	50	700		3	5	Gen Math
Pair 47	Intervention	1	M	0	87	500		NULL	NULL	NULL
	Control	1	M	0	78	500	R	NULL	NULL	NULL
Pair 48	Intervention	2	F	0	86	500	L	1	3	Gen Math
	Control	3	M	62	90	500	L	1	2	Gen Math
Pair 49	Intervention	2	F	44	32	500	L	2	4	Gen Math
	Control	3	M	35	0	500	L	2	1	Gen Math
Pair 50	Intervention	1	F	0	33	500	L	NULL	NULL	NULL
	Control	1	F	0	78	500	L	NULL	NULL	NULL

Pair 51	Intervention	1	M	0	50	500	L	NULL	NULL	NULL
	Control	1	M	0	64	500		NULL	NULL	NULL
Pair 52	Intervention	1	F	0	65	500	L	NULL	NULL	NULL
	Control	1	F	0	48	500	L	NULL	NULL	NULL
Pair 53	Intervention	1	F	0	38	500	L	NULL	NULL	NULL
	Control	3	F	49	24	500	L	NULL	NULL	NULL
Pair 54	Intervention	1	M	0	0	500	L	NULL	NULL	NULL
	Control	2	M	58	30	500		NULL	NULL	NULL
Pair 55	Intervention	2	M	69	74	500		NULL	NULL	NULL
	Control	2	M	56	60	500	L	NULL	NULL	NULL
Pair 56	Intervention	1	M	0	70	700		4	3	Gen Math
	Control	1	M	0	60	500	F	NULL	NULL	NULL

APPENDIX C

LEARNING ENVIRONMENT, ATTITUDES TOWARD MATHEMATICS AND ACADEMIC EFFICACY QUESTIONNAIRE

Items 1– 32 in this appendix are based on the What Is Happening In this Class? (WIHIC) questionnaire developed by Aldridge, Fraser and Hang (1999). Items 33–46 are based on The Attitudes Toward Mathematics Inventory developed by Tapia & Marsh (2004). Items 47–52 are based on the Patterns of Adaptive Learning Survey (PALS) developed by Midgley et al. (1996). The WIHIC is discussed in Sections 2.3.8 and 3.3.1, the ATMI is discussed in Sections 2.4 and 3.3.2, and PALS is discussed in Sections 2.5 and 3.3.3 of this thesis. These questionnaires were used in my study with the permission of their authors.

ALGEBRA 1 SURVEY

DIRECTIONS:

This is NOT a test.

There are no ‘right’ or ‘wrong’ answers. Your opinion is what is wanted.

Think how well each statement describes what your Algebra 1 class is like for students.

Draw a circle around

1 If you ***Strongly Agree***
2 If you ***Agree***
3 If you are ***Neutral***
4 If you ***Disagree***
5 If you ***Strongly Disagree***

Do not worry if some statements in this questionnaire are fairly similar.

Give your opinion to all statements.

EXAMPLE

Statement: Members of my algebra class do favors for one another.

You would need to decide whether you ‘Strongly Agree’, ‘Agree’, ‘are Neutral’ , ‘Strongly Disagree’ or ‘Disagree’ with the statement.

If you selected ‘Agree’, you would circle the number 2 on your questionnaire.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Members of my algebra class do favors for one another	1	(2)	3	4	5

Name:____

In my Algebra 1 class:

TS	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The teacher takes a personal interest in me.	1	2	3	4	5
2. The teacher goes out of his/her way to help me.	1	2	3	4	5
3. The teacher considers my feelings.	1	2	3	4	5
4. The teacher helps me when I have trouble with the work.	1	2	3	4	5
5. The teacher talks with me.	1	2	3	4	5
6. The teacher is interested in my problems.	1	2	3	4	5
7. The teacher moves about the class to talk with me.	1	2	3	4	5
8. The teachers' questions help me to understand.	1	2	3	4	5
I	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9. I discuss ideas in class.	1	2	3	4	5
10. I give my opinion during the class discussions.	1	2	3	4	5
11. The teacher asks me questions.	1	2	3	4	5
12. My ideas and suggestions are used during classroom discussions.	1	2	3	4	5
13. I ask the teacher questions.	1	2	3	4	5
14. I explain my ideas to other students.	1	2	3	4	5
15. Students discuss with me how to go about solving problems.	1	2	3	4	5

