

**Science and Mathematics Education Centre**

**Improving Learning Environment and Student Outcomes  
in Biology in North Carolina**

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of  
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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 other person except where due acknowledgement has been made.

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## ABSTRACT

This study involved using a classroom environment questionnaire in North Carolina to assess and improve biology classroom environments and to relate classroom environment to the student outcomes of achievement and attitudes.

Part 1 of the study involved 364 Grade 9 and 10 students in Biology 1 at a large comprehensive urban high school in Charlotte, North Carolina. These students completed preferred and actual forms of a modified version of the What Is Happening In this Class? learning environment questionnaire assessing student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, and equity. Also an eight-item scale from the Test of Science Related Attitudes (TOSRA) was included to measure students' attitudes towards science. Finally, student achievement in biology was assessed using the results of a district-wide achievement test.

Analyses of data collected in Part 1 of the study supported the WHIC's *a priori* factor structure, internal consistency reliability, discriminant validity and ability to differentiate between the perceptions of students in different classrooms. Investigation of gender and ethnic (black vs non-black) differences in classroom environment revealed no ethnic differences, but there were gender differences for several scales (with boys perceiving more involvement and investigation and less cooperation than girls). Various analyses of outcome-environment relationships suggested that student achievement is higher in more cohesive classes, whereas student attitudes to science are particularly favourable in investigative, task-oriented and equitable classes.

Part 2 involved one class in intervention aimed at improving both classroom environment and student achievement by giving greater emphasis to those features of the learning environment found to be empirically linked to achievement in Part 1. The students involved in the intervention were chosen because they were 'at risk' of failing at school. It was found that this intervention involving a cooperative action research plan led to improvement in both classroom environment and achievement for these 'at risk' students. Because the methods used in the intervention are low-cost and available to most teachers, they are of wide potential interest to others.

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## **Chapter 1**

### **RATIONALE AND BACKGROUND**

#### **1.1 INTRODUCTION**

Many educational programs have come and gone, and there have been great changes in the student populations in American schools, but there has been little input from stakeholders about their own education. Many school districts have invested millions of dollars in staff development programs on cooperative learning, integrative learning, Open Court, and individualized learning without asking students if their needs are being met in the classroom. Classrooms, schools, school districts, and states are facing a crisis of too few qualified teachers, lack of funding, and unmotivated students. The issues of education are too often a political football, tossed to and fro in office-seeking debates, and then placed upon the back burner during a politician's tenure in office.

The students' voices must be heard if education is ever going to meet their needs, and teachers need a way to hear those voices. In my research, I drew on the field of learning environments for ideas and questionnaires that enabled me to tap students' views about their own education. The setting for this research was in a large, urban, comprehensive, public high school in Charlotte, North Carolina.

Discussion in this introductory chapter covers four topics. First, Section 1.2 provides background contextual information about the State of North Carolina, its public schools, the strengths and weaknesses of its education system, the emphasis on high-stakes state-wide achievement tests, and the particular school that provided the setting for my study. Section 1.3 briefly introduces the field of learning environments, which provided a foundation for my study. My research questions are stated in Section 1.4. Finally the rationale for my study and its significance are discussed in Section 1.5.

## **1.2 BACKGROUND: THE EDUCATIONAL SCENE IN NORTH CAROLINA**

### **1.2.1 A brief history of North Carolina**

As the twentieth century begins, North Carolina is at a crossroads in its history. Once a struggling southern state, it is now a national growth leader. A dedicated and hard-working labor force, an ideal location, honest government, and pleasant environment are among the factors that are attracting businesses and people to North Carolina in unprecedented numbers. At the same time, this progress brings with it changes and challenges. North Carolina has always been unique in ways that set it apart from its southern setting, and it presents recurring paradoxes: being one of the nation's most industrialized states, while also being one of the nation's largest farm populations; and being home of one of the oldest and most distinguished systems of higher education, yet having a public school system that lags behind national standards. Although the high technology complex of the Research Triangle area and Charlotte's rise to national prominence as a banking center have led those parts of North Carolina to a prosperity that compares favorably with any metropolitan area in the country, other counties have been left out of the late twentieth-century boom and are mired in grinding rural poverty. Politically, North Carolina has long been a one-party state, and current political voting behaviors contradict and defy prediction. These factors have led to immense challenges for public school administrators, teachers, and students.

### **1.2.2 Good news about North Carolina's public schools**

Compared to the rest of the nation, North Carolina has made significant advances in its public schools during the last quarter of the twentieth century. On most performance indicators, the state no longer ranks near the bottom. But, because other states made notable improvements as well, North Carolina is challenged just to maintain its current ranking among the states. The American economy, including that of North Carolina, is in the midst of a profound transformation, driven by the twin engines of rapid technological change and increasing global competition. In this

century, new jobs created by the labor market will require more than a high school education, and 30% of workers will need a college degree.

There is good news about public schools in North Carolina. According to the National Education Association (2000), grade 8 students in North Carolina are among the top in the country in writing proficiency. The overall average score of North Carolina public school students is the sixth highest in the nation. According to the Nation's Report Card: Mathematics 2000, North Carolina ranks eighth in the nation in the proportion of public school fourth graders who score at the highest two levels in mathematics. The proportion of North Carolina fourth graders who scored at the highest two levels more than doubled between 1992 and 2000, and the proportion of eighth graders who scored at the highest two levels in mathematics increased by more than three-fold between 1990 and 2000. North Carolina is one of the top seven states in the nation in the proportion of public high schools offering Advanced Placement (AP) courses, through which students can earn college credit. According to the College Board (2001), 90% of North Carolina's public schools offer AP courses. Just 31% of North Carolina's private high schools offer these advanced courses.

According to the North Carolina Department of Public Instruction, the proportion of North Carolina high school graduates going on to college immediately after high school has improved by 22% since 1995. North Carolina is now one of the top 15 states in the nation in terms of the percentage of its high school graduates who continue immediately on to college. According to the College Board 2001 SAT State Results, more North Carolina students are getting high scores on their SAT college entrance examinations. In the last seven years, the proportion of graduating seniors getting high scores on the Verbal SAT has increased by 27%, and the proportion of graduating seniors getting high scores on the Mathematics SAT has increased by 54%. Since 1989, North Carolina's Verbal SAT college entrance examination scores have risen 10 times faster than the national average, and North Carolina's Mathematics SAT college entrance examination scores have risen two and a half times faster than the national average. The National Center for Public Policy and Higher Education (2001) ranks North Carolina as second out of 50 states in the

proportion of high school students taking an upper-level mathematics course, and as fourth out of 50 states in the proportion of grade 8 students taking algebra courses.

### **1.2.3 North Carolina's accountability program**

Governor James B. Hunt campaigned on the promises that he would improve the quality of education in North Carolina and raise teachers' salaries. He was responsible for starting the North Carolina ABC Program, which measures student performance through growth standards (improvement over time) and performance standards (achievement at a point in time). This program includes end-of-grade tests at the elementary and middle grades, as well as end-of-course tests at the high school level. It also includes high-stakes writing tests for grade 4 and 7 students and basic competency tests for graduation. The ABC Program was aimed at making schools accountable for student achievement, and much is at stake for the schools and teachers with this program. High-performing schools can win funds for teacher bonuses or new and enhanced school programs. Struggling schools risk the possibility of a state takeover. The public is made aware of each school's progress through a Report Card system that is easily accessible through the North Carolina Department of Public Instruction website. According to a study released by *The Princeton Review* in June 2002, North Carolina has the best testing program in the country. This review group ranked state testing programs on 25 indicators of four criteria: test alignment to the state's curriculum standards, test quality, openness of the testing program to public scrutiny, and the extent to which the accountability system is used to support school improvement. Steven Hodas, executive vice-president of *The Princeton Review* and author of the study said that "North Carolina's testing program is head-and-shoulders above the other states, including those ranked at the top". This study was prompted by the 2001 Elementary and Secondary Education Act (ESEA), commonly called President Bush's No Child Left Behind. This act will require all states to have a testing program in place by 2005.

### **1.2.4 Teacher quality**

Another part of President Bush's No Child Left Behind calls for a 'highly qualified' teacher in every classroom by 2005. Because President Bush recognizes the

difference that a good teacher makes, his State of the Union Address in January 2002 announced his “goal for America: a quality teacher in every classroom”. Congress has recognized the impact of a high-quality teacher, with Title II of the ESEA 'Preparing, Training, and Recruiting Quality Teachers and Principals' being allotted \$2.85 billion for the purpose of improving student achievement by raising teacher quality. According to the National Commission on Teaching and America's Future (NCTAF), North Carolina public school teachers are among the most qualified teachers in the country. They rank second out of 50 states, based on 12 indicators of teachers' qualifications. According to the National Board for Professional Teaching Standards (NBPTS), North Carolina ranks first in the nation in the number of National Board-certified teachers, and the number of teachers obtaining this prestigious goal has increased by 88% since 1999.

### **1.2.5 Challenges facing North Carolina's public schools**

With all of these accomplishments in education in North Carolina, why would there be a need for improvement? There are definitely challenges for public education in this state. According to the *Education Statistics Quarterly*, Spring 2001, North Carolina ranks near the bottom of all states (38<sup>th</sup> out of 50) in spending per pupil. North Carolina's total state and local revenues for public schools, as a proportion of its gross state product, is among the lowest (48<sup>th</sup> out of 50) states in the country. North Carolina's total revenue for public schools is only 2.8% of its gross state product. According to the NCTAF, demand for teachers in North Carolina is high but the supply is low. The population continues to increase as families move to the area for jobs, and North Carolina needs to get serious about investing more in its teachers. North Carolina ranks among the highest states (2<sup>nd</sup> out of 50) in the percentage of secondary schools (18%) reporting difficulty in filling vacancies for teachers of English. The North Carolina Department of Public Instruction has started the Center for the Recruitment and Retention of Teachers but, with an uncertain state budget, this center could be lost. North Carolina ranks near the bottom of the nation in teachers' salaries. According to 'Salary Gap' Quality Counts 2000, North Carolina teachers' salaries rank 48<sup>th</sup> in the nation for teacher with a Bachelor's degree and 49<sup>th</sup> in the nation for teachers with a Master's degree. And, as the school age population continues to grow, North Carolina school buildings need major improvements.

According to the ASCE's 2001 Report Card for America's Infrastructure, one-fourth of schools have crumbling roofs and one-fifth have bad plumbing. Thirty-six percent (36%) of North Carolina schools need a building extensively repaired or replaced. More than two-thirds of all North Carolina schools are in unsatisfactory environmental condition, and 23% have poor ventilation. Forty-two percent (42%) of North Carolina schools lack adequate power outlets and wiring for classroom computers.

Despite the kudos for the ABC statewide testing program that North Carolina has received from the Clinton and the Bush administrations, there are major problems with the tests. In July 2002, the North Carolina State School Board decided not to count the grades 4 and 7 writing tests from 2002 because the scores were unexplainably low. Even with expert accountability and testing consultants, the Board cannot explain the dramatic drop in scores. So, the State School Board will not count these scores as part of the school and school district accountability. They have decided to continue the testing program for next year, but changes might be made.

Classroom teachers in North Carolina are deluged with conflicting messages. Their classrooms are full of students from low socioeconomic backgrounds whose parents have poor English skills. They have a constant turnover of students, especially in high growth areas like Charlotte, where 2000 people move into the area each week. The North Carolina Department of Public Instruction provides a detailed pacing guide, giving the teacher a timeline to follow to cover the content. However individual students still have gaps in basic reading, writing, and mathematics skills. At the school level, the administrators are under pressure from the superintendents, and that pressure is passed on to the classroom teacher to produce high scores on state tests among their students. The financial incentives only increase the pressures experienced by teachers in these situations. There is no money available for resource materials, computers, software, and teaching assistants. These teachers are really in the combat zone. They must provide instruction, individualize, and remediate students' deficiencies.

### **1.2.6 Description of the school involved in the study**

The particular school studied in my research is in the Charlotte-Mecklenburg school system, the 20<sup>th</sup> largest in the nation. This school district has 164 schools and more than 112,000 students. Because it is in the second fastest growing area in the country, the number of schools and students continues to grow and to create constant challenges. The school district has built at least 10 schools per year for the past ten years. Each time a school opens, its enrollment is immediately above capacity, thus resulting in the deployment of mobile classrooms.

Since 1969, the Charlotte Mecklenburg Schools have been under the Schwann Desegregation order, which federally mandates desegregation. In order to comply with this order, the school district instituted a magnet system to entice the more affluent suburban parents to send their children to the inner city schools surrounded by poorer neighborhoods. Over the 33 years since the Schwann Desegregation order began, the magnet programs have evolved and changed to meet the demands of the community. During this time, the order has required teachers to count the number of black and non-black students in their classrooms each quarter and report this number. The order also allowed black students to have first choice of any magnet or special program offered at a school, and required the superintendent to work on decreasing the gap between black and non-black achievement in all areas of the school system. In 1994, several local parents took the school district to court over the desegregation order, claiming that it is prejudiced against non-black students. This court case was tried in several different arenas and was finally found valid in the Supreme Court in 2001. As of fall 2001, the Charlotte Mecklenburg Schools were found to be 'unitary', meaning that the desegregation order was no longer deemed necessary by the courts.

The school board spent \$5 million designing and explaining its Choice Plan, the district's alternative to the pro-black assignment plan used for more than 30 years. The Choice Plan guarantees a student a place in his/her neighborhood school and provides choices of several other schools. This plan theoretically allows any student to attend any school in the system, but the system only provides transportation if the selected school is in the student's assigned area of the county. The school that was studied in this research currently has 2300 students in a building designed for 1600



students. In the first round of the Choice Plan, 8000 students selected this school as their school of choice.

After a random lottery, 3000 students are assigned to this school for the fall of 2002. The school board and other local experts believe that the enrollment is so high at this particular school because the administrators and staff have consistently worked to reach all students. This school has also consistently enrolled approximately 50% of students of color and had students from more than 50 countries. This diversity is an advantage in many ways and provides a multitude of challenges for the staff. The staff of this school are constantly encouraging students of all ability levels to set high goals for themselves. The administrators and staff in this school are always interested in improving the quality of the education that their students receive.

### **1.3 FIELD OF LEARNING ENVIRONMENTS**

My study drew on and contributed to the field of learning environments. Because I was interested in investigating students' views about their schooling, the field of learning environments research provided a useful and appropriate conceptual and methodological framework for my study. This section briefly introduces learning environment ideas and their application in my study, whereas Chapter 2 provides a comprehensive review of the learning environments literature.

Fraser (2000a) notes that students spend approximately 20,000 in classrooms by the time that they finish their university education. Therefore, students' reactions to and perceptions of their educational experiences are very important. Nevertheless, despite the importance of what goes on in classrooms, teachers and researchers have relied heavily and sometimes exclusively on academic achievement. Although no-one would dispute the importance of achievement, it cannot give a complete picture of the educational process.

The education system in North Carolina is no exception. There is enormous emphasis on compulsory statewide achievement testing. The results on these high-stakes tests influence the salaries of teaching and other school staff. The need to

prepare students for statewide tests often dominates what goes on in schools and classrooms at the expense of other educationally worthwhile activities.

The field of learning environments provides one approach to conceptualizing, assessing and researching what happens to students during their schooling (Fraser, 1998a, 2002). In contrast to methods that rely on outside observers, the approach used in my study defines classroom environment in terms of the shared perceptions of students in that environment. This has the dual advantage of describing the class through the eyes of the actual participants and obtaining data which an observer could miss or consider unimportant.

Researchers have developed numerous questionnaires to assess students' perceptions of their classroom learning environments (Fraser, 1988b). These questionnaires, which are reviewed in Chapter 2 of this thesis, have been used in different countries and at different grade levels. They have been translated into various languages. According to Fraser (2000a), these questionnaires have been used by hundreds of researchers, thousands of teachers and millions of students. Few fields of educational research can boast of the existence of such a rich array of robust and valid questionnaires.

Researchers have carried out dozens of studies into the relationship between student achievement and the quality of the classroom learning environment (Fraser, 1994). The consistent and overwhelming evidence from these studies is that classroom environment strongly influences student achievement. Therefore, educators should not feel that it is a waste of time to devote time to attempting to improve classroom environments. The research indicates that attention to classroom environment is likely to pay off in terms of improving student achievement.

My study pioneered the use of a classroom environment questionnaire in North Carolina. In the study's first phase, I established empirical links between the student outcomes of achievement and attitudes and specific classroom environment dimensions. In the second phase, an action research study involved, first, changing the classroom environment to emphasise those aspects found to be linked to higher

achievement and, second, tracking whether changing classroom environments led to improved student achievement.

#### **1.4 RESEARCH QUESTIONS**

The present study addressed the following four main research questions:

1. Is the What Is Happening In this Class? (WIHIC) questionnaire valid and reliable when used with grade 9 and 10 biology students in Charlotte, North Carolina?
2. Are there differences in the learning environments perceived by:
  - a. boys and girls
  - b. students in years 1, 2, and 3 of the study
  - c. black and non-black students?
3. Are there associations between the classroom environment dimensions assessed by the WIHIC and scores on:
  - a. the North Carolina End-Of-Course examination in Biology
  - b. a student attitude scale?
4. Do classroom interventions – involving a cooperative action research plan aimed at changing classroom environments to emphasise dimensions found to be empirically linked with better student outcomes in the first phase of the study – lead to improved classroom environments and student achievement?

#### **1.5 RATIONALE FOR AND SIGNIFICANCE OF THE STUDY**

There are countless studies of class size, gender gaps, and teaching strategies available to teachers in the field. However, the reality of the situation is that a typical high school classroom teacher is handling a class of 30 to 40 students, most of whom have some type of special need. The physical environment is usually too small, lacking the necessary number of textbooks, materials, and other supplies. Because

these harried teachers are struggling to keep their heads above water in their daily situations, they usually do not have time to read research journals and reflect on how to integrate these findings to their teaching strategies, even if they have good intentions.

The focus of my research was to help to alleviate some of the stress experienced by teachers by pinpointing the factors that lead to student success on a high-stakes end-of-course Biology test, and by attempting an intervention to determine if an enhanced classroom learning environment could make a difference with at-risk students.

This study adds to the field of learning environment research in several ways. First of all, this study is the first to use a learning environment questionnaire in the State of North Carolina. Secondly, it uses learning environment questionnaires to provide information about student perceptions as a basis for making changes in teaching strategies in the classroom. Thirdly, with the intervention study, this research provides evidence that paying attention to learning environments can have a positive effect upon student achievement on high-stakes standardized tests. This is increasingly important in the United States as teachers in all states and of all grade levels will be required to use high-stakes standardized tests as a measure of their students' success, according to the federally-mandated ESEA Leave No Child Behind Bill. With the pressure of this federal mandate, many teachers and administrators will be actively seeking ways to improve the learning in their classrooms, and hopefully this will be an impetus to encourage using learning environment questionnaires.

## **1.6 CHAPTER SUMMARY**

In the past 20 years, the State of North Carolina has changed in many ways, including the cultural diversity of its citizens, the mobility of its workforce, and its primary sources of income. These changes have demanded that education also change to better prepare the workforce of the future. Former Governor James B. Hunt made great strides to improve teachers' salaries and working conditions and to improve the quality of North Carolina public school education. He instituted the North Carolina ABC testing program to provide a means of assessing student

achievement and worked to provide a framework for success for students and teachers. However, as the state has grown at an exponential rate, the challenges facing teachers have exploded. More and more students come from disadvantaged homes and have poor reading and mathematics skills. This has required teachers to give more effort to helping their students achieve on the high-stakes, state-mandated tests. Now, with the addition of President Bush's Leave No Child Behind Act, the pressure will only intensify. This pressure to perform means that more administrators, teachers, and professional development staff are searching for answers to the difficult situations facing teachers in North Carolina classrooms.

This study used a learning environment questionnaire as a means to gain information about the students' perceptions, and to relate the learning environment to success on the high-stakes achievement test and to student attitudes. Then, using this information, an intervention was attempted to determine if emphasizing the classroom learning environment dimensions found to be correlated to higher test scores helped at-risk students to succeed. Because the methods used in the intervention year were low-cost and available to most teachers, there will be interest from many school districts about this study.

This study not only will be of interest to teachers in North Carolina facing the pressure of the high-stakes achievement tests, but also it will contribute to the field of learning environment research by using a classroom environment questionnaire for the first time in North Carolina and by seeking associations between learning environments and scores on the North Carolina End-Of-Course Biology test. The study suggests that these questionnaires can be used in a most practical manner, to help teachers increase the efficiency of their teaching and the learning that their students experience in the classroom.

## **Chapter 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

This project began with frustration on the part of the researcher and her peers in determining how best to meet the needs of our students. The concept of classroom environment is not even addressed in most American undergraduate or graduate education programs and, because of this, most teachers neglect this important but subtle aspect of their teaching. The current American educational structure focuses too much on achievement as measured by standardized multiple-choice tests. An example of this overemphasis on achievement is that biology teachers in the Charlotte-Mecklenburg Schools are given the goals to:

1. increase student achievement as measured by the high-stakes North Carolina End-Of-Course examination in Biology
2. improve students' attitudes towards science, as measured by the number of science courses taken during their high school career
3. decrease the achievement gap between minority and non-minority (black vs. non-black) students on the high-stakes examinations.

Many administrators are encouraging, and even limiting their teachers to, activities that involve only vocabulary acquisition, because they see these teaching approaches as the most effective way to use teaching time to prepare students for multiple-choice tests. Many of these activities are not even productive use of classroom time, and these types of learning experiences are serving to frustrate the students and staff alike. With President Bush's No Child Left Behind Act, there will be even more state-mandated and nationally-mandated high-stakes testing imposed on our students. Teachers in real-world classrooms are not only dealing with district, state, and

national timelines and pacing guides, but they also face classrooms containing diverse students with a myriad of special needs. In these increasingly difficult classroom situations, assessing and addressing the classroom learning environment has become more crucial than ever.

As a backdrop to my study, this chapter provides a literature review aimed at exploring past research on learning environments and choosing an appropriate tool for measuring learning environments in the specific situation of my study. The review of literature in this chapter is structured in the following way:

- 2.2 Background to Field of Learning Environments
  - 2.2.1 Definition of learning environment
  - 2.2.2 Historical background of learning environment research
  - 2.2.3 Using perceptions to measure learning environments
  - 2.2.4 Choosing a unit of analysis
- 2.3 Instruments Used to Measure Learning Environment
  - 2.3.1 Learning Environment Inventory (LEI)
  - 2.3.2 Classroom Environment Scale (CES)
  - 2.3.3 Individualized Classroom Environment Questionnaire (ICEQ)
  - 2.3.4 My Classroom Inventory (MCI)
  - 2.3.5 College and University Classroom Environment Inventory (CUCEI)
  - 2.3.6 Questionnaire on Teacher Interaction (QTI)
  - 2.3.7 Science Laboratory Environment Inventory (SLEI)
  - 2.3.8 Constructivist Learning Environment Survey (CLES)
  - 2.3.9 What Is Happening In this Class? (WIHIC) Questionnaire
  - 2.3.10 Other Instruments
- 2.4 Applications of Classroom Environment Instruments
  - 2.4.1 Associations between classroom environment and student outcomes
  - 2.4.2 Action research aimed at improving classroom environments
  - 2.4.3 Determinants of classroom environment perceptions
- 2.5 Defining and Measuring Student Attitudes
- 2.6 Summary

## **2.2 BACKGROUND TO FIELD OF LEARNING ENVIRONMENTS**

Before reviewing literature on specific questionnaires for assessing classroom learning environment (Section 2.3) and research applications (Section 2.4), this section is devoted to various background issues (such as definitions and historical background).

### **2.2.1 Definition of learning environment**

The word 'environment' has many meanings. In biology, it refers to the biotic (living) and abiotic (nonliving) factors that currently occupy the same physical location as the organism. The study of these biotic and abiotic factors and their relationships is known as ecology. In a similar way, the learning environment is a complex and ever-changing entity.

Educational research has traditionally focused on achievement, while neglecting other variables that lead to the quality of a student's educational experience. The physical factors of the learning environment are relatively easy to outline: the size of the room, the availability of resources (books, computers, laboratory supplies), the furniture, the lighting, and the layout of the room. The human environment that influences relationships in the classroom is much harder to measure. This includes the students and teacher in the classroom and their interactions with one another. Human factors make up the psychological and social aspects of the classroom. As enablers of learning, teachers can play an important role in making the classroom a more productive environment that is conducive for their students' learning. Past studies have often shown that a positive classroom environment leads to effective learning (Brophy & Putnam, 1979; Fraser, 2002).

Although the concept of classroom learning environment is somewhat subtle and nebulous (Fraser, 1989), remarkable progress has been made to date in terms of conceptualizing it, measuring it, and analyzing its determinants and effects (Fraser, 1993a, 1998a). Fraser (1986a) defined classroom environment as the shared perceptions of students, and sometimes that of teachers, in a particular environment. Such perceptions not only describe or evaluate the class through the eyes of the



participants themselves, but also they include information that an observer could miss or consider unimportant.

### **2.2.2 Historical background of learning environments research**

Learning environment research has been conducted in schools for more than 30 years. Pioneering conceptual and empirical work was conducted by Kurt Lewin and Henry Murray in the 1930s. The familiar  $B=f(P, E)$  formula of Lewin (1936) also is referred to as the person-environment interaction paradigm (Hunt, 1975). The *B-P-E* combination stands for Behavior (*B*), Person (*P*), and Environment (*E*) together with the interactive function (*f*). In the classroom setting, behavior or learning would be viewed as being jointly determined by the person (the learner) and the environment (e.g. the way of teaching). Murray (1938) further developed this paradigm through needs-press theory. He introduced the term 'alpha press' to describe the environment as viewed by an observer and the term 'beta press' to describe the environment as perceived by people within a particular situation. However, Murray's needs-press theory was applied more in the study of personality than in the study of teaching-learning processes in classrooms. Inadvertently, Lewin and Murray provided a means of extending environment research into the classroom.

Classroom environment research really began with groundbreaking work involving the use of learning environment instruments in an evaluation of Harvard Project Physics (Walberg & Anderson, 1968). It has spread geographically and in scope since that time. Simultaneously, there were also studies being done with social climate scales for use in various clinical and family therapy situations, as well as in school classrooms, in the 1960s and 1970s (Moos, 1973, 1979a, 1979b). The work of Walberg and Moos led to many major research studies in the 1970s that involved a distinct tradition of research involving student perceptions of their classroom learning environment (Fraser & Walberg, 1981). The rich diversity of studies conducted during this time is evidenced by literature reviews (Anderson & Walberg, 1974; Chavez, 1984; Fraser, 1989, 1994, 1998a, 2002; MacAuley, 1990; von Saldern, 1992; Walberg, 1976; Walberg & Haertel, 1980), monographs (Fisher, 1992, 1993; Fisher & Fraser, 1983a; Fraser, 1981a) guest-edited journal issues (Fraser, 1980; McRobbie & Ellett, 1997), an annotated bibliography (Moos &

Spinrad, 1984), books (Fraser, 1986a; Fraser & Walberg, 1991; Freiberg, 1999; Goh & Khine, 2002; Khine & Fisher, 2003; Moos, 1979a; Wubbels & Levy, 1993) and the editor's introduction to the new international journal entitled *Learning Environments Research* (Fraser, 1998b).

Literature reviews (Fraser, 1986, 1994, 1998a; Fraser & Walberg, 1991) place these developments into historical perspective and show that learning environment assessments have been used as a means of assessing dependent and independent variables in a rich variety of research applications spanning many countries. As the field of learning environment research has grown, researchers have employed quantitative and qualitative methods, and an important accomplishment within the field has been the productive combination of these research methods (Tobin & Fraser, 1998). There are also methods that involve an external observer's perceptions and the mapping of the events in a classroom (Brophy & Good, 1986), as well as approaches that involve case study and interpretive research methods (Erickson, 1998).

### **2.2.3 Using perceptions to measure learning environments**

The literature on classroom learning environments (Fraser, 1986b, 1994) reveals there are three basic methods for obtaining information on the learning environment: use of a trained outside observer to record systematic observations of classroom events and practices; the use of case studies; and the assessment of perceptions of students and teachers. Because the introduction of an outside observer changes the classroom learning environment, most of the work has been done with perceptions of students and teachers.

Using the perceptions of students and teachers has many benefits according to Fraser (1986a, 1998c). First of all, the cost of a pen-and-paper assessment is much less than that of training observers to make classroom observations. Another benefit of using student and teacher perceptions is that their responses are based on many weeks or months of class time, as opposed to classroom observations that draw conclusions based upon a small number of lessons. Using the combined perceptions of all students, a researcher is also able to base assessments of classroom environment

upon many participants' opinions. These opinions then can be disaggregated to determine differences in the environment experienced by ethnic, ability, or gender groupings. Many studies have shown that student perceptions of a classroom environment have a much greater impact on their behavior and achievement than do observed behaviors. Finally, it has been found that students' perceptions account for considerably more variance in student learning outcomes than directly-observed variables in the classroom. Taking into consideration all of these factors, I decided to use student perceptions as the major source of information about the classroom learning environment in my study.

#### **2.2.4 Choosing a unit of analysis**

A literature search on learning environment assessments shows that many research studies have used two levels or units of statistical analysis. The distinction between levels of analysis can be linked to the needs-press theory of Murray (1938), who used the terms 'alpha press' to describe the environment viewed by an outside observer, and 'beta press' to describe the perceptions of the environment held by people functioning within the system being observed. The distinction continued when Pace and Stern (1958) used the two terms 'private beta press' (to denote the idiosyncratic view of the environment held by each individual) and 'consensual beta press' (to depict the shared view that members of a group hold about the environment) to differentiate between the personal view of an individual and the common view shared by a group. Of course, private and consensual beta press could differ from each other and both could also differ from the independent view of alpha press of a trained observer (Fraser, 1994).

The choice of units of analysis clearly is relevant to studies of perceptions of classroom environment. The literature suggests that statistical analyses often are performed for two levels or units of analysis, namely, the individual student's score and the class mean score (e.g. McRobbie & Fraser, 1993), which correspond to the distinction between private and consensual beta press. Also researchers have used multilevel analysis in classroom environment research so that the influence of student-level and class-level variables can be considered simultaneously (e.g. Goh, Young & Fraser, 1995).

## 2.3 INSTRUMENTS USED TO MEASURE LEARNING ENVIRONMENT

There is no question that the classroom learning environment is important to a student's ability to learn in a particular classroom. However, what is 'classroom learning environment'? Most educators would agree that there are two parts to the classroom environment, namely, the physical environment and the social environment. The physical environment is affected by the size of the room, the quality of the furnishings, the lighting, the resources, and the physical arrangement of the room. There have been numerous studies aimed at pinpointing the optimum class size, the types of furniture needed to meet various learning styles (Dunn & Dunn, 1994), the best type of lighting, and the placement of the resources in the room.

Much of the past classroom learning environment research has focused on developing and validating instruments to measure various psychosocial dimensions in the classrooms. The development and validation of these instruments over the past 40 years has led to a wide range of useful instruments including: the *Learning Environment Inventory* (LEI); the *Classroom Environment Scale* (CES); the *Individualized Classroom Environment Questionnaire* (ICEQ); the *My Class Inventory* (MCI); the *College and University Classroom Environment Inventory* (CUCEI); the *Questionnaire on Teacher Interaction* (QTI); the *Science Laboratory Environment Inventory* (SLEI); the *Constructivist Learning Environment Survey* (CLES); and the *What Is Happening In this Class* (WIHIC) questionnaire. Each of these instruments is a low-cost, pencil-and-paper questionnaire, which can be scored easily by hand or by computer. Each instrument has its own unique origin and is best suited for specific purposes. Each questionnaire is discussed by Fraser (1998c).

In order to focus on various learning environment instruments, and their strengths, weaknesses, and applications, Table 2-1 provides an overview of these tools. The table displays the name of the scales in each instrument, the grade levels for which the instrument was developed (primary, secondary, higher education), the number of items in each scale, and the classification of each scale according to Moos' three broad domains of classroom climate dimensions (Moos, 1979a). *Relationship* dimensions identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment

and support and help one another. *Personal development* dimensions assess basic directions along which personal growth and self-enhancement tend to occur. *System maintenance and change* dimensions involve the degree to which the environment is orderly, clear in expectations, maintains control and is responsive to change. The classroom environment scales in these instruments, though different in nature, can still be arranged within common or similar sets of social dimensions as categorized by Moos under these three broad domains. For example, the different classroom environment scales of Cohesiveness, Friction, and Satisfaction in the LEI are classified under Moos' category of Relationships, whereas the eight teacher behavior scales of the QTI all fall within the Relationship dimension.

Even though each of these instruments was developed for a specific audience and a particular use, they share many common aspects. Each is a paper-and-pencil questionnaire assessing students' perceptions of dimensions of their classroom. Most of the instruments use a five-point response scale. Most of the instruments have separate actual and preferred versions, which allow a researcher to look for discrepancies between students' actual and preferred learning environment, thus providing a framework for improving the learning that is occurring in an individual classroom. Most of these instruments also have parallel teacher and student versions. This means that information can be obtained from the perceptions of both the teacher and the students of each class about their actual and preferred learning environment.

Helping teachers to analyze their students' actual and preferred environments can lead to many improvements in learning for their students. Comparing teachers' and students' perceptions of the actual classroom also can be enlightening for most teachers. Using data that include students' actual and preferred perceptions, as well as teachers' perceptions, can help a teacher or researcher to determine a useful picture of the classroom learning environment for all participants.

TABLE 2-1 Overview of Scales contained in Nine Classroom Environment Instruments (LEI, CES, ICEQ, MCI, CUCEI, QTI, SLEI, CLES and WIHIC)

Instrument	Level	Items Per Scale	Scales Classified According to Moos's Scheme		
			Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganisation Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organisation Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	Elementary	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	Higher education	7	Personalisation Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualisation
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8-10	Helpful/Friendly Understanding Dissatisfied Admonishing		Leadership Student Responsibility and Freedom Uncertain Strict
Science Laboratory Environment Inventory (SLEI)	Upper secondary/ Higher education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In This Classroom (WIHIC)	Secondary	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity

Adapted from Fraser (1998a, 1998b)

The following sections briefly describe the LEI (2.3.1), CES (2.3.2), ICEQ (2.3.3), MCI (2.3.4), CUCEI (2.3.5), QTI (2.3.6), SLEI (2.3.7), CLES (2.3.8), WIHIC (2.3.9) and other instruments (2.3.10).

### **2.3.1 Learning Environment Inventory (LEI)**

One of the first instruments developed to assess classroom environment was the *Learning Environment Inventory* (LEI), which was used in the late 1960s in conjunction with the evaluation of Harvard Project Physics (Fraser, Anderson & Walberg, 1982; Walberg & Anderson, 1968). This instrument contains 105 statements (seven per scale) descriptive of typical school classes at the secondary school level. It assesses the scales of Cohesiveness, Friction, Favoritism, Cliquesness, Satisfaction, Apathy, Speed, Difficulty, Competitiveness, Diversity, Formality, Material Environment, Goal Direction, Disorganization, and Democracy. Students respond with the choices of Strongly Disagree, Disagree, Agree, and Strongly Agree. A typical item in the Cohesiveness scale is “All students know each other well” and in the Speed scale is “The pace of this class is rushed”. The scoring direction is reversed for some items. This instrument was originally designed for the specific goal of ascertaining if Harvard Project Physics was accomplishing its mission.

### **2.3.2 Classroom Environment Scale (CES)**

Another instrument developed around the same time as the LEI was the *Classroom Environment Scale* (CES). The CES (Fisher & Fraser, 1983b; Moos, 1979; Moos & Trickett, 1987) grew out of a comprehensive body of research on various environments, including psychiatric hospitals, prisons, university residences, and work sites (Moos, 1974). The final version of the CES contains nine scales each having 10 items of True-False response format. The scales are Involvement, Affiliation, Teacher Support, Task Orientation, Competition, Order and Organization, Rule Clarity, Teacher Control and Innovation. Typical items in the CES are “The teacher takes a personal interest in the students” (Teacher Support) and “There is a clear set of rules for students to follow” (Rule Clarity). The published CES materials include a test manual, a questionnaire, an answer sheet, and a transparent hand-scoring key. Although this instrument was designed to be used in

secondary school settings, the number of questions and several of the scales were considered to be inappropriate for my study.

### **2.3.3 Individualized Classroom Environment Questionnaire (ICEQ)**

The *Individualized Classroom Environment Questionnaire* (ICEQ) (Fraser, 1990) is an instrument designed to be used in secondary school settings to assess those dimensions which distinguish individualized classrooms from traditional ones. This instrument's development was guided by literature on individualized, open, and inquiry-based education. It contains 50 items, with an equal number of items belonging to each of five scales of Personalization, Participation, Independence, Investigation, and Differentiation. Each item is responded to on a five-point frequency scale with the choices of Almost Never, Seldom, Sometimes, Often, and Very Often. The scoring direction is reversed for many of the items. Typical items are "The teacher considers students' feelings" (Personalization) and "Different students use different books, equipment, and materials" (Differentiation). The copyright arrangement gives permission to purchasers to make an unlimited number of copies of the questionnaires and response sheets. Because the classrooms involved in my research were not all using individualized or inquiry based learning techniques, this instrument was deemed to be inappropriate for the study.

### **2.3.4 My Class Inventory (MCI)**

In response to a need for instruments to be used in elementary settings, the LEI was simplified to form the *My Class Inventory* (MCI) (Fisher & Fraser, 1981; Fraser, Anderson & Walberg, 1982; Fraser & O'Brien, 1985). This instrument differs from the LEI in that it only contains the following five of the LEI's original 15 scales: Cohesiveness, Friction, Satisfaction, Difficulty, and Competitiveness. The reading level has been simplified to accommodate the typical reading abilities of elementary school students, and the questionnaire has been abbreviated to accommodate the shorter attention span among students in this age group. The responses were also changed to Yes or No, and students answer directly on the questionnaire itself to eliminate the errors that can occur in transferring information from one sheet to



another. These adaptations make this instrument applicable to middle school students with low reading ability.

The final published form of the MCI contains 38 items altogether, although Fraser and O'Brien (1985) have developed a shorter 25-item version. Typical items are "Children are always fighting with each other" (Friction) and "Children seem to like the class" (Satisfaction). Goh, Young and Fraser (1995) changed the MCI's Yes-No format to a three-point response format (Seldom, Sometimes, and Most of the Time) in a modified version of the MCI which includes a Task Orientation scale. Recently, Majeed, Fraer and Aldridge (2002) used the MCI in Brunei Darussalam with a large sample of 1565 mathematics students in 81 classes in 15 government secondary schools.

### **2.3.5 College and University Classroom Environment Inventory (CUCEI)**

Most of the work on classroom learning environments has been done at the elementary or secondary level, with relatively few studies having been conducted at the college level. The *College and University Classroom Environment Inventory* (CUCEI) was developed for use in typical higher education classrooms, where there are often smaller classes of up to 30 students, sometimes referred to as 'seminars' (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The final form of the CUCEI contains seven seven-item scales, namely, Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation, and Individualization. Each item has four responses (Strongly Agree, Agree, Disagree and Strongly Disagree). Scoring is reversed for nearly half of the items. Typical items are "Activities in this class are clearly and carefully planned" (Task Orientation) and "Teaching approaches allow students to proceed at their own pace" (Individualization). The target audience of this instrument makes it inappropriate for use in my project.

### **2.3.6 Questionnaire on Teacher Interaction (QTI)**

Researchers in The Netherlands focused on the interactions between teachers and students and the quality of these relationships (Wubbels & Brekelmans, 1998; Wubbels & Levy, 1993). Drawing upon a theoretical model of proximity (cooperation versus opposition) and influence (dominance versus submission), the *Questionnaire on Teacher Interaction* (QTI) was developed to assess student perceptions of eight behavioral aspects of their primary or secondary classrooms: Helping/Friendly, Understanding, Dissatisfied, Admonishing, Leadership, Student Responsibility and Freedom, Uncertain, and Strict behavior. There are 8-10 items per scale and each item has a five-point response scale ranging from Never to Always. Typical items are “She/he gives us a lot of free time” (Student Responsibility and Freedom) and “She/he gets angry” (Admonishing). The 64-item version of the QTI has been reduced to 48 items and validated (Goh & Fraser, 1996).

Cross-validation and comparative work with the QTI has been completed in various grade levels across the USA (Wubbels & Levy, 1993), Australia (Fisher et al., 1995), Singapore (Goh & Fraser, 1996), Brunei (Khine & Fisher, 2002; Riah & Fraser, 1998; Scott & Fisher, 2001), Indonesia (Soerjaningsih, Fraser & Aldridge, 2001b) and Korea (Kim, Fisher & Fraser, 2000). The QTI is suitable for the ages of students included in my research, but its focus primarily on teacher/student interactions makes this instrument inappropriate for my study.

### **2.3.7 Science Laboratory Environment Inventory (SLEI)**

Because of the importance of laboratory settings in science education, an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels was developed (Fraser, Giddings & McRobbie, 1995; Fraser & McRobbie, 1995). The SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often. Typical items are “I use the theory from my regular science class sessions during laboratory activities” (Integration) and “We know the results that we are supposed to get before we commence a laboratory activity” (Open-Endedness). The SLEI was field tested and validated simultaneously with a sample of 5447 students in 269 classes in six different countries (the USA,

Canada, England, Israel, Australia and Nigeria), and cross-validated with 1594 Australian students in 92 classes (Fraser & McRobbie, 1995) and 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1997).

The SLEI has been cross-validated and found useful in several Asian countries in both the English and the Korean languages. The English version of the SLEI has been used with 1592 chemistry students (Wong & Fraser, 1996) and 497 chemistry students (Quek, Fraser & Wong, 2001) in Singapore and with 644 chemistry students in Brunei Darussalam (Riah & Fraser, 1998). Lee and Fraser (2001b, 2002) have used a translated version of the SLEI in Korea.

### **2.3.8 Constructivist Learning Environment Survey (CLES)**

According to the constructivist view, meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, and this sense-making process involves active negotiation and consensus building. The CLES (Taylor, Fraser & Fisher, 1997) was developed to assist researchers and teachers to assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology, and to assist teachers to reflect on their epistemological assumptions and reshape their teaching practice. The CLES has 36 items with five response alternatives ranging from Almost Never to Almost Always. Typical items are "I help the teacher to decide what activities I do" (Shared Control) and "Other students ask me to explain my ideas" (Student Negotiation).