16. I am asked to explain how I solve problems.	1	2	3	4	5
TO	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
17. Getting a certain amount of work done is important to me.	1	2	3	4	5
18. I do as much as I set out to do.	1	2	3	4	5
19. I know the goals for this class.	1	2	3	4	5
20. I am ready to start this class on time.	1	2	3	4	5
21. I know what I am trying to accomplish in this class.	1	2	3	4	5
22. I pay attention during this class.	1	2	3	4	5
23. I try to understand the work in this class.	1	2	3	4	5
24. I know how much work I have to do.	1	2	3	4	5
E	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
25. The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5
26. I get the same amount of help from the teacher as do other students.	1	2	3	4	5
27. I have the same amount of say in this class as other students.	1	2	3	4	5
28. I am treated the same as other students in this class.	1	2	3	4	5
29. I receive the same encouragement from the teacher as other students do.	1	2	3	4	5
30. I get the same opportunity to contribute to class discussions as the other students.	1	2	3	4	5

31. My work receives as much praise as other students' work.	1	2	3	4	5
32. I get the same opportunity to answer questions as other students.	1	2	3	4	5
V	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
33. Mathematics is a very worthwhile and necessary subject.	1	2	3	4	5
34. I want to develop my mathematical skills.	1	2	3	4	5
35. Mathematics helps develop the mind and teaches a person to think.	1	2	3	4	5
36. Mathematics is important in everyday life.	1	2	3	4	5
37. High school mathematics courses would be very helpful no matter what I decide to study.	1	2	3	4	5
38. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in mathematics.	1	2	3	4	5
39. I am comfortable answering questions in math class.	1	2	3	4	5
E	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
40. Mathematics is dull and boring.	1	2	3	4	5
41. I like to solve new problems in mathematics.	1	2	3	4	5
42. I would prefer to do an assignment in mathematics than to write an essay.	1	2	3	4	5
43. I am happier in a math class than in any other class.	1	2	3	4	5
44. Mathematics is a very interesting subject.	1	2	3	4	5
45. I am willing to take more than the required amount of mathematics.	1	2	3	4	5

46. I think studying advanced mathematics is useful.	1	2	3	4	5
AE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
47. I'm certain I can master the skills taught in class this year.	1	2	3	4	5
48. I'm certain I can figure out how to do the most difficult class work.	1	2	3	4	5
49. I can do almost all the work in class if I don't give up.	1	2	3	4	5
50. Even if the work is hard, I can learn it.	1	2	3	4	5
51. I can do even the hardest work in this class if I try.	1	2	3	4	5

ALGEBRA 1 ENCUESTA

INSTRUCCIONES:

No se trata de una prueba.

No hay ningún 'derecho' o 'malo' respuestas. Su opinión es lo que quería.

Piense qué tan bien cada una declaración describe lo que su clase de álgebra 1 es como para los estudiantes.

Dibuje un círculo alrededor

1 Si ***muy de acuerdo***
2 Si ***usted está de acuerdo***
3 Si se ***neutral***
4 Si ***no está de acuerdo***
5 Si ***muy en desacuerdo***

No se preocupe si algunos estados en este cuestionario son bastante similares.

Dar su opinión a todos los estados.

EJEMPLO

Declaración: Los miembros de mi clase de álgebra para hacer favores uno al otro.

Usted tendrá que decidir si 'Muy de acuerdo', 'de acuerdo', 'son neutros', 'en Desacuerdo' o 'muy En Desacuerdo' con la declaración
.

Si ha seleccionado 'Acepto', usted círculo el número 4 en su cuestionario.

	Muy De Acuerdo	De Acuerd o	Son Neutros	En Desacuerdo	Muy En Desacuerd o
1. Los miembros de mi clase de álgebra para hacer favores uno al otro.	1	(2)	3	4	5

Nombre:____

En mi clase de Algebra 1:

TS	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
1. El profesor toma un interés personal en mí.	1	2	3	4	5
2. El maestro sale de su manera de ayudar a mí.	1	2	3	4	5
3. El profesor considera que mis sentimientos.	1	2	3	4	5
4. El profesor me ayuda cuando tengo problemas con el trabajo.	1	2	3	4	5
5. El profesor habla conmigo.	1	2	3	4	5
6. El profesor está interesado en mis problemas.	1	2	3	4	5
7. El maestro se mueve sobre la clase a hablar conmigo.	1	2	3	4	5
8. Los profesores las preguntas me ayudan a entender.	1	2	3	4	5
I	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
9. I debatir las ideas de la clase.	1	2	3	4	5
10. Doy mi opinión durante los debates de clase.	1	2	3	4	5
11. El profesor me pide preguntas.	1	2	3	4	5
12. Mis ideas y sugerencias se utilizan durante los debates de clase.	1	2	3	4	5
13. Pido al maestro preguntas.	1	2	3	4	5
14. I explicar mis ideas con otros estudiantes.	1	2	3	4	5
15. Los estudiantes discutir conmigo cómo resolver los problemas.	1	2	3	4	5
16. Se me pide que explique cómo resolver los problemas.	1	2	3	4	5
TO	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo

17. Obtener una cierta cantidad de trabajo realizado es importante para mí.	1	2	3	4	5
18. Hacer todo lo que se propuso hacer.	1	2	3	4	5
19. Sé que los objetivos para esta clase.	1	2	3	4	5
20. Estoy dispuesto a comenzar esta clase a tiempo.	1	2	3	4	5
21. Yo sé lo que estoy tratando de lograr en esta categoría.	1	2	3	4	5
22. I prestar atención durante esta categoría.	1	2	3	4	5
23. Trato de entender el trabajo de esta categoría.	1	2	3	4	5
24. Sé cuánto trabajo tengo que hacer.	1	2	3	4	5
E	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
25. El le da tanta atención a mis preguntas como a otros estudiantes las preguntas de los.	1	2	3	4	5
26. Me da la misma cantidad de la ayuda de la maestra al igual que otros estudiantes.	1	2	3	4	5
27. Tengo la misma cantidad de decir en esta clase como los demás estudiantes.	1	2	3	4	5
28. Me recibir el mismo trato que los demás estudiantes de esta categoría.	1	2	3	4	5
29. Voy a recibir el mismo aliento de la maestra como otros estudiantes hacer.	1	2	3	4	5
30. Me da la misma oportunidad de contribuir a los debates de clase como los otros estudiantes.	1	2	3	4	5
31. Mi trabajo recibe la mayor cantidad de elogios que los demás estudiantes de trabajo.	1	2	3	4	5
32. Me da la misma oportunidad de responder a las preguntas que los demás estudiantes.					

	1	2	3	4	5
V	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
33. Matemáticas es muy útil y necesario tema.	1	2	3	4	5
34. Quiero desarrollar mis habilidades matemáticas.	1	2	3	4	5
35. Matemáticas ayuda a desarrollar la mente y enseña a una persona a pensar.	1	2	3	4	5
36. Las matemáticas son importantes en la vida cotidiana.	1	2	3	4	5
37. La escuela secundaria los cursos de matemáticas sería muy útil no importa lo que yo decida studio.	1	2	3	4	5
38. Estoy cómodo expresar mis propias ideas sobre la manera de buscar soluciones a un problema difícil en matemáticas.	1	2	3	4	5
39. Estoy cómodo respondiendo preguntas en clase de matemáticas.	1	2	3	4	5
E	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
40. Las matemáticas son aburridas y aburrido.	1	2	3	4	5
41. Me gusta resolver nuevos problemas en matemáticas.	1	2	3	4	5
42. Yo preferiría hacer una cesión en matemáticas que para escribir un ensayo.	1	2	3	4	5
43. Estoy feliz en una clase de matemáticas que en cualquier otra clase.	1	2	3	4	5
44. Matemáticas es un tema muy interesante.	1	2	3	4	5
45. Estoy dispuesto a tomar más de la cantidad requerida de las matemáticas.	1	2	3	4	5
46. Creo que el estudio de las matemáticas avanzadas es útil.	1	2	3	4	5
AE	Muy De Acuerdo	De Acuerdo	Son Neutros	En Desacuerdo	Muy En Desacuerdo
47. Estoy segura que puedo dominar las habilidades enseñadas en clase	1	2	3	4	5

este año.					
48. Estoy segura que puedo averiguar cómo hacer más difícil el trabajo de clase.	1	2	3	4	5
49. Que puedo hacer casi todo el trabajo en clase si no se dé por vencido.	1	2	3	4	5
50. Incluso si el trabajo es duro, no puedo aprenderlo.	1	2	3	4	5
51. Que puedo hacer incluso el trabajo más duro en esta categoría si lo intento.	1	2	3	4	5

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