Kim, Fisher and Fraser (1999) translated the CLES into Korean and administered it to 1083 science students. Lee and Fraser (2001a) replicated the five-factor structure of the Korean-language version of the CLES among 440 science students. Aldridge, Fraser, Taylor and Chen (2000) cross-validated a Chinese-language of the CLES with 1079 science students in Taiwan. Nix, Fraser and Ledbetter (2003) used the CLES with 1079 high school students in North Texas, whereas Sebela, Fraser and Aldridge (2003) used the CLES with a sample of 1864 Grade 4 – 9 students in South Africa.

### **2.3.9 What Is Happening In this Class? (WIHIC) Questionnaire**

In 1996, the *What Is Happening In This Class* (WIHIC) questionnaire was developed (Fraser, Fisher & McRobbie, 1996) to bring together many of the most effective scales that had been developed in the field of learning environments. This instrument also includes learning environment scales considered important by contemporary educators and researchers. The original 90-item, nine-scale version was refined by statistical analysis of data from 355 junior high science students, as well as through extensive interviewing of students about their views of their classroom environments in general (Fraser, Fisher & McRobbie, 1996). Only 54 items in seven scales survived these procedures, and these items were expanded to 80 items in 8 scales for the field testing of the second version of the WIHIC. The final 56-item version of the CLES (Aldridge, Fraser & Huang, 1999) has the following seven scales: Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity.

An Australian sample of 1081 students in 50 classes responded to a revised English version of the WIHIC, whilst a Taiwanese sample of 1879 students in 50 classes responded to a Chinese version that had undergone careful procedures of translation and back translation (Aldridge & Fraser, 2000; Aldridge, Fraser & Huang, 1999). This led to a final form of the WIHIC containing the seven eight-item scales, and which has been successfully used in studies carried out in Australia, Canada and England (Dorman, Adams & Ferguson, in press), Singapore (Chionh & Fraser, 1998; Fraser & Chionh, 2000; Khoo & Fraser, 1997), Brunei (Khine & Fraser, 2001; Riah & Fraser, 1998), Canada (Raaflaub & Fraser, 2002; Zandvliet & Fraser, 1998), the USA (Allen & Fraser, 2002; Pickett & Fraser, 2002), Korea (Kim, Fisher & Fraser, 2000) and Indonesia (Margianti, Fraser & Aldridge, 2001; Soerjaningsih, Fraser & Aldridge, 2001a).

The WIHIC is appropriate for use with students of middle and high school age, and it includes scales that seem practical for classroom teachers to guide their attempts to improve their classroom environment. Also it has proven to be valid in a wide variety of studies in numerous countries. So, it was selected to be used in my research. The scales of the instrument and the reasons for its selection in this study are detailed

further in section 3.4.1 of this thesis. A copy of the modified WIHIC is provided in the Appendix.

### **2.3.10 Other Instruments**

In addition to the instruments discussed above, there are several other instruments that were developed with a specific focus. These include instruments to assess learning environments in Catholic schools (Dorman, Fraser & McRobbie, 1997), computer-assisted learning situations (Maor & Fraser, 1996; Teh & Fraser, 1994), students' perceptions of specific teacher interactions (Woods & Fraser, 1995), culturally-sensitive factors in learning environments (Fisher & Waldrup, 1997), and the environment experienced by students involved in distance learning (Jegede, Fraser & Fisher, 1995; Walker, 2003). These instruments have been successfully field-tested and validated in various situations, thus suggesting that there is great value in specifically creating an instrument with a narrow focus and purpose.

## **2.4 APPLICATIONS OF CLASSROOM ENVIRONMENT INSTRUMENTS**

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Fraser (1998c) outlines 12 types of past classroom learning environment research which focus on:

- associations between student outcomes and classroom environment
- evaluation of educational innovations
- differences between students' and teachers' perceptions of the same classrooms
- whether students achieve better when in their preferred environments
- teachers' practical attempts to improve their classroom environments
- combining qualitative and quantitative methods
- school psychology
- links between educational environments
- cross-national studies
- transition for elementary to secondary school
- teacher education
- teacher assessment.

Literature reporting two of the above lines of research directly relevant to my study is reviewed below: associations between student outcomes and classroom environment (Section 2.4.1); and action research aimed at improving classroom environments (Section 2.4.2). Also relevant to my study is past research on determinants (e.g. gender) of perceived classroom environment; this is reviewed in Section 2.4.3.

#### **2.4.1 Associations between classroom environment and student outcomes**

There have been many research studies that have found associations between the learning environment and student outcomes. Fraser (1994) collated a set of 64 studies of associations between outcome measures and perceptions of classroom environment that have involved a variety of cognitive and affective outcome measures, a variety of classroom environment instruments, and a variety of samples (from various countries and grade levels). Haertel, Walberg and Haertel (1981) synthesised 734 correlations from a total of 12 studies of 10 data sets from 823 classes involving 17, 805 students in four different countries. This meta-analysis revealed consistent and strong associations between posttest learning scores and regression-adjusted gains in student cognitive and affective outcomes. They found that higher achievement was consistently evident in classrooms in which students perceived more cohesiveness, satisfaction, and goal direction and less disorganization and friction.

Over the past 30 years, there have been many studies of associations between classroom environment and student outcomes. In an early study in Australia (Fraser & Fisher, 1982b), sizeable associations between student perceptions of classroom environment and numerous student outcomes supported a positive link between classroom environment and student outcomes. Studies conducted in Southeast Asian countries, such as Indonesia (Fraser, 1985; Fraser, Pearse & Azmi, 1982; Margianti & Fraser, 2000; Paige, 1978, 1979; Schibeci, Rideng & Fraser, 1987), Singapore (Chionh & Fraser, 1998; Fraser & Chionh, 2000; Goh, Young & Fraser, 1995; Teh & Fraser, 1993, 1994; Wong & Fraser, 1994, 1996), Korea (Kim, Fisher & Fraser, 1999; Lee & Fraser, 2000) and Brunei (Riah & Fraser, 1998; Scott & Fisher, 2001) replicated prior research in that the nature of the psychosocial climate in classrooms

was found to be an important determinant of student outcomes (Fraser, 2000). The results of these studies are striking and relevant to the research goals of my study and to the teachers working in the school being studied.

With the added pressure of the National Science Standards, American science teachers are dealing with the need to incorporate more laboratory experiences for their students. There have been studies that explore associations between student outcomes and science laboratory classroom environments. These include Wong and Fraser's (1994) research undertaken in chemistry classes in Singapore secondary schools, which found strong associations between the scales of chemistry laboratory environment and student affective outcomes.

Research by Henderson, Fisher and Fraser (1994, 1995, 2000) in secondary biology laboratory classrooms in Tasmania, Australia, also replicated earlier findings of positive relationships between student outcomes and the science laboratory environment. This type of work is well illustrated by the study of Fraser, Giddings and McRobbie (1992a, 1995) involving 5,447 senior high school and university students in 269 laboratory classes in Australia, the USA, England, Canada, Israel, and Nigeria. This cross-national research was the first of its kind in that a new instrument, called the *Science Laboratory Environment Inventory* (SLEI), was designed for use in laboratory settings, and was validated and used in the six countries simultaneously. The finding of significant associations between the nature of the science laboratory environment and students' affective outcomes replicated prior research in science classrooms. This study also provided insights into the merits and pitfalls of cross-national research of this nature (Fraser, Giddings & McRobbie, 1992a, 1992b, 1995; Fraser, McRobbie & Giddings, 1993).

While many past learning environment studies have employed techniques such as multiple regression analysis, few have use multilevel analysis (Bryk & Raudenbush, 1992), which takes cognisance of the hierarchical nature of classroom settings. Recently, however, two studies compared the results from multiple regression analysis with those from an analysis involving the hierarchical linear model. In Wong, Young and Fraser's (1997) study involving 1592 Grade 10 students in 56 chemistry classes in Singapore, associations were investigated between three student

attitude measures and a modified version of the SLEI. In Goh, Young and Fraser's (1995) study with 1512 Grade 5 mathematics students in 39 classes in Singapore, scores on a modified version of the MCI were related to student achievement and attitude. Most of the statistically significant results from the multiple regression analyses were replicated in the hierarchical linear model analyses, as well as being consistent in direction.

Psychosocial learning environment is one factor in Walberg's (1981) multi-factor psychological model of educational productivity, which holds that learning is a function of student age, ability and motivation; of quality and quantity of instruction; and of the psychosocial environment of the home, the classroom, the peer group and the mass media. In principle, any factor at a zero-point results in zero learning; thus either zero motivation or zero time for instruction results in zero learning. Moreover, it does less good to raise a factor that already is high than to improve one that currently is the main constraint to learning. Empirical probes of the educational productivity model involved extensive research syntheses involving the correlations of learning with the factors in the model (Fraser, Walberg, Welch & Hattie, 1987; Walberg, 1986) and secondary analyses of large data bases collected as part of the National Assessment of Educational Achievement (Walberg, 1986) and National Assessment of Educational Progress (Walberg, Fraser & Welch, 1986). In these studies, classroom and school environment was found to be a strong predictor of both achievement and attitudes even when a comprehensive set of other factors was held constant.

#### **2.4.2 Action research aimed at improving classroom environments**

The availability of actual and preferred forms of classroom environment instruments, which can be used either with students or teachers, enables investigations into differences between students and teachers in their perceptions of the same actual classroom environment and the environment preferred by students or teachers. Fisher and Fraser (1983a) reported that students preferred a more positive environment than was actually the case, and that teachers perceived a more positive environment than did their students in the same classrooms. These findings also emerged in studies carried out in classrooms of secondary schools in the USA (Moos, 1979a), Australia



(Fraser, 1982), Israel (Raviv, Raviv & Reisel, 1990), The Netherlands (Wubbels, Brekelmans & Hooymayers, 1991) and Singapore (Teh & Fraser, 1993; Wong & Fraser, 1994). Generally, these studies emphasize that students and teachers are likely to perceive the nature of the same classroom differently and that students tend to see their actual classroom environment as less positive than they would prefer.

The availability of actual and preferred forms of classroom environment instruments also allows person-environment fit studies of whether students achieve better in their preferred environment (Fraser, 1991). Findings from a study in science classes by Fraser and Fisher (1983b, 1983c) suggest that an actual-preferred match in the classroom environment could enhance student outcomes.

The above research is relevant to my study because I used the actual and preferred forms of the WIHIC to show teachers that a discrepancy existed between their actual classroom environments and those of their students. These actual and preferred forms were also used in the intervention stage of my research study. Copies of the actual and preferred versions of the WIHIC used in this study are included in Appendix ??? of this thesis.

Feedback information based on student or teacher perceptions has been employed in a five-step procedure as a basis for reflection upon, discussion of, and systematic attempts to improve classroom environments at the early childhood level (Fisher, Fraser & Bassett, 1995), primary level (Fraser & Deer, 1983), secondary level (Sinclair & Fraser, 2002; Thorp, Burden & Fraser, 1994; Woods & Fraser, 1996) and higher education level (Yarrow & Millwater, 1995; Yarrow, Millwater & Fraser, 1997). First, all students in the class respond to the preferred form of a classroom environment instrument, while the actual form is administered in the same time slot about a week later (assessment). Second, the teacher is provided with feedback information derived from student responses in the form of profiles representing the class means of students' actual and preferred environment scores (feedback). These profiles permit identification of the changes in classroom environment needed to reduce major differences between the nature of the actual environment and that preferred by students. Third, the teacher engages in private reflection and informal discussion about the profiles in order to provide a basis for a decision about whether

an attempt would be made to change the environment in terms of some of the dimensions (reflection and discussion). The main criteria used for selection of dimensions for change are, first, that there should be a sizeable actual-preferred difference on that variable and, second, that the teacher should feel concerned about this difference and want to make an effort to reduce it. Fourth, the teacher introduces an intervention of approximately two months' duration in an attempt to change the classroom environment (intervention). For example, strategies used to enhance the dimension of Teacher Support could involve the teacher moving around the class more to mix with students, providing assistance to students and talking with them more than previously. Fifth, the student actual form of the scales is readministered at the end of the intervention to see whether students are perceiving their classroom environments differently from before (reassessment).

Woods and Fraser (1995) used this basic approach to improving classroom environments with 16 teachers who used the actual and preferred forms of the Classroom Interaction Patterns Questionnaire to assess student perceptions of teacher behaviour (Praise and Encouragement, Open Questioning, Lecture and Direction, Individual Work, Discipline and Management, and Group Work). Whereas half of the teachers received feedback and attempted changes in their classrooms, the other half only administered the questionnaires. Teachers who received feedback, compared with the teachers who didn't receive feedback, were able to achieve more reductions in actual-preferred discrepancies on most classroom environment dimensions.

Yarrow, Millwater and Fraser (1997) reported a study in which 117 preservice education teachers were introduced to the field of learning environment through being involved in action research aimed at improving their university teacher education classes and the 117 primary school classes during teaching practice. The CUCEI was used at the university level and the MCI was used at the primary level. Improvements in classroom environment were observed, and the preservice teachers generally valued both the inclusion of the topic of learning environment in the preservice programs and the opportunity to be involved in action research aimed at improving classroom environments.

Sinclair and Fraser (2002) involved a group of three teachers and three of each teacher's classes in action research aimed at improving their classroom environments. Based on students' responses to actual and preferred forms of a classroom environment questionnaire, the teachers developed their own action research plans. These attempts to alter their classroom environments led to changes in classroom climate, thus supporting the efficacy of the environmental change strategy. In particular, changes occurred for all classroom environment dimensions for which teachers attempted changes, with the sizes of these changes ranging between 0.25 and 0.50 standard deviations. An important insight gained from this study was that, in classes where males and females had distinctly different perceptions of perceived and preferred classroom environment, environmental change attempts needed to involve different interventions for students of different genders.

#### **2.4.3 Determinants of classroom environment perceptions**

Under President Bush's No Child Left Behind Act (2001), a major goal of American high schools is to increase the number of mathematics and science courses taken by all students. This leads to questions about differences in the classroom environment perceptions of different students. Studies of determinants of classroom environment have been conducted in countries such as the USA, Australia, and Singapore (Fraser, 1998a). These focused mainly on how the classroom environment varies with factors such as class size, grade level, subject content, teacher/students personality, the nature of the school environment (as opposed to the classroom environment) and the type of school (primary compared to middle school).

For instance, Walberg and Anderson (1968a, 1968b) examined classroom climate and student characteristics in terms of their unique personalities, shared role expectations and abilities. Walberg (1969) also reported an interesting study of class size and learning environment. A study by Owens and Straton (1980) into student preferences for different types of classroom environment (cooperative, competitive, and individualized) revealed that girls preferred a cooperative classroom atmosphere more than did boys, whereas boys preferred both competition and individualization more than did girls. In Singapore, gender-related differences in perceptions of

classroom environment were examined also by Teh and Fraser (1993) in a study of computer-assisted learning and by Wong and Fraser (1994) in a study of chemistry laboratory learning environments. Margianti, Fraser and Aldridge (2001a) reported gender differences in a study of mathematics learning environments in an Indonesian university.

These studies are relevant to my research because I investigated differences in the classroom environment perceptions on the WIHIC between males and females, between black and non-black students, and between students in the first and second years of the study.

## **2.5 DEFINING AND MEASURING STUDENT ATTITUDES**

The Charlotte Mecklenburg Schools, the North Carolina Department of Public Instruction, and the National Education Association have listed as an important goal promoting students' positive attitudes towards science. An essential component of my study involved assessing students' attitudes to science and investigating associations between attitudes and classroom environment.

Defining attitude is a difficult task that has been debated by researchers for nearly 100 years. According to Mueller (1986), attitudes cannot be observed or measured directly. Their existence must be inferred from their consequences. Given that an attitude is a non-observable psychological construct whose presence can only be deduced from the behavior manifested, it is not surprising that social scientists cannot agree on the definition for the term attitude.

Several scaling techniques have been developed to measure attitudes, such as Likert attitude scaling (Likert, 1932), Thurstone scaling, Guttman scaling and the semantic differential technique. In measuring the attitude of a respondent using the Likert scaling technique, the researcher locates the respondent's position on a continuum ranging from the extreme end of positive to that of negative. Responses to given statements about an attitudinal object on a five-point continuum (e.g., Strongly Agree, Agree, Uncertain, Disagree and Strongly Disagree) are tallied. This historical perspective on attitude assessment is important because many of the learning

environment instruments use Likert-type statements as responses. In fact, the attitude scale used in my study makes use of the Likert response scale.

One of the most-widely used and effective instruments for assessing students' attitudes towards science is the *Test of Science-Related Attitudes* (TOSRA) developed by Fraser (1981b). The TOSRA is based on the classification of students' attitudinal aims according to Klopfer's (1971) six categories: attitude to science and scientists, attitude to inquiry, adoption of scientific attitudes, enjoyment of science learning experiences, interest in science, and interest in a career in science. This instrument has been widely used to measure attitudes related to the study of science. Examples of items in the TOSRA are "Science lessons bore me" and "Schools should have more science lessons each week". Some of the items have negative scoring and there are a total of 70 items in the questionnaire.

This questionnaire is appropriate for middle and high school students. Therefore, items from this instrument were included in my study in order to assess students' attitudes toward science. I included only 7 items, from one scale (Enjoyment of Science Lessons).

In the intervention phase of my study, I was keen to design instruction that would be interesting and motivating to students. Wankat and Oreovicz (1993, p. 284) present a scientific learning cycle to help students in their mental development. The scientific learning cycle has the three phases of Exploration, Term Introduction, and Concept Application. In this cognitive view of motivation, it is the teacher's first duty to ensure that the students will be able to learn. If a student cannot make any sense of new information, supporting structures will not be incorporated into the student's mental framework, and the new information will not be added, but will be rejected, returning the student to a state of equilibrium. The teacher should make a point of getting to know the students and should stress the required background knowledge or prerequisites for the class, so that the student can experience success. To motivate students, the scientific learning cycle seems to suggest that it is important that the material presented is not overly organized or too comprehensive. Holes and gaps in presentations are not seen as a problem in this theory of learning. The ideal situation would involve a teacher presenting students with enough background knowledge so

that they can effectively 'fill in the details' for themselves and, in so doing, acquire a clear understanding of the content being studied.

Wankat and Oreovicz (1993, p. 298) provide a good introduction to Maslow's (1970) theory of motivation, that states that individuals have a hierarchy of needs. When a need is unfulfilled, the individual will be motivated to fulfill that need. Once all lower needs are satisfied, higher-level needs can be addressed. In particular, if one of the lower needs is suddenly not satisfied, this need will become the most important need until it is again satisfied. In today's schools, with many children of low socioeconomic status, some students can come to school with unfulfilled basic needs. This theory helps to explain their outwardly unmotivated behaviors. It is truly difficult to worry about the equation for photosynthesis if a student is hungry and worried about his/her parents losing a job. Many students in today's comprehensive urban high schools can find that their needs for love and belonging are no longer satisfied. They are struggling through the adolescent needs to detach themselves from their parents and are searching for a group in which they are accepted. Teachers need to be aware of the interactions of their students with one another and need to structure classroom activities that allow the students to get to know one another, and to value each person's unique qualities.

Students' motivation has been studied by psychologists and educational researchers since the early 1950s. Early researchers treated motivation as being similar to an inner drive. However, since Atkinson's (1957) discussion of motivation as the product of expectation of succeeding at a task and perceived value of accomplishing that task, motivation has increasingly been treated by researchers as a function of cognitive decision-making. Attribution theory (Weinger, 1984), self-worth theory (Covington, 1992) and goal-orientation theory (e.g., Ames, 1992; Blumenfeld, 1992; Elliott & Dweck, 1988) all assume that individuals only put forth effort when they perceive that effort will result in fulfillment of their personal goals. Factors outside of school, including parents' attitudes towards schools and their actions, are very influential in the motivation of students (Eccles, Adler, Futterman, Goff, Kaczala, Meece & Midgley, 1985).

Another important motivation variable is the effect of task difficulty. A number of researchers (e.g., Blumenfeld, 1992; Paris & Turner, 1994; Stipek, 1996) note the importance of providing students with moderately difficult tasks. Tasks that are too difficult frustrate students, while tasks that are too easy can lead to boredom and misbehavior (Kloosterman & Cougan, 1994) or to the feeling that the teacher has low expectations of them (Nicholls, 1984). This means that the teacher has an immense responsibility in structuring the organization of the lessons in a manner that is not too difficult, but challenging enough to keep the students interested in the content.

The present study was indirectly associated with motivation in terms of how students with a history of poor performance in science classes could be motivated to achieve. This motivation factor came into play during the intervention year when teachers selected their students most likely to fail and placed them in the intervention classes. Also, student attitudes to science were assessed using a scale adapted from the Test of Science-Related Attitudes (TOSRA; Fraser, 1981).

## **2.6 CHAPTER SUMMARY**

This literature review chapter provided a definition of 'learning environment' (Fraser, 1989), a historical account of the theoretical perspectives that have underpinned classroom environment research, a review of some of the instruments used to measure classroom environments, and a description of some common lines of learning environment research.

The literature indicates that classroom environment research opens useful avenues for exploring teaching and learning from student, teacher, and observer viewpoints. The range of instruments available makes it possible for educators to investigate the nature of learning environments in classroom and laboratory classroom environments, and to measure students' actual and preferred environment.

A review of the literature reveals that the strongest tradition in past classroom environment research has been the investigation of associations between student outcomes and student perceptions of psychosocial characteristics of their classrooms. Research using perceptions of both teachers and students across varying grade levels

(primary, secondary, higher education), different content areas (science, mathematics, languages), different types of schools and various countries (the USA, Canada, Australia, Israel and Indonesia) generally supports the contention that the learning environments of classrooms account for a considerable proportion of the variance in student outcomes. My study incorporated this line of research.

These research activities over the past 30 years were accompanied by the development and validation of various instruments to evaluate the classroom environment. Each of these instruments is a paper-and-pencil questionnaire measuring the perceptions of students and teachers of different psychosocial dimensions of their classroom, mainly using five-point rating scales. One of these questionnaires (the *What Is Happening in this Class?*, WIHIC) was selected for use in my study.

Improving classroom learning environment is not only educationally desirable, but it is one way of enhancing students' outcomes. However, in order for this practice to become more widespread, classroom teachers must become familiar with learning instruments and ideas. Fraser (1994) indicates that incorporating classroom environment work into preservice and inservice teacher education programs would help teachers to understand the importance of classroom environment. Hopefully, knowledge of classroom environment and its importance for improving student outcomes would lead to classroom teachers conducting action research on their own or in collaboration with university researchers. My study involved attempts to improve classroom learning environments and, subsequently, student achievement.

The literature review has also shown that classroom environment instruments are not only useful for investigating the effects of classroom environments on student learning outcomes, but also for evaluating curricula and educational innovations. Studies indicate that these instruments can provide teachers and administrators with valuable information about the efficacy of new programs and the information technologies employed in the classroom.

Tobin and Fraser (1998) suggest that the inclusion of both quantitative and qualitative methods in the same study would help classroom environment researchers



gain better understandings of classroom events. For the present study, a modified version of the *What Is Happening In this Class?* (WIHIC) was used to measure the classroom environment and, in addition, qualitative methods were used in a relatively minor way.

The concept of attitude, its definition, and its measurement have been widely explored in books such as by Eiser (1984), Mueller (1986) and Lemon (1973). The notion that attitudinal behavior is learned and can be modified is widely accepted by social scientists and psychologists. Also acknowledged by researchers and educators is the relationship of attitudes to values and beliefs. Several scaling techniques have been developed to measure attitudes, such as Likert attitude scaling, Thurstone scaling, Guttman scaling and the semantic differential technique. These beliefs contribute to student academic achievement and can be measured by instruments such as the *Test of Science Related Attitudes* (TOSRA). In fact, a scale from the TOSRA was used in my study to assess students' attitudes to science.

Numerous studies have investigated attitudes as one of the student outcome measures to be related to classroom environment. Many of these studies (e.g., McRobbie & Fraser, 1993a) showed positive relationships between students' attitudes towards science and classroom environments. For the present study, the scale selected from the TOSRA was used in relating students' attitude towards science and relate them to classroom environment.

My study was distinctive in that it not only used the learning environment instrument to determine if there was a relationship between classroom learning environment and students' achievement and attitudes, but I also conducted an intervention study. This intervention study used insights gained from the literature search and the results from the classroom environment survey to improve both the learning environment and science achievement for low-achieving students. This study is similar to past research, but is unique in that it was conducted in Charlotte, North Carolina and it provides additional information about interventions aimed at improving teaching and learning in a difficult urban setting.

## **Chapter 3**

### **METHODS**

#### **3.1 INTRODUCTION**

The main focus of this study, as discussed in Chapter 1, was to investigate classroom learning environment, student achievement on a high-stakes end-of-course examination in Biology, and student attitudes toward science. This research involved cross-validating a widely-applicable learning environment questionnaire (What Is Happening In this Class?, WIHIC), as well as exploring gender and ethnic differences in students' perceptions of their classroom learning environments. Also, based on the feedback information from the classroom environment questionnaires, an intervention was designed and implemented in an attempt to improve the classroom environment and student achievement.

This chapter describes the different phases of the present study in terms of the research design, the sample, the instruments used (together with their modification and validation), data collection, statistical procedures used in analyzing the data, and strategies used during the intervention phase of the study. The following structure is used in discussing the research methods employed in this study.

#### **3.2 Research Design**

#### **3.3 Sample**

#### **3.4 Instruments used in the present study**

##### **3.4.1 What Is Happening In this Class? (WIHIC) Questionnaire**

##### **3.4.2 Field testing of the WIHIC**

##### **3.4.3 Assessment of student attitudes**

#### **3.5 Data Collection for Part 1 of the Study: Questionnaire Survey**

#### **3.6 Data Collection for Part 2 of the Study: Intervention**

##### **3.6.1 Design of intervention study**

##### **3.6.2 Intervention study methods**

### 3.7 Statistical Analyses

#### 3.7.1 Choice of units of statistical analysis

#### 3.7.2 Statistical analysis procedures

##### 3.7.2.1 Validity and reliability of questionnaire

##### 3.7.2.2 MANOVA for differences in perceptions between groups

##### 3.7.2.3 Associations between learning environment and student outcomes

### 3.8 Chapter Summary

## 3.2 RESEARCH DESIGN

My study was primarily quantitative in nature, although a minor qualitative portion was devoted to semi-structured interviews with students after the questionnaire survey to elaborate on their responses. Also, during the intervention phase of the study, I was the classroom teacher and had many opportunities for personal interactions with students and parents involved in the intervention. Owing to the tight schedule of the participating students and time constraints imposed by the State of North Carolina curriculum, further interviews were not possible. Overall, the combination of quantitative and qualitative data-gathering methods in learning environment research has been recommended by Tobin and Fraser (1998).

Perceptual measures were considered to provide an appropriate method for assessing and studying classroom environment. As outlined by Fraser and Walberg (1981), perceptual measures can be considered more useful than direct observations for several reasons. First, perceptual measures are more economical in terms of the amount of time and costs involved than direct observation. And, in this particular case, direct observation would have been impossible, as the researcher is also a full-time classroom teacher. Second, more accurate representations can be obtained using perceptual measures, as “perceptual measures are based on students’ experience over many lessons . . .” (Fraser, 1986a, p. 3) as opposed to a small number of lesson observations made by an outside observer. Third, the use of perceptual measures enables the researcher to provide a collective representation of the members of the class as opposed to that of a single outside observer. Fourth, perceptual measures were selected because students’ behaviors are more likely to be influenced by their

perceptions than by the situation as observed by an outsider. And, fifth, research has shown that students' perceptual measures of classroom environments contribute more to the variance in student learning outcomes than do directly-observed variables.

### **3.3 SAMPLE**

All of the teachers, classes, and students in my study's sample were from Independence High School, a large comprehensive, urban school in Charlotte, North Carolina. During each of the three years of the study, Independence High School had approximately 2300 students, 48% of whom are of color. There are students from 50 different countries with many different cultures. This high school has several 'schools within a school' and each of these programs has a specific focus.

The most advanced students are enrolled in the International Baccalaureate program, which is extremely rigorous and includes classes in science, mathematics, history, the arts, English, and philosophy. The students in this program take examinations that are normed internationally, and most earn at least one year of college credit based upon their examination scores. Many students at this high school are in the English as a Second Language program. These students come from other countries and need special assistance with English. Many students are in the International Studies program, which uses international issues as a background for all their studies. This program also encourages the students to spend time abroad. Many students are in the Advancement via Individual Determination (AVID) program. This program targets students whose parents did not go to college in order to open their eyes to the options after high school graduation and to help them to construct a plan to realize opportunities after graduating. A small number of students are enrolled in the Biomedical Academy, which prepares students to enter a medical or allied health profession. Approximately 30% of the students in this high school are not enrolled in any special program and are working towards a high school diploma. Because all students must enroll in Biology and pass the course in order to graduate from high school in North Carolina, all types of students are found in the Biology classrooms.

In the first two years of my study, I investigated whether the What Is Happening in this Class? (WIHIC) questionnaire would be suitable, reliable and valid for use with first-year Biology students in Charlotte, North Carolina, and to identify which WIHIC scales are most strongly correlated with scores on an attitude questionnaire and on the North Carolina Biology End-Of-Course examination. This validation was conducted over a two-year period because the end-of-course examination varies from year to year, and students are also different each year. All of the students were in first-year Biology classes (grades 9 and 10), and these 18 classes were taught by five different teachers with various levels of experience. The teachers involved in Part 1 of the study had teaching experience ranging from 7 to 25 years. Two teachers were male and three were female. All of the teachers were white and all had at least a Bachelor's degree in education. All of the teachers participated in the program on a voluntary basis. They were assured by the researcher and the school administration that the results would not be used in a punitive manner, but would provide data for self-reflection on teaching.

Part 1 of the study involved a questionnaire survey conducted during the 1998-1999 and 1999-2000 school years. A total of 364 grade 9 and grade 10 students completed preferred and actual versions of a classroom environment questionnaire about their Biology class. This number represents 36% of the students in Biology and 71% of the teachers during the two-year period. The preferred version of the WIHIC was given to determine students' preferences in terms of Biology classroom environments and, then, one week later, the actual version of the WIHIC was given to assess students' perceptions of what the present class actually was like. These two versions of the instrument were printed on paper of different colors to help students to distinguish visually between the two forms. This process occurred after at least 10 weeks in the classroom.

Part 2 involved one teacher (the researcher) in conducting an intervention during the 2000-2001 school year with one class of 25 students. The school studied is labeled Equity Plus because at least 25% of students attending that school have economic circumstances that qualify them for free lunch or to purchase lunch at a reduced price. This high percentage of students of low socioeconomic status provides each teacher at these schools with a salary bonus of \$2500 per year. The teachers were

also interested in strategies for improving their students' test scores because of the accountability bonuses that can be as much as \$2500 each year.

The performance of the students at this school on the End-Of-Course (EOC) Biology Examinations prior to this study are shown in Table 3-1, which shows the percentages of students scoring 80% or higher on their high-stakes test. This number is used because the state of North Carolina has deemed 80% correct as the benchmark for students to be considered 'at grade level'. The performance of various subgroups of students are shown and compared with the school, district, and state averages in Table 3-1.

The percentages in Table 3-1 indicate that this particular school is doing a good job with its students of varied ethnic and socioeconomic background. Even though the biology teachers were already doing a good job with their students, they were sincerely interested in improving their classroom learning environments if it would yield an improvement in student test scores.

Table 3-1 End-Of-Course Biology Examination Results Prior to the Study

Category	Percentage of Students Proficient (80% or Higher)		
	1995-1996	1996-1997	1997-1998
African-American	39.3	42.1	42.9
White	75.7	76.9	77.4
Other	45.7	46.8	47.9
Female	62.9	63.1	63.4
Male	55.1	55.2	55.3
Free/reduced-priced lunch	30.9	31.5	32.0
Paid lunch	65.4	66.1	67.1
School Average	58.5	59.1	59.5
District Average	55.5	56.4	57.3
State Average	53.5	55.5	56.9

Data provided by North Carolina Department of Public Instruction, Statistics Department

### **3.4 INSTRUMENTS USED IN THE PRESENT STUDY**

This section describes the questionnaires used to assess classroom environment and student attitudes in my study. Section 3.4.1 discusses the What Is Happening In this Class? (WIHIC) questionnaire. Section 3.4.2 briefly reports a small pilot study with the WIHIC. Section 3.4.3 considers the assessment of student attitudes.

Chapter 2 described a large number of past studies that have reported the successful adaptation and use of classroom environment instruments that have originated from Western countries, in a variety of cultural settings, including Asian countries (Aldridge & Fraser, 2000; Chionh & Fraser, 1998; Fraser, Pearse, & Azmi, 1982; Goh & Fraser, 1995; Goh, Young & Fraser, 1995; Khoo & Fraser, 1997; Riah & Fraser, 1998; Schibeci, Rideng & Fraser, 1987; Teh & Fraser, 1993, 1994; Walberg, Singh & Rasher, 1977; Wong & Fraser, 1994, 1996). These studies have indicated that the instruments are reliable and valid for use in those cultures in which the studies took place. This is important because of the diversity of the student body in the school being studied in my research. The students in my school come from more than 50 countries and, even though they all can speak English at some level, it is comforting to know that these instruments have been found to be valid in many countries. Some of these studies have been undertaken in high school classrooms in North America (Pickett & Fraser, 2002; Raaflaub & Fraser, 2002), and the results provided confidence that the instruments were appropriate for use in my study.

#### **3.4.1 What Is Happening In this Class? (WIHIC) Questionnaire**

The instrument chosen as the most useful in my research was the What Is Happening In this Class? (WIHIC) questionnaire. Section 2.3.9 reviews literature relevant to the WIHIC, which contains the following scales:

1. **Student Cohesiveness** – the extent to which students know and help one another in the classroom
2. **Teacher Support** – the extent to which the teacher shows an interest in helping the student to succeed

3. **Involvement** – the extent to which the student is actively involved in learning in this classroom
4. **Investigation** – the extent to which inquiry learning and problem-solving activities are experienced in this classroom
5. **Task Orientation** – the extent to which it is important to stay on task and complete work assigned by the teacher in this classroom
6. **Cooperation** – the extent to which students work together to help one another complete work assigned by the teacher in this classroom
7. **Equity** – the extent to which students are treated fairly by the teacher.

Of the instruments discussed in Section 2.3, the WIHIC stands out as being parsimonious (Fraser, Fisher & McRobbie, 1996). It can provide a fairly comprehensive and clear indication of both the ‘actual’ state of the psychosocial learning environment of the classroom and the ‘preferred’ state of an educational environment as desired by the student learners. Because of this, the WIHIC is a highly-suitable instrument for describing the actual ‘health’ of the classroom. Following Fraser, Giddings and McRobbie’s (1995) recommendation, the modified WIHIC was used in its ‘personal’ rather than ‘class’ form. That is, items ask students for their individual perceptions of the class as a whole. For example, an item in the ‘personal’ form of a questionnaire could be “The teacher’s questions help me to understand”, whereas the parallel item in the ‘class’ form would be “The teacher’s questions help students to understand”. According to Fraser et al. (1996), the ‘personal’ form is more suited for investigations of the classroom environment perceptions of within-class subgroups (e.g. different genders or ethnic groups) or for the construction of case studies of individual students. Given the purposes of my research, the ‘personal’ form was chosen as more suitable than the ‘class’ form. The Biology team teachers were interested in creating a positive learning environment for each of their students because, in this school district, students annually complete a survey about their own individual opinions of their education. Because these student surveys are published and used by many parents to select schools, it was deemed appropriate to ask ‘personal’ opinions about the classroom learning environment.

In line with past research (Fraser, 1994, 1998a), separate actual (or perceived) and preferred (or ideal) forms of the WIHIC were developed and used in the present



investigation. All items in the actual and preferred forms are parallel and can be examined in Appendices A & B. The item wording below illustrates the differences between actual and preferred forms:

I ask the teacher questions. (actual form)

I would ask the teacher questions. (preferred form)

The Biology team teachers also wanted to look at differences in perceptions of the environment according to gender, race, and academic track. Because the preferred form of questionnaires is concerned with “goals and value orientations” (Fraser, 1994, p. 409), this information was important for my study.

The items in the WIHIC were also non-threatening to the teachers and students in the classrooms involved. In this study, the teachers were participating voluntarily and began meeting weekly to discuss what they were observing in their classrooms. As the items of the WIHIC do not directly assess the personality, performance or character of the teacher and students, it is highly unlikely that it would be perceived as threatening. The WIHIC was modified slightly for my study by the biology teachers themselves to ensure that they obtained information which they considered valuable. Lastly, the WIHIC is an appropriate instrument to use because the teachers themselves administer the questionnaire to their classes and receive feedback in a timely manner from the responses of their students.

The final version of the WIHIC questionnaire used in my study had 50 items and a five-point response scale. The five response alternatives for each of the items are: Almost Never, Seldom, Sometimes, Often, and Almost Always. The students were instructed to circle the response that best fits his/her perception of the classroom environment under assessment. Copies of the actual and preferred versions of this modified What Is Happening In This Biology Class? (WIHIC) questionnaire can be found in the Appendix of this thesis.

### **3.4.2 Field testing of the WIHIC**

To field test the What Is Happening In this Biology Class? (WIHIC) questionnaire, one of the researcher’s classes was selected. This class was a ‘regular’ biology class,

which designates the lowest-performing students in the class. The team of biology teachers had examined the instrument and found it to be acceptable. It was assumed that the 'regular' classes would have the most difficulty in interpreting the statements and choosing an appropriate response. The Biology team teacher were concerned with student interpretation of Seldom and Often, and whether the lowest-ability students would be able to distinguish between the preferred and actual versions of the questionnaire. Therefore, the students in a low-ability 'regular' class were chosen as the subjects for field testing of the questionnaire.

After the class completed the questionnaire, a discussion was held to identify any difficulties. Overall, the students reported no problems in understanding the statements and selecting a response. This class was also encouraged to write additional information, and these qualitative statements were used as a basis for selecting several students for personal interviews to clarify their answers. These students of low reading ability needed approximately 20 minutes to complete the questionnaire. This was pertinent information because it helped the teachers to plan an appropriate amount of time for classes to complete the questionnaires during the main study. After this field test, the final version of the WIHIC was printed using paper of two different colors to help students to understand that there were different versions.

### **3.4.3 Assessment of student attitudes**

An eight-item attitude scale was also included in my study to measure the students' attitudes toward science. Measuring attitudes was consistent with Charlotte-Mecklenburg School system's goal to increase the number of science courses taken by all students. The biology team decided that better attitudes to science would be likely to lead more students to take science classes in the future, and so decided that these data would be beneficial. This is consistent with the work of Jelinek (1998) that suggests that involving students in more inquiry experiments improves their attitude towards science.

I drew on the Test of Science Related Attitudes (TOSRA; Fraser, 1981b) for attitude items for my study. The original TOSRA assesses seven attitude dimensions and is

based on Klopfer's (1971) scheme for classifying scientific attitudes. The areas encompassed by the original TOSRA are social implications of science, normality of scientists, attitude to inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, and career interest in science. Learning environment studies that have used the TOSRA include research in Singapore (Wong & Fraser, 1996) and in Australia (Fraser & Butts, 1982) and a cross-national study in Australia and Indonesia (Adolphe, Fraser & Aldridge, 2002).

Because of time constraints, the Biology teachers at my school recommended that only one scale from TOSRA be included in my study. The scale chosen was the one assessing students' enjoyment of their science lessons.

The TOSRA scale has a five-point Likert response format (Strongly Agree, Agree, Not Sure, Disagree, Strongly Disagree). The Biology team teachers were concerned about whether low-ability students would be able to distinguish between 'not sure' and 'disagree'. After field testing with a 'regular' class, their fears were allayed. The items used to assess attitudes towards science in my study are provided in Appendix C.

### **3.5 DATA COLLECTION FOR PART 1 OF THE STUDY: QUESTIONNAIRE SURVEY**

Part 1 of my study involved a survey of a large sample of students using the What Is Happening In this Class? (WIHIC) questionnaire and the attitude scale described in Section 3.4.

Because the biology teachers felt that the presence of the classroom teacher could inhibit student responses, I personally administered the questionnaire in each of the 18 classes involved in the study. The students were assured that their answers would not affect their Biology grade in any way and that their responses were important in helping teachers to make decisions about improving the quality of education in their classes. The students reacted favorably and were excited about voicing their opinions. Students wrote the teacher's name, the class type (pre-International Baccalaureate Honors class, Academically Gifted, or regular), their own name, their

student number, and their ethnic group. Having student names/ID numbers was important so that the student's End-Of-Course Biology examination grade could be used in the study for investigating associations between classroom learning environment and achievement.

The teachers received feedback based on the questionnaire data within several weeks of the data collection. They were given various graphs showing profiles of mean classroom environment scores that contrasted actual vs preferred scores, male vs female scores, and black vs non-black students' scores. These graphs were discussed along with possible interventions. There was no pressure on these teachers to attempt to change their teaching strategies at this point. Discussions focused only on possible reasons for observed patterns of student perceptions.

### **3.6 DATA COLLECTION FOR PART 2 OF THE STUDY: INTERVENTION**

This section describes the design of the intervention phase of my study (Section 3.6.1) and the details of the intervention itself (Section 3.6.2). After examining the graphs generated in Part 1 of the study, the Biology teachers at this school were interested in seeing if this information could be used in the intervention phase. They saw the link between classroom learning environment and student outcomes (attitudes and high-stakes test scores), but were not willing to take the risks themselves. Therefore, as the researcher, I assumed the responsibility for the intervention classes, with the help of my peer teachers serving as observers in this phase of the study.

#### **3.6.1 Design of intervention study**

For reasons of economy, it was decided to restrict reporting of the intervention phase of the study to one class. This part of the study involved only 25 students with one teacher, and the data were collected in much the same way as in Part 1 of the study. At about 10 weeks into the school year (after about five weeks in their new classroom environment), the Biology students responded to the preferred form of the modified WIHIC. Approximately one week later, students were given the actual form

of the instrument. They were informed from the time of their schedule change, at five weeks into the school year, that they were part of the researcher's study, and that the goal was to provide the best possible learning environment for each student. Their information was entered into a database and graphical representations of the information were studied by the team of biology teachers. Because the other teachers were not actually teaching the intervention class, they were free to come to observe the class during their planning periods, as well as to suggest ideas which they might not have been comfortable trying out themselves. The biology team teachers also monitored the quarterly assessment grades of the intervention class, and compared the intervention students' achievement scores to those of the rest of the school and school district.

### **3.6.2 Intervention study methods**

The sample for Part 2 of the study comprised only 25 students of the teacher-researcher. At the end of five weeks of school, I offered to take the biology students whom the other teachers had designated most 'at risk' of failure. The students were told that changes in staff led to their schedule change and, because schedule changes are fairly common in this school, the students believed this explanation. When these 25 students were given a simple reading test, it was found that nearly 65% of these students read at or below the 4<sup>th</sup> grade level. This is significant because the reading level of their high-stakes End-Of-Course Biology examination has been established at the 8<sup>th</sup> grade level. After five weeks in this new classroom, the intervention students were given the *What Is Happening In This Biology Class?* questionnaire in both its actual and preferred forms. The data were collected and graphs were prepared to represent the data. During the intervention year, the team of biology teachers met weekly to examine what was occurring in the researcher's classes and to offer suggestions for ways to improve. The methods used for changing the classroom environment and meeting all the students' needs were based on the steps advocated in past studies by Fraser and Fisher (1986), Thorp, Burden and Fraser (1994) and Yarrow, Millwater and Fraser (1997).

The intervention methods are described below:

1. I invited students and parents to an evening meeting on 'How to succeed in high school biology'. This meeting was held at a local black church in the community in which many of these students lived. At this meeting, parents were informed about 'learning style' and they responded to the Dunn and Dunn (1994) Learning Style Inventory themselves. Parents completed a questionnaire about ways in which their son or daughter would need assistance to succeed, and they were tutored in using the website [www.schoolnotes.com](http://www.schoolnotes.com) to find the weekly agendas, internet helpsites, morning/afternoon tutoring opportunities, the Study Buddy program, and more. Many of these parents were not computer literate and were helped to set up a free email account at their local library.
2. The students were taught 'test exercises' based on the work of Marian Diamond (2001) in order to help them to relax during a stressful test-taking situation. These exercises were modeled and used before tests during the year (Winters, 2001).
3. The students were given planners in which they were required to record their assignments and were instructed to write a sentence each day to summarize what they had learned in class that day. Their parents signed the planner each week and teacher-parent communication was accomplished in this manner. The planners were used because many of these students and their parents listed 'lack of organization' as one of their main weaknesses.
4. Relevant speakers were scheduled monthly so that students could see that the content that they were learning was relevant to future career opportunities. This was done in response to the student comments that "school is boring because it has nothing to do with my life, now, or in the future". These types of activities enhance students' ability to transfer knowledge from school to nonschool activities (Bransford, Brown, & Cocking, 2000).
5. The researcher (classroom teacher) spoke with each student and their parents during an afternoon or evening meeting to discuss the student's future plans. The appropriate courses to take and beneficial volunteer/work experiences

were discussed, and a plan of action for each student was created to help them and their families to seek out information and visit places offering post-secondary education. This was done in response to the parents' comments that many of them had not gone to college and did not know how to help their son/daughter succeed in high school and to plan for the future.

6. The website [www.schoolnotes.com](http://www.schoolnotes.com) became a valuable tool for communication with parents. This site allows parents and students to send a question or comment directly to the site via their email. The teacher also posted positive information about student behavior and accomplishment on this site, as well as details of family-oriented activities that could earn extra credit towards students' grades.
  
7. The number of laboratory experiences and hands-on/minds-on activities were increased in these intervention classes. Because of their low reading abilities, the students needed to be given a method of learning that allowed them to experience success. Although inquiry-based science is the buzz these days, many curriculum materials are still based on traditional methods that fail to engage students in inquiry. The Biology team teachers used the ideas from the National Research Council's (2000, p. 25) essential features of inquiry, which state that students are doing inquiry when they:
  - are engaged with scientifically-oriented questions
  - give priority to evidence
  - formulate evidence-based explanations
  - compare and evaluate the merit of explanations
  - communicate and justify explanations.

Using these guidelines, the Biology team helped the teacher-researcher to develop ways to support inquiry and long-term laboratory activities for the intervention students. According to Elstgeest (2001), classroom teachers support inquiry when they raise productive questions that provide opportunities for students to define variables and develop procedures, challenge students to look for patterns in data, guide students as they develop

evidence-based explanations, and create situations in which students communicate and justify explanations on the merit of the evidence. This required much discussion and applying an inquiry analysis tool to the traditional cookbook laboratory activities provided in the North Carolina curriculum.

8. The researcher/classroom teacher wrote stories and songs, created simulations, and used human body sculptures to engage the many right-brained learners in the classes. (I found that 82% of the students in the intervention classes were right-brained, according to the Dunn and Dunn Learning Style Inventory.) Many of these activities were used at the beginning of a unit to give global learners 'the big picture'. This goes along with current research in cognitive science that has shown that eliciting prior understandings is a necessary component of the learning process. Bransford, Brown, and Cocking (2000) has shown that expert learners are much more adept at the transfer of learning than novices and that practice in the transfer of learning is required in good instruction. These intervention students definitely qualified as 'novices' and so this strategy was employed to help them learn.
  
9. 'Guided notes' were created by the researcher/classroom teacher to help these students with low reading skills to succeed. Students were never given reading assignments without a 'guided reading' worksheet. Also, they usually completed reading assignments in small groups, so that more accomplished readers could help those with lower reading abilities. Students were given instruction in predicting what would come next, as suggested by Armbruster et al. (1983), Collins (1994), Flavell (1981), Garner (1987) and Tei and Stewart (1985). Reading assignments were often accompanied by an Anticipation Guide, as defined by Head and Readence (1992). In these anticipation guides, the teacher poses five statements to students and asks them to agree or disagree. This is done to elicit a student's personal opinion and to give them a reason to read to learn more. With other reading assignments, the Active Comprehension method designed by Singer and Donlan (1989) and Vacca and Burkey (1992) were used. After reading a brief



section of the text aloud, the teacher asks the students a question such as: “What more would you like to know about photosynthesis?” After several student responses are written on the board, the students are asked to finish the reading, considering the questions generated by the class as they read.

10. The teacher-researcher and the Biology team developed novel activities for review of material. All of the experienced teachers inherently felt that these ‘at risk’ students needed additional review, and so developing effective review strategies was imperative. Even with an already packed schedule of topics to cover, the Biology team decided that review would be critical for student success, as suggested by Dempster (1991). Dempster’s work states that spaced repetitions of material can foster student achievement. Making these review activities activity-oriented and exploratory was necessary to maintain the students’ attention. This is consistent with Winters’ (2001) claim that, when students are entertained, intrigued, and involved in critical thinking about the subject matter prior to an examination, they will perform better.

At the end of the school year, the researcher readministered the actual form of the What Is Happening In this Biology Class? (WIHIC) questionnaire to see if students perceived their classroom environments more favorably than at the beginning of the year. In addition, data on student achievement on the End-Of-Course Biology examination were collected. The students’ scores on the quarterly examinations, written by the local school district, were also collected.

### **3.7 STATISTICAL ANALYSES**

Several different methods were used in the present study to answer its research questions. The choice of the units for statistical analysis (Section 3.7.1) and the statistical procedures used for analyzing the data obtained (Section 3.7.2) are described below.

### **3.7.1 Choice of units of statistical analysis**

Fraser (1986b) discussed four reasons why choosing an appropriate unit or level of statistical analysis is important. First, with the use of different units of statistical analysis, variables with the same operational definition could have different substantive interpretations. Second, there is the possibility that relationships found by using a particular unit of statistical analysis could differ in size and even in sign from those obtained using another unit of analysis (Robinson, 1950). Third, with the use of certain units of statistical analysis, there is the possibility of violating the condition of independence of observations, and hence the validity of statistical significance tests. (Peckham, Glass & Hopkins, 1969; Ross, 1978). And, fourth, using different units of statistical analysis could involve the testing of conceptually-different hypotheses (Burstein, Linn & Capel, 1978). For the purposes of this study, and in keeping with past classroom environment research, the two units of analysis chosen were the individual student score (between-student analysis) and the class mean score (between-class analysis). This choice enables me to compare the results of my study with those in previous research.

### **3.7.2 Statistical analysis procedures**

This section describes the statistical analysis techniques chosen to answer my study's research questions. Section 3.7.2.1 discusses the various methods used to analyse data to shed light on the first research question concerning the reliability and validity of the questionnaire used to assess classroom environment. Section 3.7.2.2 describes the analysis methods used to answer the second research question concerning differences in classroom environment perceptions according to student gender, the year of the study, and ethnicity. Section 3.7.2.3 discusses the statistical analysis techniques used to answer the third research question concerning associations between learning environment and student outcomes.

#### *3.7.2.1 Validity and reliability of questionnaire*

One of the primary goals of this study was to determine the validity and reliability of the modified What Is Happening In this Class? (WIHIC) questionnaire when used with grade 9 and 10 Biology 1 students in Charlotte, North Carolina. In order to do

this, the factor structure, internal consistency reliability, discriminant validity and ability to differentiate between classrooms were calculated for the sample of 364 students in 18 classes.

Factor and item analyses were undertaken with the aim of refining the instrument and providing evidence of its validity and reliability. The technique most often used to improve scale internal consistency is to remove any item which is not reasonably well correlated with the total score for its scale. The factor structure can be improved by removing any item whose factor loading is small with its own scale or large with any other scale in the questionnaire.

Principal components factor analysis with varimax rotation was used to check whether the WIHIC's *a priori* factor structure could be replicated. An item was only retained if its loading with its own scale exceeded 0.4 and if its loading with all other scales was less than 0.4.

The internal consistency of each of the seven scales from the WIHIC was determined using the Cronbach alpha coefficient for two units of analysis, namely, the individual and the class mean. It is commonly accepted that a scale score is only interpretable when the scale possesses substantial internal consistency in that each item in the scale measures the same construct as the rest of the items (Cronbach, 1951).

Scales should possess discriminant validity in that each scale should measure a unique dimension not measured by any other scale in the battery (Campbell & Fiske, 1959). Using two units of analysis, an estimate of the discriminant validity of each scale was determined, using the mean magnitude of the correlation of a scale with the other scales in the same instrument as a convenient index.

A one-way ANOVA was computed for each scale of the WIHIC, with class membership as the main effect and using the individual student as the unit of analysis, to determine if each WIHIC scale can differentiate between the perceptions of students in different classes. Usually students in the same class will perceive the classroom environment relatively similarly, while the class mean should vary from classroom to classroom. The common indices used from ANOVA are the

significance level and the  $\eta^2$  statistic. The  $\eta^2$  statistic, which is the ratio of 'between' to 'total' sums of squares, indicates the proportion of variance explained by class membership.

### *3.7.2.2 MANOVA for differences in perceptions between groups*

The second aim of my study was to ascertain differences in perceptions of classroom environment of different groups of students. One-way multivariate analyses of variance (MANOVA) was used to investigate differences in the classroom environment perceptions of each of three groups of students (males vs. females; students in the first year of the study vs. students in the second year; and black vs. non-black students). Because the multivariate test yielded statistically significant results using Wilks' lambda criterion, the one-way univariate ANOVA was interpreted for each WIHIC scale for independent variable.

### *3.7.2.3 Associations between learning environment and student outcomes*

A series of simple and multiple correlation analyses was conducted separately for each student outcome to determine the associations between factors in the learning environment and the two student outcomes of achievement (as measured by the End-Of-Course examination) and attitudes to science. The magnitudes of environment-outcome relationships was compared for two units of analysis, the individual student and the class mean.

A simple correlational analysis of relationships between each individual outcome measure and each individual environment scale was performed to provide information about associations between particular environment variables and particular outcomes. The biology teacher team was very interested in determining which factors in the classroom environment were associated with higher achievement and attitude scores. A multiple correlation analysis of relationships between each outcome measure and the set of environment scales as a whole was conducted to provide a more complete picture of the joint influence of correlated environment dimensions on outcomes and to reduce the Type I error rate associated with simple correlation analysis. This analysis is likely to be of particular relevance to people interested in specific outcome measures.

In order to interpret which individual environment scales make the largest contribution to explaining variance in student outcomes, an examination was made of the regression weights to see which ones are significantly greater than zero ( $p < 0.05$ ). The regression weight describes the influence of a particular environment variable on an outcome when all other environment variables in the regression analysis are mutually controlled.

### **3.8 CHAPTER SUMMARY**

This chapter described the research methods used in my study of classroom learning environment, student attitudes toward science, and student achievement as exhibited on an end-of-course high-stakes Biology examination. The sample consisted of 364 students in 18 classes for the questionnaire survey and 15 students in one class in the intervention phase of the study. The research was conducted in a large, comprehensive, urban public school in Charlotte, North Carolina.

The instrument used to assess classroom learning environment was a modified form of the What Is Happening In this Class? (WIHIC) questionnaire (Aldridge & Fraser, 2000), which assesses Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity. This instrument was field-tested and then used for the two years of my study. Also an attitude scale from the Test of Science-Related Attitudes (TOSRA; Fraser, 1981) was used and this enabled the investigation of attitude-environment associations.

To determine the reliability and validity of the WIHIC, the factor structure, internal consistency reliability, discriminant validity and ability to differentiate between classrooms were examined. Multivariate analyses of variance (MANOVA) was chosen for investigating gender and race differences in environment perceptions. To investigate outcome-environment associations, simple correlation and multiple regression analyses were conducted for two units of analysis.

In the intervention phase of the study, the results from administering the classroom environment survey were used to guide classroom interventions aimed at improving the classroom environment and, ultimately, student achievement. The methods used

in this phase of the study are similar to those reported by Thorp, Burden and Fraser (1994) and Yarrow, Millwater and Fraser (1997). An intervention in one class of at-risk students was evaluated in terms of changes in classroom environment and student achievement.

## Chapter 4

### DATA ANALYSIS AND FINDINGS

#### 4.1 INTRODUCTION

Foci of the present study included determining which factors in the classroom learning environment are most closely associated with student attitudes and achievement, as assessed by the North Carolina End-Of-Course examination in Biology, and evaluating the effectiveness of an intervention in terms of improving the classroom learning environment and student achievement. Other aims of my study were to validate a widely-applicable classroom environment questionnaire, to investigate gender and race differences in learning environment perceptions, and to explore associations between student outcomes and classroom environment.

This chapter reports the results of the analyses of the data collected in both Part I (questionnaire survey) and Part II (intervention) of this study. Section 4.2 reports the reliability and validity of the main instrument used for the study, namely, the *What Is Happening In this Class?* (WIHIC) questionnaire. This section also focuses on the assessment of student attitudes and End-Of-Course achievement.

Section 4.3 reports an investigation of within-classroom differences in the learning environment perceptions of boys and girls and of black and non-black students. These differences are relevant to the Charlotte-Mecklenburg school district's goal of decreasing the gap in achievement between different groups, especially black and non-black students.

Section 4.4 is devoted to the results of analyses of associations between the classroom learning environment (as assessed by the WIHIC) and the two student outcomes of attitudes and achievement.

Section 4.5 reports classroom interventions aimed at improving the classroom environment and student achievement.

## **4.2 VALIDATION OF THE WIHIC**

This section reports the analysis and results pertaining to Research Question #1:

*Is the What Is Happening In this Class? (WIHIC) questionnaire valid and reliable when used with grade 9 and 10 biology students in Charlotte, North Carolina?*

To measure students' perceptions of the classroom learning environment, I used a modified version of the *What Is Happening In this Class? (WIHIC)* questionnaire (Fraser, Fisher & McRobbie, 1996). The original version of the WIHIC has seven, eight-item scales each measuring a different dimension of the learning environment. The origins of the WIHIC, and its use and validity in a variety of countries and subject areas, are described in Chapter 2 (Section 2.3.9) of this thesis. For the purposes of this present study, the original 56-item version of the WIHIC was reduced to 42 items in the same seven scales in order to decrease the time needed for questionnaire administration. The names of the scales are Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity.

The WIHIC was validated in terms of its factor structure (Section 4.2.1) and its internal consistency reliability, discriminant validity, and ability to differentiate between classrooms (Section 4.4.2). The sample available for these analyses consisted of 364 Biology 1 students in 18 classes, as described in Section 3.3.

### **4.2.1 Factor structure**

Validation of the *What Is Happening In this Class? (WIHIC)* questionnaire began with factor and item analyses. For the sample of 364 students, data for the 42 items were subjected to principal components factor analysis with varimax rotation. This led to the omission of one item (Item 6) from the Student Cohesiveness scale. For the remaining 41 items, 40 of the items had a factor loading of more than 0.40 with its



own scale and less than 0.40 with all of the other scales (see Table 4-1). Item 5 was the only item that had a factor loading of less than 0.40 with its own scale (see Table 4-1). Together these seven factors accounted for 57.5% of the variance (see the bottom of Table 4-1).

Table 4-1 Factor Loadings for the WIHIC

Item No.	Factor Loading						
	Student Cohesiveness	Teacher Support	Involvement	Investigation	Task Orientation	Cooperation	Equity
1	0.62						
2	0.56						
3	0.65						
4	0.64						
5	-						
7		0.64					
8		0.72					
9		0.64					
10		0.71					
11		0.51					
12		0.43					
13			0.53				
14			0.82				
15			0.48				
16			0.63				
17			0.69				
18			0.66				
19				0.50			
20				0.52			
21				0.77			
22				0.82			
23				0.72			
24				0.75			
25					0.46		
26					0.70		
27					0.69		
28					0.71		
29					0.58		
30					0.46		
31						0.69	
32						0.63	
33						0.67	
34						0.78	
35						0.66	
36						0.42	
37							0.67
38							0.68
39							0.76
40							0.78
41							0.70
42							0.71
%	5.36	7.88	8.72	9.22	7.47	8.85	11.00
Variance							

Loadings less than 0.4 omitted  
 N=364 students  
 Item 6 was omitted.

#### **4.2.2 Reliability, discriminant validity and ability to differentiate between classrooms**

Item analysis was used to provide information about each WIHIC scale's internal consistency reliability (extent to which items within the same scale measure a common construct) and discriminant validity (extent to which each scale assesses a unique construct not assessed by other scales in the instrument). The internal consistency reliability of each WIHIC scale was calculated using Cronbach's alpha coefficient for two units of analysis (the student and the class mean). Table 4-2 shows that the alpha reliability for different WIHIC scales ranges from 0.81 to 0.91 with the individual student as the unit of analysis and from 0.81 to 0.97 with the class as the unit of analysis.

The bottom of Table 4-2 also shows that the attitude scale used in my study exhibited satisfactory internal consistency reliability (0.76 for individuals and 0.85 for class means).

As a measure of the discriminant validity of raw scores on WIHIC scales, the mean correlation of a scale with the other six scales was calculated. Table 4-2 shows that the value of the mean correlation for different WIHIC scales ranges from 0.37 to 0.44 with the individual student as the unit of analysis and from 0.35 to 0.65 with the class as the unit of analysis. These values are low enough to support the independence of WIHIC scales, but suggest a certain degree of overlap between scales in terms of raw scores. However, the factor analysis supports the independence of factor scores on each WIHIC scale.

Another desirable characteristic of any learning environment scale is that students in the same class perceive it relatively similarly, but that mean class perceptions vary from class to class. In order to investigate the ability of each WIHIC scale to differentiate between the perceptions of students in different classrooms, a one-way ANOVA (with class membership as the independent variable) was conducted for each WIHIC scale. The figures presented in Table 4-2 show that five of the seven WIHIC scales differentiate significantly ( $p < 0.05$ ) between the perceptions of students in different classrooms. The  $\eta^2$  statistic, which represents the proportion of

variance in environment scores explained by class membership, ranges from 0.06 to 0.22 for different scales.

Table 4-2 Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation of a Scale with Other Scales) and Ability to Differentiate between Classrooms (ANOVA Results) for Two Units of Analysis for Scales for the WIHIC

WIHIC Scale	Unit of Analysis	Alpha Reliability	Mean Correlation	ANOVA ( $\eta^2$ )
Student Cohesiveness	Individual	0.81	0.37	0.08*
	Class Mean	0.86	0.35	
Teacher Support	Individual	0.90	0.44	0.17**
	Class Mean	0.97	0.65	
Involvement	Individual	0.86	0.38	0.06
	Class Mean	0.81	0.53	
Investigation	Individual	0.91	0.41	0.22**
	Class Mean	0.96	0.57	
Task Orientation	Individual	0.85	0.39	0.15**
	Class Mean	0.93	0.63	
Cooperation	Individual	0.87	0.39	0.07
	Class Mean	0.87	0.65	
Equity	Individual	0.91	0.38	0.14**
	Class Mean	0.96	0.56	
Attitude	Individual	0.76		
	Class Mean	0.85		

\*  $p < 0.05$

\*\*  $p < 0.01$

The sample consisted of 364 students in 18 classes.

The  $\eta^2$  statistic (which is the ratio of 'between' to 'total' sums of squares) represents the proportion of variance explained by class membership.

Overall, the results in Tables 4-1 and 4-2 provide fairly strong support for the validity and reliability of the WIHIC when used with biology students in North Carolina, and they replicate considerable past research involving the use of the WIHIC with a wide variety of samples in numerous countries (Aldridge & Fraser, 2000; Dorman, 2003; Chionh & Fraser, 1998; Raaflaub & Fraser, 2002).

#### 4.3 DIFFERENCES BETWEEN GENDERS, YEARS 1 AND 2, AND ETHNIC GROUPS

This section reports the use of learning environment dimensions as dependent variables in investigating differences in the classroom environment according to

student gender, the two years of Part I of the study, and ethnic groups. This part of the study addressed Research Question #2:

Are there differences in the learning environment perceived by:

- boys and girls
- students in year 1 and year 2 of the study
- black and non-black students?

When investigating gender differences in learning environment perceptions with the present sample, the unit of analysis chosen was the within-class gender subgroup formed by calculating the boys' mean and the girls' mean for each class. That is, for every group of boys in any class, there was a group of girls matched with respect to the school setting (same school, same teacher, same curriculum, and same classroom facilities). This avoids the potential confounding that could arise when a comparison is made between a group of boys in certain school settings and a group of girls in different school settings.

A MANOVA for repeated measures was used to examine overall gender differences for the set of WIHIC scales as a whole. Gender was the repeated measure factor. Because the MANOVA overall yielded significant gender differences in terms of Wilks' lambda criterion, the univariate ANOVA results were interpreted for each WIHIC scale. Table 4-3 shows that statistically significant gender differences ( $p < 0.05$ ) exist for three WIHIC scales: Involvement, Investigation, and Cooperation. Relative to girls, boys perceive greater involvement and investigation and less cooperation in their classrooms.

In order to estimate the magnitude of the gender differences in WIHIC scores (in addition to their statistical significance), effect sizes were calculated as recommended by Thompson (1988). In Table 4-3, the effect size for each scale is simply the difference between the means for males and females divided by the pooled standard deviation. Table 4-3 shows that effect sizes for different scales range from 0.13 to 0.66 standard deviations. For the scales for which statistical significance occurred, effect sizes range from 0.44 to 0.66, suggesting that gender differences on these three scales are large enough to be educationally important.

Table 4-3 Average Item Mean, Average Item Standard Deviation, and Difference Between Boys' and Girls' Perceptions (MANOVA Results and Effect Size) for Each WIHIC Scale Using the Within-Class Gender Mean as the Unit of Analysis

Scale	Average Item Mean		Average Item Standard Deviation		Difference	
	Male	Female	Male	Female	F	Effect Size
Student Cohesiveness	3.22	3.26	0.20	0.19	0.89	0.20
Teacher Support	3.58	3.61	0.25	0.23	-0.76	0.13
Involvement	2.98	2.77	0.33	0.32	2.04**	0.66
Investigation	3.28	3.15	0.24	0.24	1.72**	0.54
Task Orientation	3.63	3.72	0.29	0.30	-1.23	0.31
Cooperation	3.28	3.39	0.22	0.28	-1.51*	0.44
Equity	3.33	3.21	0.43	0.38	1.29	0.29

\*  $p < 0.05$

\*\*  $p < 0.01$

The sample consisted of 364 students in 18 classes.

A MANOVA was also conducted to investigate differences between the learning environment perceptions of students in year 1 and year 2 of the study. Because the MANOVA revealed significant differences overall, the ANOVA result was interpreted for each WIHIC scale. The only scale for which a statistically significant difference occurred was Cooperation (Table 4-4). Students in year 2 perceived more cooperation in their classes than did students in year 1. During year 1, the Biology teachers examined the students' results and proposed ways in which to increase the students' opportunities to cooperate in learning. Perhaps this could have been reflected in the increased cooperation perceived by students in year 2 of the study.

Table 4-4 shows that effect sizes for differences between years range from 0.03 to 0.21 for different WIHIC scales and are smaller than those for gender differences in Table 4-3. This suggests that the magnitudes of the differences between years on WIHIC scales generally are of limited educational importance.

When MANOVA was used to explore ethnic differences (black versus non-black students) in learning environment perceptions for the overall sample, there were no statistically significant differences between racial groups for any WIHIC scale. However, some interesting within-class differences in learning environment

perceptions were present for numerous individual classes for some WIHIC scales; these are discussed later in the chapter.

**Table 4-4** Average Item Mean, Average Item Standard Deviation and Difference Between Students' Perceptions in Years 1 and 2 (MANOVA Result and Effect Size) for each WIHIC Scale

Scale	Average Item Mean		Average Item Standard Deviation		Difference	
	Year 1	Year 2	Year 1	Year 2	F	Effect Size
Student Cohesiveness	3.21	3.27	0.52	0.48	0.12	-1.39
Teacher Support	3.62	3.59	0.61	0.59	0.05	0.85
Involvement	2.86	2.84	0.79	0.68	0.03	0.69
Investigation	3.22	3.20	0.67	0.62	0.03	0.70
Task Orientation	3.70	3.64	0.75	0.69	0.08	1.15
Cooperation	3.29	3.42	0.60	0.62	0.21	-1.84**
Equity	3.28	3.23	0.79	0.68	0.07	1.08

\*\*  $p < 0.01$

The sample consisted of 364 students in 18 classes.

#### **4.4 ASSOCIATIONS BETWEEN LEARNING ENVIRONMENT AND STUDENT OUTCOMES**

One of this study's main objectives was to explore associations between classroom environment as assessed by the WIHIC scales and the two student outcomes of attitudes and achievement. The overall achievement of students and teachers in this school system is assessed in terms of scores on the Biology End-Of-Course examination. This high-stakes examination takes place in May, and is written by the North Carolina Department of Public Instruction (DPI) and graded externally from the school system. The state of North Carolina hires college students to grade the examinations given by the local schools, and teachers and school staff are not allowed to see the test answer sheets. The local school system also creates and monitors quarterly assessments to provide information for teachers and principals about the achievement of their students as the year progresses. In Part 1 of my study, achievement was only measured by the use of End-Of-Course student scores. In Part 2 (the intervention phase) achievement was monitored quarterly by using the End-Of-Course scores.

An eight-item scale from the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) was modified and used to assess students' attitudes towards science (see Section 2.5).

Simple correlations and multiple regression analyses were conducted separately for each outcome for two units of analysis (the individual student and the class). Whereas the simple correlation describes the bivariate relationship between each outcome and each learning environment scale, the multiple regression analysis provides a more parsimonious picture of the joint influence of the set of correlated environment scales on each outcome. This section addresses Research Question #3:

Are there associations between the classroom environment dimensions assessed by the WIHIC and scores on:

- the North Carolina End-Of-Course examination in Biology
- a student attitude scale?

Table 4-5 shows the results of the simple and multiple correlation analyses. Generally, the associations between attitudes and learning environment are stronger than associations between achievement and learning environment.

The simple correlation analyses reported in Table 4-5 show that every WIHIC scale is significantly related to student attitudes at both the student and class levels of analysis ( $p < 0.05$ ). On the other hand, for the achievement outcome, only Student Cohesiveness is significantly correlated with achievement at both levels of analysis. Investigation and Equity also are significantly correlated with achievement at the student level only.

The results of the multiple regression analysis (Table 4-5) show that the set of WIHIC scales is significantly related to attitudes at both levels of analysis ( $R = 0.50$  and  $0.88$ , respectively) and to achievement at the student level ( $R = 0.25$ ). In order to identify which individual WIHIC scales are most strongly related to outcomes, when all other WIHIC scales are mutually controlled, an examination was made of the standardized regression coefficients ( $\beta$ ).

Table 4-5 shows that the three scales of Investigation, Task Orientation, and Equity are significant independent predictors of student attitudes at the student level. Investigation also is a significant independent predictor of attitudes at the class level. For achievement, Student Cohesiveness, Cooperation and Equity are significant independent predictors at the student level. As well, Student Cohesiveness also is a significant independent predictor of achievement at the class level. With only one exception, every significant outcome-environment association in Table 4-5 is positive, thus replicating considerable past research that supports the positive influence of classroom environment on student outcomes (Fraser, 1998a)

However, because the multiple regression analysis yielded a negative association between achievement and Cooperation, there is a need to replicate this analysis in future studies. Overall, these results suggest that achievement is higher in more cohesive classes, whereas attitudes are particularly favorable in investigative, task oriented and equitable classes.

Table 4-5 Simple Correlation and Multiple Regression Analyses for Associations between Student Outcomes (Attitudes and Achievement) and Scores on the WHIC for Two Units of Analysis

WHIC Scale	Unit of Analysis	Attitudes		Achievement	
		<i>R</i>	$\beta$	<i>r</i>	$\beta$
Student Cohesiveness	Individual	0.24**	0.06	0.14**	0.24**
	Class Mean	0.48*	0.09	0.61**	0.80*
Teacher Support	Individual	0.35**	-0.01	0.09	0.03
	Class Mean	0.70**	-0.55	0.24	0.18
Involvement	Individual	0.26**	0.00	0.06	-0.02
	Class Mean	0.53*	0.07	0.13	-0.22
Investigation	Individual	0.40**	0.23**	0.12**	0.10
	Class Mean	0.81**	0.61*	0.29	0.21
Task Orientation	Individual	0.39**	0.17**	0.02	-0.08
	Class Mean	0.78**	0.55	0.12	-0.29
Cooperation	Individual	0.23**	-0.08	-0.01	-0.21**
	Class Mean	0.68**	-0.11	0.27	-0.19
Equity	Individual	0.41**	0.23**	0.13*	0.15*
	Class Mean	0.66**	0.37	0.19	0.19
Multiple Correlation ( <i>R</i> )	Individual		0.50*		0.25**
	Class Mean		0.88*		0.70

\*  $p < 0.05$

\*\*  $p < 0.01$

The sample consisted of 364 students in 18 classes.



## **4.5 INTERVENTION AIMED AT IMPROVING CLASSROOM ENVIRONMENT AND ACHIEVEMENT**

Whereas Part 1 of my study involved a large-scale survey of the learning environments and students' attitudes and achievement in 18 Biology 1 classes, Part 2 focused on a case study of one class for which the teacher introduced an intervention aimed at improving the classroom environment and student achievement. Section 4.5 starts by providing descriptive information for selected classes in Part 1 of the study in Section 4.5.1. Then, in Section 4.5.2 to 4.5.4, a detailed case study is provided of the intervention introduced in one class to improve classroom environment and student achievement.

Section 4.5 describes the methods and results for Research Question #4:

Do classroom interventions – involving a cooperative action research plan aimed at changing classroom environments to emphasise dimensions found to be empirically linked with better student outcomes in the first phase of the study – lead to improved classroom environments and student achievement?

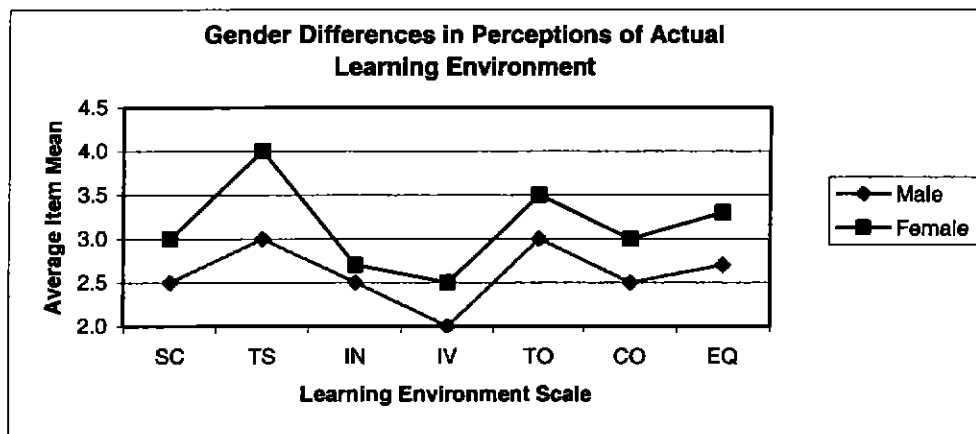
### **4.5.1 Describing classrooms in Part 1 of the study**

Although the teachers in the first part of the study were under no obligation to make changes to their classrooms based upon the data, many discussions were held among teachers to consider feedback on the scores obtained by each class on the classroom environment scales assessed by the WIHIC. Examples of the types of graphs that they examined are given below. These discussions among teachers in Part 1 of the study guided the interventions in Part 2 of the study.

For example, Figure 4-1 shows the average actual classroom learning environment scores obtained for one typical class in Part 1 of the study. Class means are shown separately for male and female students for this class (Figure 4-1). The graph in Figure 4-1 is drawn for the average item mean (i.e., the scale mean divided by the number of items in that scale).

When the Biology teachers first met to discuss this graph, they observed that generally females' perceptions of the classroom were more positive than those of the

males. In this particular classroom, there were many more discipline problems with the male students and the teachers believed that this could explain the overall trend. The teacher in this classroom is male, and had a much better relationship with his female students. The teachers discussed ways in which this particular classroom teacher could improve the male students' perceptions of cooperation in the classroom. In this classroom, the only cooperative learning experiences were in laboratory settings, and the teacher allowed the female students to select their laboratory partners. He did this because he said that his female students were more mature and more responsible. The Biology team teachers recommended that this teacher either choose the laboratory partners for the entire class, or allow the whole class to select their laboratory partners.

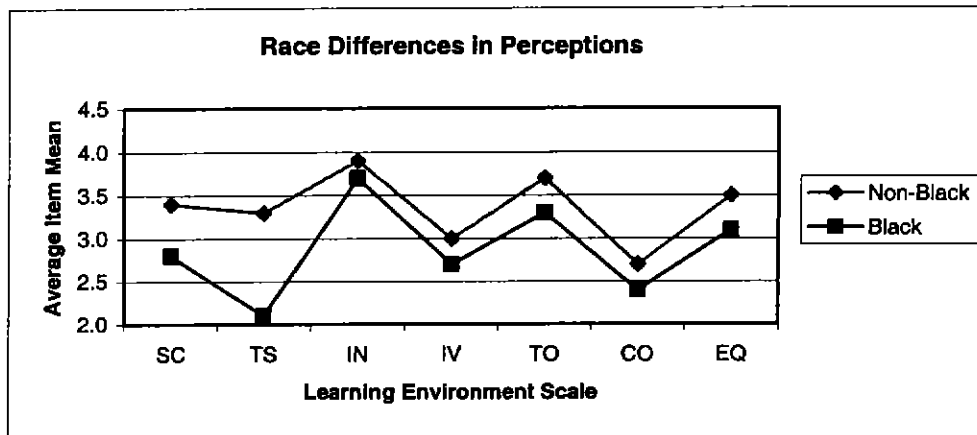


**Figure 4-1 Gender Differences in Perceptions of Actual Classroom Learning Environment in a Typical Classroom in Part 1 of the Study**

A second classroom from Part 1 of the study is depicted in Figure 4-2. This figure shows mean actual WHIC scores separately for black and non-black students in this class. Figure 4-2 generally shows that the non-black students in this classroom had more positive perceptions of the classroom learning environment than did non-black students.

For this study, the labels 'black and non-black' were used because they represent the politically-correct groupings used in this school district. Under the Schwann Desegregation Order, the Charlotte Mecklenburg Schools are required to record the number of black and non-black students in each class at the beginning of each school

quarter. There is no sure way to determine who is black or non-black; the teachers simply ask the students to raise their hands if they consider themselves to be black. All other students are classified as 'non-black'.



**Figure 4-2 Race Differences in Perceptions of Actual Classroom Learning Environment for a Second Classroom in Part 1 of the Study**

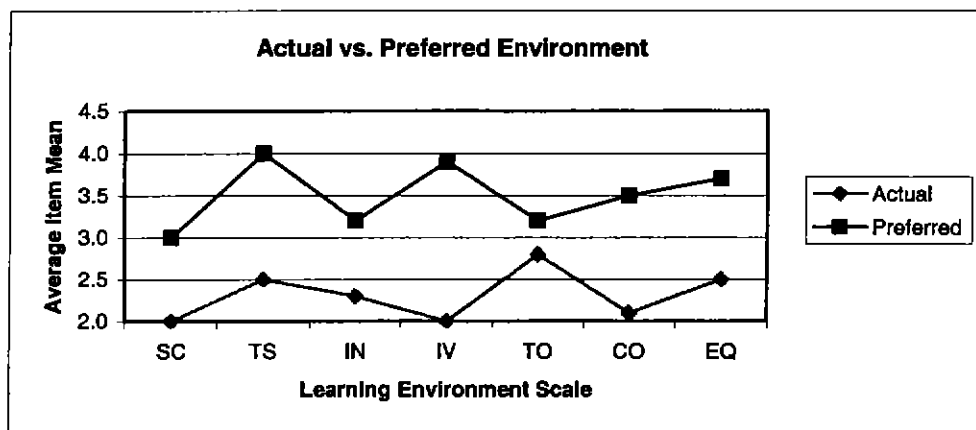
The students in this particular classroom agreed that there was a high level of task-orientation and that this teacher is known as a well-organized and strict taskmaster. This teacher provides written instructions for labeling homework papers, quizzes, and tests. She also follows a regimented agenda in each class so that the students know the order in which they will experience activities in this class each day. She provides a written agenda outlining the lecture topics, the class assignments and the homework that would be assigned for a two-week period.

Some of the major differences between black and non-black students seemed to be in their perceptions of Teacher Support and Investigation (Figure 4-2). The Biology team discussed ways in which this particular teacher could show more Teacher Support in ways that would be meaningful to her students. They encouraged her to incorporate more group activities so that she would have the opportunity to interact more with her students on a one-on-one basis. She has a traditional lecturing style of teaching and the group helped her to see the benefit of varying her techniques to allow her time to interact individually with her students. She had always been uncomfortable doing group work because she viewed it as unproductive. The team also discussed ways to make her students feel that they were doing more

investigation instead of following cookbook instructions. The team offered suggestions to allay this teacher's fears that investigative work leads to the classroom being out of control. When this teacher also admitted to fear of mispronouncing her black students' names, the team promised to help her with pronunciation.

In general, the teachers were surprised at the differences between the actual and preferred classroom learning environments perceived by their students. After the initial shock, the teachers were able to use the data and the graphs to help them to make decisions about their classroom management style, delivery of content, and organization of work groups.

Figure 4-3 depicts the average levels of actual and preferred classroom environment for a third class from Part 1 of the study. Clearly, students would prefer more emphasis on most WHIC dimensions than they perceived as being actually present. Many of the teachers were shocked to learn that their students desired more Teacher Support, because the teachers envisioned themselves as already being very supportive (Figure 4-3). In several classrooms, this led to discussions with students about what they would like in terms of the nature and level of teacher support.



**Figure 4-3 Differences Between Actual and Preferred Classroom Learning Environment for a Third Classroom Involved in Part 1 of the Study**

This particular classroom was taught by an experienced teacher who rarely planned group work or laboratory investigations for her students. The only learning environment dimension for which the actual classroom environment matched students' preferences was Task Orientation (Figure 4-3). This teacher prided herself on being very clear with her expectations. She was shocked that her students wanted

more Student Cohesiveness, Investigation, and Cooperation because she intensely disliked any kind of group work. She viewed any strategy other than lecturing as wasteful of time and not really relevant to enhancing Statewide End-Of-Course (EOC) results. However, after her initial shock at seeing the results depicted in Figure 4-3, she was willing to listen to suggestions from the team about her classroom's results.

#### **4.5.2 Classroom interventions in Part 2 of the study**

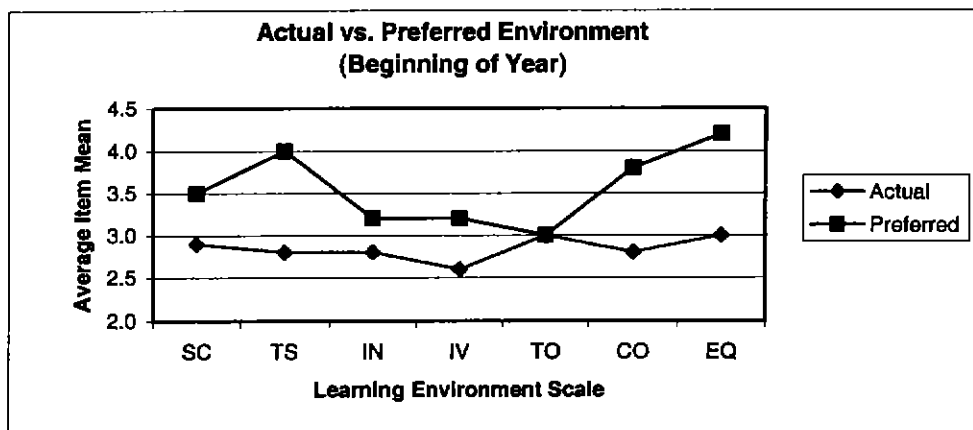
The fourth goal of this research was to evaluate the effectiveness of classroom interventions that attempted to improve classroom environments using a cooperative action research plan. The aim in Part 2 of the study was to change classroom environment dimensions found to be empirically linked with better achievement and attitudes in the first phase of the study. The basic method used for changing classroom environments was based on the steps advocated in past studies by Fraser and Fisher (1986), Thorp, Burden and Fraser (1994), Yarrow, Millwater and Fraser (1997), and Sinclair and Fraser (2002). In addition to improving classroom environment, I also was interested in monitoring improvements in student achievement during intervention.

For the sake of economy, only the intervention and change attempt in one class has been selected as a case study to be reported in this thesis. This intervention and change attempt involved a Regular Biology class taught by the researcher. (Regular track means the lowest level found in the school system that is not considered to be mentally challenged.) In years 1 and 2 of the study, the Biology teachers had examined graphs that contrast actual and preferred classroom environment means for their classes, and then they discussed ways in which this feedback could be used to improve teaching and learning in their classrooms (and lead to improvement in the students' End-Of-Course examination scores). This experience guided the later intervention phase of the study.

For the intervention year, the Biology team was enlisted to help in selecting the students to be in the intervention class. After five weeks of school, the researcher invited the other Biology teachers to shuffle their classes and to select their lowest-

performing students who were likely to be destined to fail the End-Of-Course examination. Due to the tremendous growth in the Charlotte-Mecklenburg schools and teacher turnover, student schedule changes are common. The students selected were informed that they were changing teachers to balance classes. These students were placed into a new class of 25 regular students.

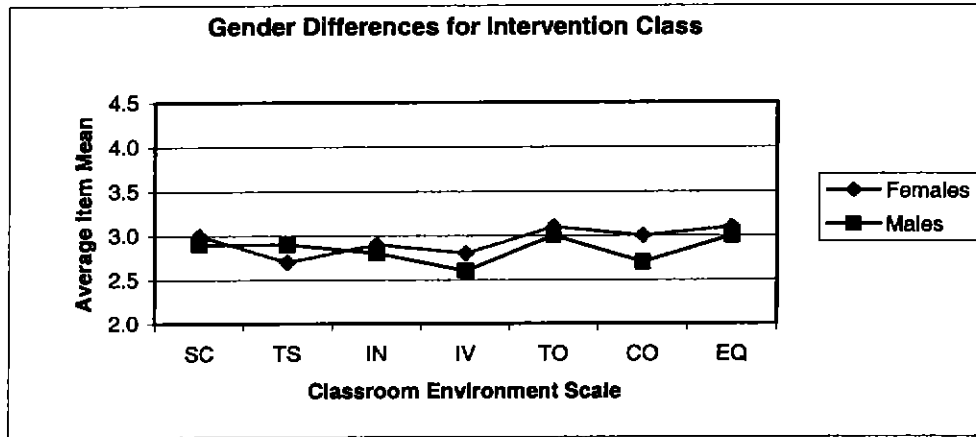
The interventions were discussed in the Biology team weekly meetings and these teachers continued to discuss the progress and problems of these students during the course of the year. One aspect of the intervention involved giving students the Dunn and Dunn (1994) Learning Styles Inventory within the first week of their schedule change, and they were instructed in how best to accommodate their own unique learning style. Many of these students were frustrated because they considered themselves 'dumb', and the elaboration of their own special abilities was an attempt to empower them to learn. The students were given the preferred and actual versions of the WIHIC after they had been in this class for ten weeks. This information was graphed and discussed by the Biology team teachers. These graphs are shown in Figure 4-4 for the whole intervention class, as well as separately for males and females (Figure 4-5) and separately for black and non-black students (Figure 4-6).



**Figure 4-4 Actual and Preferred Perceptions of Classroom Learning Environment Scores for the Intervention Class**

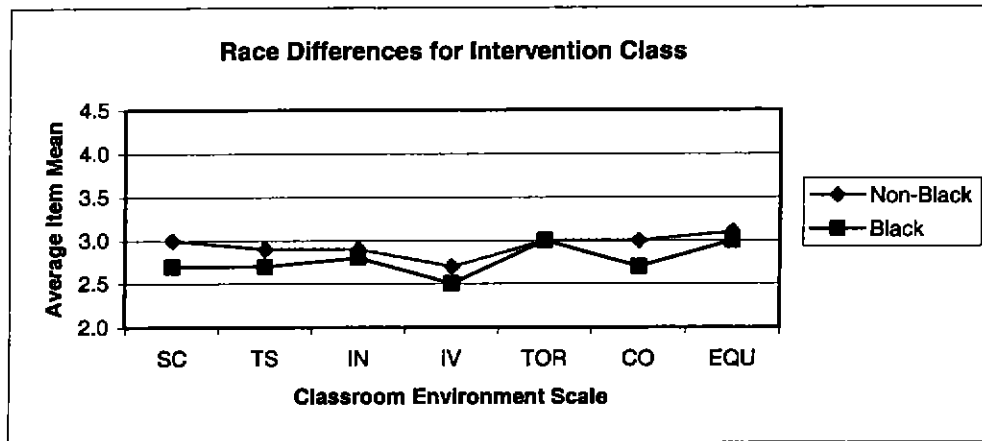
This particular class of 25 students had experienced much failure during their school years. They were in the lowest-ability mathematics classes and the lowest-ability

English classes, and they had poor attendance records. These students' relatively unfavourable perceptions of their Biology classroom environment was influenced by their past experiences of school and their expectations of how school would be in the future. None of the students nor their parents contacted the school or teacher to complain about their schedule change; they just seemed to assume that school was a place that would not be pleasant for them.



**Figure 4-5 Gender Differences in Regular Biology Intervention Class**

Figure 4-5 contrasts the average classroom environment perceptions of males and females in the intervention class. This figure suggests that the intervention class showed the same trends as the larger sample in Part 1 of the study, with females generally having more positive perceptions of their classroom environment than their male peers in the same classroom. This particular class had two white females and six black females, compared with 17 males. This gender ratio was probably due to the fact that, in this school, there are three times as many discipline problems with male students as with female students. This probably was a factor when the teachers were selecting their lowest-performing students to participate in this study.



**Figure 4-6 Differences Between Black and Non-Black Student Perceptions in Regular Biology Intervention Class**

The intervention class had seven non-black students and 18 black students. The average actual environment scores of black and non-black students are contrasted in Figure 4-6. In general, the non-black students in the intervention class had more positive perceptions of their classroom learning environment, which is the same trend that was observed in Part 1 of this study (Figure 4-2). The intervention classroom teacher is a white female, and all of the teachers in Part 1 are white as well.

These graphs were discussed by the Biology team. These discussions were integral in structuring the activities and strategies employed with these students. In general, the females and the non-black students had a more positive impression of their learning environment, while all students perceived a relatively high level of Task Orientation.

Some other aspects of the intervention are described below:

1. The students and their parents were invited to an evening meeting on 'How to Succeed in High School'. Of these 25 students, 24 (95%) received free or reduced-priced lunch (because of their socioeconomic circumstances), as compared to 20% of the student body. If a student is able to receive free or reduced-price lunch, this indicates that their family's income is below the poverty level, as defined by the federal government, and are considered to be 'at risk' for failure. Only two of the 25 students (8%) came from two-parent families. Many of these single parents were working at two or more jobs and



lived in project neighborhoods (i.e. neighborhoods with dense, government-subsidized housing) that were nearly an hour's travel away from school.

Because a typical parent night meeting at this school attracts only 20% of the parents, this meeting was held at a local church in the community of many of these students. The majority of these students were black, so a prominent black preacher and his church was chosen to assist in reaching these parents. Each parent was sent a letter and received a telephone call from the teacher to extend a personal invitation to attend. Several local pastors were engaged to announce these meetings from their pulpits and to encourage the parents to attend. Due to these efforts, 22 of the 25 students (88%) had a parent at this meeting. Many of these parents had never attended a school-sponsored meeting and were skeptical about the whole process. Most of them admitted to being unsuccessful in school themselves, and to expecting their children to have the same experience. Many of them considered school an intimidating institution, and one that was not interested in the needs of their children.

At this meeting, the parents were informed about their student's learning style and the best way for each student to study. The parents were also given the Learning Styles Inventory and their own individual learning style was explained to them. The parents completed a questionnaire about the ways in which their students would require assistance. Parents were informed of the website [www.schoolnotes.com](http://www.schoolnotes.com), where the biweekly agendas, internet helpsites, morning tutoring opportunities, and Tuesday/Thursday Study Buddy programs were explained to these interested adults. When many of these parents expressed concern over their lack of internet access, the teacher-researcher and a prominent member of the congregation offered to set up a session at the public library located nearby. At this session, parents were tutored through the process of establishing Hotmail accounts by the pastor, a computer-savvy congregation member, and the teacher.

2. The students were given a test to determine their reading level. This *Diagnostic Assessment of Reading* (DAR) (Rosewell & Chall, 1992) was administered to determine any reading weaknesses that might impact on the

student's ability to succeed on the Biology End-Of-Course Examination. This assessment is comprised of six individually-administered tests and provides information on word analysis, oral reading, silent reading, comprehension, spelling, and word meaning. Even though oral reading and spelling would not be directly assessed on the North Carolina Biology End-Of-Course examination, this assessment provided the most useful information for the teacher. It also only required 30 minutes of class time and was easily scored and explained to students. This test was also reasonably priced at \$120 for the class. Cost was a consideration because the teacher-researcher did not receive any extra funds for this research and paid for this test herself. The results of this assessment were sent home to the parents with an explanation letter. The explanation letter outlined the types of activities that would be used to strengthen the students' reading skills during the course of the year. This letter also explained the value of improving reading skills for all types of high-stakes multiple-choice testing in school and beyond.

3. The students were taught 'test exercises', based on the brain research of Marian Diamond (2001), to help them to relax during stressful test-taking situations. These test exercises were practised before each and every unit test, and the science behind these exercises was explained to the students as well.
4. The students were given planners in which they were required to record their assignments and were instructed to write a sentence each day about what they had learned. The teacher constantly modeled the use of planners and checked to see that the students were using them. These planners were also used as communication tools between parents and the teacher.
5. Relevant speakers were scheduled monthly so that the students could see that the content that they were learning was relevant to future career opportunities. At the parent meeting, the students and parents expressed the opinion that school-based learning had no bearing on their future and these activities were to combat that perception.

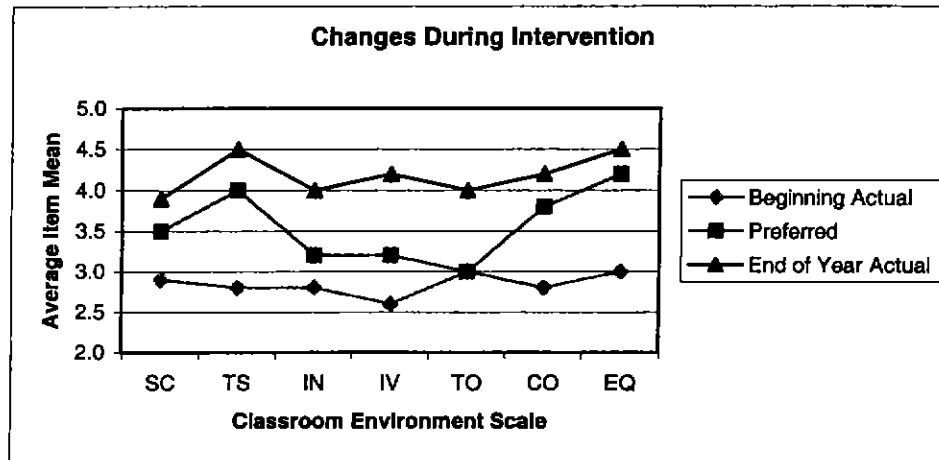
6. The teacher scheduled parent/student meetings with each and every student to discuss that individual student's future plans. Appropriate courses to take in high school and pertinent volunteer/summer experiences were discussed. A 'plan of action' was created for each student to guide him/her in his/her search for post-graduation opportunities. These meetings were scheduled at night at the local church to make them more accessible to parents. These meetings did not replace the guidance counselor meetings, but were in addition to those.
7. The website [www.schoolnotes.com](http://www.schoolnotes.com) was used to communicate to students and parents about the content and assignments. The agendas are always posted there, with internet helpsites, extra credit opportunities, and anecdotal notes about positive student behaviors seen in class. This site generated at least 25 messages each week from parents about their students and their progress, and helped to create a community of learners among the families of the students involved.
8. The number of laboratory and hands-on activities was increased, because the majority of these students were right-brained, tactile-kinesthetic learners, according to their responses to the Dunn and Dunn (1994) Learning Style Inventory. To help them to learn vocabulary-laden concepts, songs and stories were written for each unit, and students participated in many simulations.
9. Many of the students reported frustration with note-taking in their classes and, to alleviate this frustration, 'guided notes' and 'guided readings' were incorporated into a 'study guide'. The guided notes provided a framework of either an outline or concept map, with the main ideas already listed there so that the students could add examples and diagrams as they were discussed. The guided readings were designed for all reading assignments so that students experiencing difficulty in reading would be able to work with a more experienced reader to accomplish their tasks. These study guides not only provided students with a road map to read their content, but provided a framework for their questions when seeking help.

10. To begin each class, the students participated in 'Good and New'. This activity allowed students to share events in their lives with one another, so that the class could become more cohesive. Because the data from years 1 and 2 of the study indicated that achievement is higher in cohesive classes, and that attitudes are higher in more equitable classes (see Table 4-5), this activity was deemed integral to the success of the students. Many of these students were from homes with problems and this 10 minutes of class time became a very important way for them to show their concern for one another. The Biology team teachers worried that these 10 minutes would make it impossible for the teacher to cover the required content. But it did not seem to hinder content acquisition, and the intervention class was able to cover all the content proscribed in the district pacing guide. The students reported that 'Good and New' showed them that the teacher really cared about their lives and made them feel important. It also seemed to allow content-specific activities to occur more smoothly and quickly because the students were getting to know each other.
11. At the end of the school year, the students were given the actual form of the WIHIC to determine if the classroom learning environment had improved during the intervention. For the regular biology students, their preferred environments were met in most instances as shown in Figure 4-7.

#### **4.5.3 Classroom environment and achievement results for intervention class**

Figure 4-7 indicates that there was a marked improvement in students' perceptions of actual classroom environment over the time of the intervention on all WIHIC scales. The changes in average item mean are quite large and range from around 1.0 to 1.5 (or well over one standard deviation). That is, students' average response changed from perceiving that practices covered by WIHIC items occurred 'Sometimes' (item mean of 3) to 'Often' (item mean of 4). Figure 4-7 shows that the students in the intervention class not only had more positive perceptions of their Biology classroom by the end of the year, but that their actual perceptions exceeded their preferred environment at the beginning of the intervention. Closer inspection indicated that

this pattern was replicated for all subgroups, especially males and females and blacks and non-blacks.



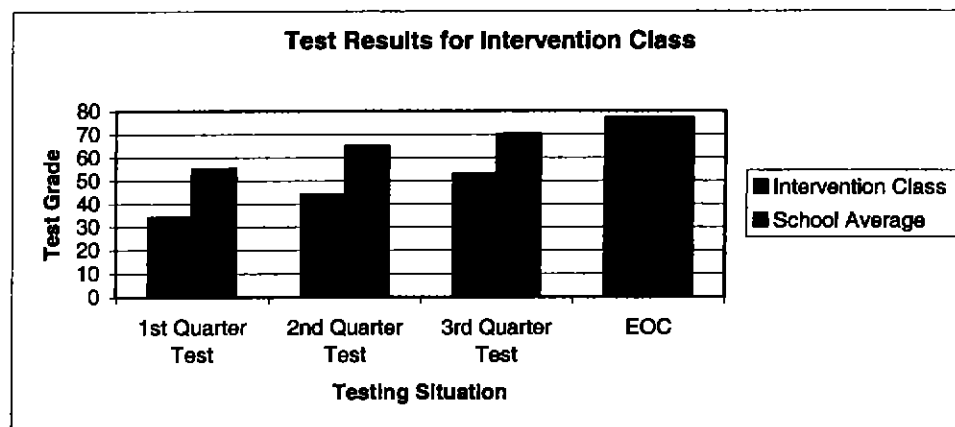
**Figure 4-7 Changes in Classroom Learning Environment During the Intervention**

The Charlotte-Mecklenburg Schools administers a standard multiple-choice examination at the end of the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> quarters of the school year to determine which students and teachers are struggling with content. These examinations are meant to provide feedback to teachers so that proper remediation can be provided for students who are experiencing difficulties. All Biology students in the Charlotte-Mecklenburg Schools are required to take these quarterly tests and the teachers and schools are evaluated in terms of the results on these quarterly examinations. The intent of these tests is to ensure that all students will have the ability to pass the End-Of-Course examination. These scores are used to provide administrators and department leaders with guidance in remediating low-performing students. Because these quarterly and End-Of-Course (EOC) scores are really important to school and district administrators, the Biology team teachers spent much time examining and discussing these test scores. Graphs comparing the intervention class's achievement to their school and district peers are shown in Figures 4-8 to 4-10.

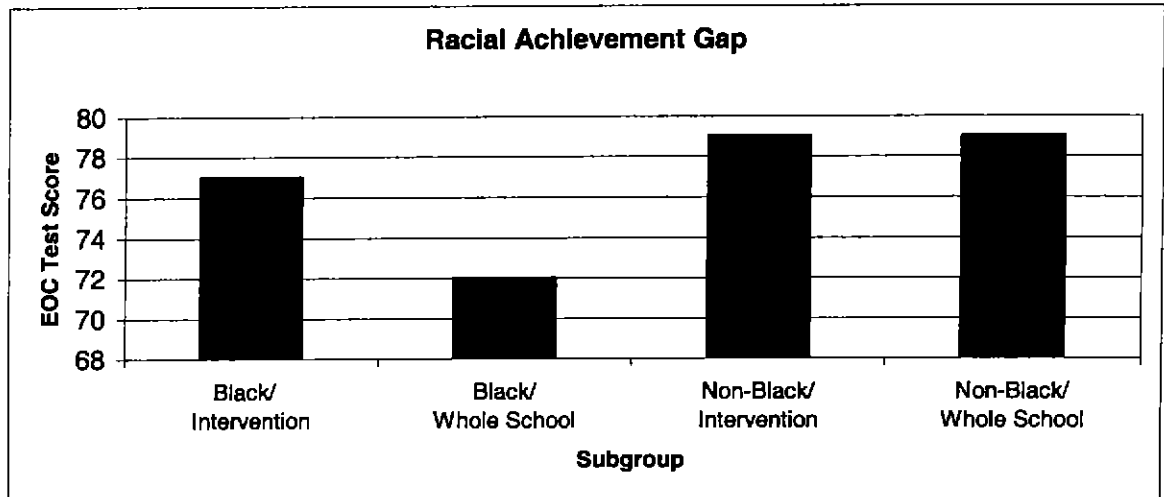
Figure 4-8 shows the achievement scores obtained by the students in the intervention class relative to the school as a whole. The intervention class's 1<sup>st</sup> quarter test average was 34, compared to 55 for the school average on this assessment. This is not surprising given that the intervention class consisted of a specially-selected group

of at-risk students. However, by the End-Of-Course examination at the end of the year, this intervention class's achievement matched the average of their school. The graph suggests that the intervention students improved each quarter and matched their school peers on the high-stakes North Carolina written examination by the end of the year.

These data are particularly impressive when you consider that, in this class of regular biology students, 65% of students were reading at the 4<sup>th</sup> grade level and 95% of students were of low socioeconomic status (as categorized by being on free or reduced-priced lunch). The class was composed of 65% black, 60% male, and 90% of the students came from single-parent homes. Figures 4-9 and 4-10 depict the achievement of the various subgroups (namely, males vs. females and blacks vs. non-blacks) in the intervention class and in the school as a whole.

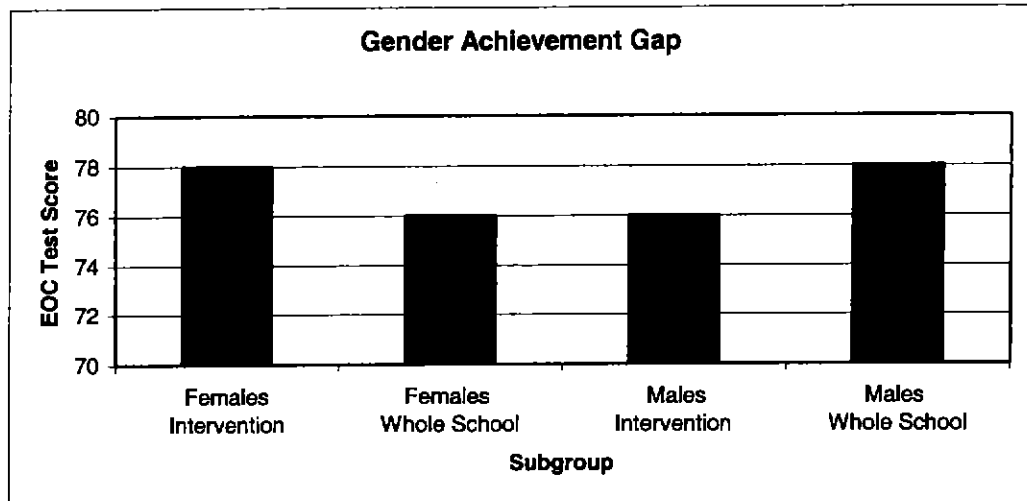


**Figure 4-8 Comparison of the Academic Achievement of the Regular Biology Intervention Class and the School as a Whole**



**Figure 4-9 Comparison of the End-Of-Course (EOC) Achievement of Black and Non-Black Subgroups in the Intervention Class and the School as a Whole**

Whereas Figure 4-8 depicts the End-Of-Course (EOC) achievement for the intervention class as a whole, Figure 4-9 compares the achievement of black and non-black subgroups within the intervention class and for the school as a whole. First, this graph in Figure 4.9 depicts the average EOC achievement score of 18 black students in the intervention group of 25 students altogether. Second, the graph shows the average EOC scores of the entire group of approximately 300 black students in the school. Third, Figure 4-9 shows the average test scores of the non-black students in the intervention class ( $n=7$ ). Fourth, the graph shows the average scores of the entire group of 300 non-black students in this school. The most remarkable feature of the Figure 4-9 is that the difference between the average achievement scores of black and non-black students is only two points for the intervention class, compared with a gap of 7 points for the school as a whole. Moreover, this school has the smallest gap between achievement of black and non-black students in the whole school district, with the achievement gap for the district as a whole being 12 points.



**Figure 4-10 Comparison of the End-Of-Course (EOC) Achievement of Males and Females in the Intervention Class and the School as a Whole**

Figure 4-10 illustrates gender differences in End-Of-Course (EOC) Biology examination scores both for the intervention students and for the entire school. The average for the females in the intervention class is 76 and represents the scores of eight students. The school average for the whole 380 females taking the examination is 78. The average for the 17 males in the intervention class also is 78. And the average for all 220 males in the whole school is 76.

Interestingly, for female students, the intervention class achieved slightly lower than the school as a whole but, for males, the intervention class achieved slightly higher than the school as a whole.

Overall, the EOC achievement results were deemed to support the success of the intervention by the Biology team teachers, the administrators at this school, and the school district administrators. These intervention students were at high risk of failure for many reasons. Whereas only 20% of the students in this high school qualify for free or reduced-priced lunch, 95% of the students in the intervention class qualified. Approximately 50% of the students in this school live in single-parent homes, but 90% of students in the intervention class came from single-parent homes. This factor is important because it usually means less parental support, due to the stress of parents working multiple jobs. Although the students selected for these interventions were chosen because their teachers believed that they would fail, only two of these students did not pass the End-Of-Course examination. And, even the students who



failed the examination passed the course and completed this graduation requirement. In this school district, approximately 50% of all Regular students fail Biology, while 100% of these intervention students passed the course. The students not only passed the course, but Figure 4-8 shows that they performed at or above the level of their peers in their school on their high-stakes EOC test. Figures 4-9 and 4-10 show that there were fairly similar levels of achievement for black and non-black students and for males and females in the intervention group.

#### **4.5.4 Follow-up of students in the intervention class**

In order to glean information about the long-term effects of the intervention, the students in this class were followed for the next two years of their school life. Interestingly, 22 of the 25 students remained at this same school, with 20 of the 22 (91%) choosing to undertake science for two more years. This seems to suggest that, with the provision of a more positive classroom environment, students are likely to take more science classes. This number is unusually high because only 45% of the students in this high school and approximately 48% of the students in this district take two more science classes after completing Biology. These students and their parents remained in contact with their intervention teacher for advice on academic scheduling, summer jobs and internships, and college choices over their next two years of high school. All of the 22 intervention students who remained at this school graduated in four years, and 20 of the 22 are enrolled to begin college in the fall of 2003. Considering the magnitude of these students' weaknesses upon entering this intervention class, these outcomes are most promising, thus suggesting the desirability of undertaking further research that attempts to replicate these positive results.

#### **4.5.5 Significance of results to field of classroom environment**

This study is significant in the field of learning environment research because it incorporated an intervention study that used feedback about the learning environment to guide a teacher in providing at-risk students with a better chance of success. Although a relatively small number of past studies has involved teachers' action research aimed at improving classroom environments (Sinclair & Fraser, 2002;

Thorp, Burden & Fraser, 1994; Yarrow, Millwater & Fraser, 1997), none has focused specifically on at-risk students.

The intervention not only led to impressive improvement in the classroom environment, but also in achievement as well. In North Carolina and in all parts of the United States, administrators and teachers are being pressured into teaching towards tests. With the 'No Child Left Behind' legislation, all American schools are evaluated on how all groups of students perform on high-stakes tests. This small-scale study provides preliminary evidence that good teaching, which incorporates laboratory activities, cooperative learning, and multiple learning styles, can lead to an improved classroom environment and higher high-stakes test scores. This is of great significance as schools across the country scramble to produce school improvement plans to present strategies to their stakeholders for improving their students' test scores. With President Bush's 'No Child Left Behind Act', schools will be required to publish test results and show active planning to improve their students' scores on these tests. A major part of the President's legislation is to require schools to reach all subgroups of students, and a school is not considered to be effective unless all subgroups of students show acceptable scores. This means that most schools and school districts are going to be struggling to find strategies to reach their traditionally lower-achieving students.

#### **4.6 CHAPTER SUMMARY**

This chapter reported the results of the two-part study of classroom learning environments in North Carolina. In Part 1, the study's aims included validating a modified form of the What Is Happening In this class? (WIHIC) questionnaire, investigating some determinants of classroom environment (especially gender and ethnicity), and exploring the effects of classroom environment on the two student outcomes of attitudes to science and achievement (assessed with a state-wide test). Part 2 involved an action research study attempting to improve one class of students' classroom environment and achievement by changing the learning environment to emphasise dimensions found to be empirically linked to achievement in the first phase of the study.

The sample consisted of 364 Biology I students in 18 classes in one high school in Charlotte, North Carolina. This school is distinctive in that it has students from 50 countries and approximately half of its students are of color. Many students are at risk of failing.

In Part 1 of the study, Research Question 1 involved the validity and reliability of the modified WIHIC when used with the sample in North Carolina. The WIHIC assesses the dimensions of Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. Principal components factor analysis with varimax rotation strongly supported the WIHIC's *a priori* structure. Together, the seven factors accounted for 57.5% of the variance. Each WIHIC scale's internal consistency reliability was good, with alpha coefficients ranging from 0.81 to 0.91 at the individual level and from 0.81 to 0.97 at the class level. As well, most of the WIHIC scales were capable of differentiating significantly between the perceptions of students in different classrooms.

Research Question 2 involved differences between genders, years 1 and 2 of the study, and ethnic groups (black vs. non-black) in terms of classroom environment perceptions on the WIHIC. MANOVA revealed little difference between black and non-black students and between years 1 and 2 of the study. However, statistically significant gender differences emerged for three WIHIC scales, with males perceiving more involvement and investigation but less cooperation than females. Effect sizes ranged from 0.44 to 0.66 for these three scales, suggesting the educational importance of these gender differences.

Research Question 3 in Part 1 of the study involved investigation of associations between learning environment, as assessed by WIHIC scales, and two student outcomes of attitudes to science and achievement on a state-wide biology test. Simple correlation and multiple regression analyses were conducted for two units of analysis (the student and the class mean). For the simple correlation analysis, there was a significant achievement-environment association for several WIHIC scales. Overall the multiple regression analyses revealed that achievement was higher in more cohesive classes, whereas attitudes were particularly favorable in more investigative, task-oriented and equitable classes.

Part 2 of the study involved whether a classroom intervention, using cooperative action research aimed at changing classroom environments to emphasise dimensions found to be empirically linked with better outcomes in Part 1, would lead to improved classroom environments and student achievement. This part of the study involved assembling one class of 'at risk' students who were likely to fail. I was the teacher of this class, but the whole Biology team of teachers was involved in meetings, discussions and suggesting ideas.

During the time of the intervention, students reported considerable improvement in their perceptions of all aspects of the classroom learning environment that are assessed by the WIHIC. Also, based on a state-wide achievement test in biology, the achievement of this class of at risk students improved throughout the school year until, by the time of the End-Of-Course examination, the class mean for the intervention class was the same as for the school as a whole. Interestingly, the racial achievement gap (black vs. non-black students) was much smaller for the intervention class than for the school as a whole. Moreover, a follow-up study revealed that most of the students from the intervention class chose to continue their science studies for two more years and that, more surprisingly, most enrolled in college. Given the magnitude of these students' weaknesses prior to the study, further research is warranted so that these very promising results might be replicated.

## Chapter 5

### DISCUSSION AND CONCLUSIONS

#### 5.1 INTRODUCTION

The present study investigated factors in the classroom learning environment that are associated with the student outcomes of achievement, as measured by a state-wide biology test, and attitudes, as assessed by a scale from the Test of Science Related Attitudes (TOSRA; Fraser, 1981b). The study also evaluated an intervention with low-performing students, involving the teacher changing those factors of classroom learning environment found to be empirically related to student outcomes, in terms of improvements in both classroom environment and achievement. As this was the first use of the What Is Happening In this Class? (WIHIC; Aldridge & Fraser, 2000) questionnaire in North Carolina, another aim was to cross-validate this questionnaire with the present sample.

The study provides important insights into the field of learning environments and it provides useful information for classroom teachers who teach diverse and low-performing students. To date, only a limited number of learning environment studies have included an intervention component aimed at improving the classroom environment (e.g. Sinclair & Fraser, 2002). Valuable information was provided to the teachers involved in Part 1 of the study (the questionnaire survey) about the perceptions of their students in their class, and this generated beneficial dialogue among the teachers in the biology team. In Part 2 of the study (the intervention), members of the biology team were provided with feedback information about students' actual and preferred classroom environment, and they were involved in action research about the efficacy of intervention methods implemented in the classroom taught by the researcher.

This final chapter provides a summary of Chapters 1 – 3 (Section 5.2), summary of major findings (Section 5.3), significance and implications (Section 5.4) and limitations and suggestions for future research (Section 5.5).

## **5.2 SUMMARY OF CHAPTERS 1 - 3**

### **5.2.1 Summary of Chapter 1**

Chapter 1 of this thesis provides background about education in North Carolina in general, and about the Charlotte-Mecklenburg Schools in particular. It outlines the historical events that led to the Schwann Desegregation order that began in 1969 and dictated the method of assignment of students to schools until the fall of 2002. This history explains the reasoning behind classifying students as black and non-black in my study. The current state of education in Charlotte-Mecklenburg Schools, including the exponential growth of the Charlotte region, is also considered in Chapter 1.

Independence High School, the site for the present study, is a large, comprehensive, urban high school that epitomizes all of the problems occurring in growing urban schools in the United States. With students from more than 50 US states, with a student body that is 48% of color, and with approximately 20% of students qualifying for free and/or reduced-cost lunch, the teachers are faced with diversity in academic skills and backgrounds among students in their classrooms. The teachers and students are also faced with continual change in the composition of students in their classes, making it difficult to create a strong sense of community within the classroom. The teachers are under great pressure from the high school administration, the district, and the state of North Carolina for students to achieve high scores on the End-Of-Course examination. This pressure is increased by the use of financial incentives for schools with high-performing students, and with state takeovers of low-performing schools. This pressure has also increased with President Bush's Leave No Child Behind Act that began to take effect in the fall of 2003.

A main purpose of the present study was to provide important insights into classroom learning environments in biology at the high school level in North Carolina. There is

a severe shortage of teachers in North Carolina, and many teachers enter the classroom with little educational training and background. This year, the Charlotte-Mecklenburg Schools hired nearly 100 new high school teachers, but only three of them are certified teachers with an education degree. Even teachers with education degrees have had little or no exposure to the concept of classroom learning environment, and probably were never given any practical instruction in how to manage and educate diverse learners. Most teachers have never considered their students' perceptions of the classroom and have no idea that it is possible to assess their students' perceptions of their classroom environment. Many of these teachers are frantically looking for ways to improve teaching and learning, but are under constraints of time and energy. The typical Charlotte-Mecklenburg science classroom teacher has at least 30 students in the classroom (with some classes having as many as 40 students), an insufficient supply of books and materials, and students with a plethora of learning disabilities. The intervention part of the study was undertaken to determine if molding the classroom learning environment in ways that emphasize dimensions found to be linked with higher achievement would lead to improved classroom environment and achievement in a real classroom full of students considered to be at risk.

The research objectives are outlined in Chapter 1:

1. Is the What Is Happening In this Class? (WIHIC) questionnaire valid and reliable when used with grade 9 and 10 biology students in Charlotte, North Carolina?
2. Are there differences in the learning environments perceived by:
  - a) boys and girls
  - b) students in years 1 and 2 of the study
  - c) black and non-black students?
3. Are there associations between the classroom environment dimensions assessed by the WIHIC and scores on:
  - a) the North Carolina End-Of-Course examination in Biology
  - b) a student attitude scale?

4. Do classroom interventions – involving cooperative action research aimed at changing classroom environments to emphasize dimensions found to be empirically linked with better achievement and attitudes in the first phase of the study – lead to improved classroom environments and student achievement?

### **5.2.2 Summary of Chapter 2**

Chapter 2 provides a comprehensive literature review. This literature reviewed provides a definition of ‘learning environment’ (Fraser, 1989), a historical account of the theoretical perspectives that have underpinned classroom environment research, a review of some of the instruments used to measure classroom environments, and a description of some common lines of learning environment research.

The literature indicates that classroom environment research opens useful avenues for exploring teaching and learning from student, teacher, and observer viewpoints. The range of instruments available makes it possible for educators to investigate the nature of learning environments in classroom and laboratory classroom environments, and to measure students’ actual and preferred environment.

A review of the literature reveals that the strongest tradition in past classroom environment research has been the investigation of associations between student outcomes and student perceptions of psychosocial characteristics of their classrooms (Fraser, 1998a). Research using perceptions of both teachers and students across varying grade levels (primary, secondary, higher education), different content areas (science, mathematics, languages), different types of schools and various countries (the USA, Canada, Australia, Israel and Indonesia) generally supports the contention that the learning environments of classrooms account for a considerable proportion of the variance in student outcomes. My study incorporated this line of research.

These research activities over the past 30 years were accompanied by the development and validation of various instruments to evaluate the classroom environment (Fraser, 1998a). Each of these instruments is a paper-and-pencil questionnaire measuring the perceptions of students and teachers of different



psychosocial dimensions of their classroom, mainly using five-point rating scales. One of these questionnaires (the *What Is Happening In this Class?*, WIHIC) was selected for use in my study (Aldridge & Fraser, 2000).

Improving classroom learning environment is not only educationally desirable, but it is one way of enhancing students' outcomes. However, in order for this practice to become more widespread, classroom teachers must become familiar with learning instruments and ideas. Fraser (1994) indicates that incorporating classroom environment work into preservice and inservice teacher education programs would help teachers to understand the importance of classroom environment. Hopefully, knowledge of classroom environment and its importance for improving student outcomes would lead to classroom teachers conducting action research on their own or in collaboration with university researchers. My study involved attempts to improve classroom learning environments and, subsequently, student achievement.

The literature review in Chapter 2 also shows that classroom environment instruments are not only useful for investigating the effects of classroom environments on student learning outcomes, but also for evaluating curricula and educational innovations. Studies indicate that these instruments can provide teachers and administrators with valuable information about the efficacy of new programs and the information technologies employed in the classroom.

Tobin and Fraser (1998) suggest that the inclusion of both quantitative and qualitative methods in the same study would help classroom environment researchers gain better understandings of classroom events. For the present study, a modified version of the *What Is Happening In this Class?* (WIHIC) was used to measure the classroom environment and, in addition, qualitative methods were used in a relatively minor way.

The concept of attitude, its definition, and its measurement have been widely explored in books such as by Eiser (1984), Mueller (1986) and Lemon (1973). The notion that attitudinal behavior is learned and can be modified is widely accepted by social scientists and psychologists. Also acknowledged by researchers and educators is the relationship of attitudes to values and beliefs. Several scaling techniques have

been developed to measure attitudes, such as Likert attitude scaling, Thurstone scaling, Guttman scaling and the semantic differential technique. These beliefs contribute to student academic achievement and can be measured by instruments such as the *Test of Science Related Attitudes* (TOSRA). In fact, a scale from the TOSRA was used in my study to assess students' attitudes to science.

Numerous studies have investigated attitudes as one of the student outcome measures to be related to classroom environment. Many of these studies (e.g., McRobbie & Fraser, 1993a) showed positive relationships between students' attitudes towards science and classroom environments. For the present study, the scale selected from the TOSRA was used in relating students' attitude towards science and relate them to classroom environment.

My study was distinctive in that it not only used the learning environment instrument to determine if there was a relationship between classroom learning environment and students' achievement and attitudes, but I also conducted an intervention study. This intervention study used insights gained from the literature search and the results from the classroom environment survey to improve both the learning environment and science achievement for low-achieving students. This study is similar to past research, but is unique in that it was conducted in Charlotte, North Carolina and it provides additional information about interventions aimed at improving teaching and learning in a difficult urban setting.

### **5.2.3 Summary of Chapter 3**

Chapter 3 describes the research methods used in my study of classroom learning environment, student attitudes toward science, and student achievement as exhibited on an end-of-course high-stakes Biology examination. The sample consisted of 364 students in 18 classes for the questionnaire survey and 15 students in one class in the intervention phase of the study. The research was conducted in a large, comprehensive, urban public school in Charlotte, North Carolina.

The instrument used to assess classroom learning environment was a modified form of the What Is Happening In this Class? (WIHIC) questionnaire (Aldridge & Fraser,

2000), which assesses Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity. This instrument was field-tested and then used for the two years of my study. Also an attitude scale from the Test of Science-Related Attitudes (TOSRA; Fraser, 1981) was used and this enabled the investigation of attitude-environment associations.

To determine the reliability and validity of the WIHIC, the factor structure, internal consistency reliability, discriminant validity and ability to differentiate between classrooms were examined. Multivariate analyses of variance (MANOVA) was chosen for investigating gender and race differences in environment perceptions. To investigate outcome-environment associations, simple correlation and multiple regression analyses were conducted for two units of analysis (the individual and the class mean).

In the intervention phase of the study, the results from administering the classroom environment survey were used to guide classroom interventions aimed at improving the classroom environment and, ultimately, student achievement. The methods used in this phase are similar to those reported by Thorp, Burden and Fraser (1994) and Yarrow, Millwater and Fraser (1997). An intervention in one class of at-risk students was evaluated in terms of changes in classroom environment and student achievement.

### **5.3 SUMMARY OF MAJOR FINDINGS**

Chapter 4 reports the results of the two-part study of classroom learning environments in North Carolina. In Part 1, the study's aim included validating a modified form of the What Is Happening In this Class? (WIHIC) questionnaire, investigating some determinants of classroom environment (especially gender and ethnicity), and exploring the effects of classroom environment on the two student outcomes of attitudes to science and achievement (assessed with a state-wide test). Part 2 involved an action research study attempting to improve one class of students' classroom environment and achievement by changing the learning environment to emphasise dimensions found to be empirically linked to achievement in the first phase of the study.

The sample consisted of 364 Biology I students in 18 classes in one high school in Charlotte, North Carolina. This school is distinctive in that it has students from 50 countries and approximately half of its students are of color. Many students are at risk of failing.

In Part 1 of the study, Research Question 1 involved the validity and reliability of the modified WIHIC when used with the sample in North Carolina. The WIHIC assesses the dimensions of Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. Principal components factor analysis with varimax rotation strongly supported the WIHIC's *a priori* structure. Together, the seven factors accounted for 57.5% of the variance. Each WIHIC scale's internal consistency reliability was good, with alpha coefficients ranging from 0.81 to 0.91 at the individual level and from 0.81 to 0.97 at the class level. As well, most of the WIHIC scales were capable of differentiating significantly between the perceptions of students in different classrooms. These findings crossvalidate other studies involving the WIHIC in Australia and Taiwan (Aldridge & Fraser, 2000), Singapore (Fraser & Chionh, 2000), Indonesia (Margianti, Fraser & Aldridge, 2002) and other countries (Dorman, 2003; Fraser, 2002).

Research Question 2 involved differences between genders, years 1 and 2 of the study, and ethnic groups (black vs. non-black) in terms of classroom environment perceptions on the WIHIC. MANOVA revealed little difference between black and non-black students and between years 1 and 2 of the study. However, statistically significant gender differences emerged for three WIHIC scales, with males perceiving more involvement and investigation but less Cooperation than females. Effect sizes were 0.44 to 0.66 for these three scales, suggesting the educational importance of these gender differences.

Research Question 3 in Part 1 of the study involved investigation of associations between learning environment, as assessed by WIHIC scales, and two student outcomes of attitudes to science and achievement on a state-wide biology test. Simple correlation and multiple regression analyses were conducted for two units of analysis (the student and the class mean). For the simple correlation analysis, there

was a significant achievement-environment association for several WIHIC scales. Overall the multiple regression analyses revealed that achievement was higher in more cohesive classes, whereas attitudes were particularly favorable in more investigative, task oriented and equitable classes. This finding of outcome-environment associations replicates many past studies in different countries (Fraser, 1998a, 2000; Goh, Young & Fraser, 1995; Goh & Khine, 2003).

Part 2 of the study involved whether a classroom intervention, using cooperative action research aimed at changing classroom environments to emphasise dimensions found to be empirically linked with better outcomes in Part 1, would lead to improved classroom environments and student achievement. This part of the study involved assembling one class of 'at risk' students who were likely to fail. These at risk students had various problems including low reading ability, poor organizational skills, and lack of motivation. Most of these students had become disenfranchised for many reasons.

I was the teacher of this class, but the whole Biology team of teachers was involved in meetings, discussions and suggesting ideas. The Biology team of teachers and the teacher-researcher generated ideas about how best to reach these students. The students were never told why they were moved to another class and, as this is a normal occurrence in this school, they were not offended. The students were given the modified WIHIC to determine their perceptions of actual and preferred classroom learning environment. The teacher-researcher discussed the results with the students and spent the year working on creating a classroom learning environment that emphasized dimensions preferred by students and which had been found to be correlated to achievement.

During the time of the intervention, students reported considerable improvement in their perceptions of all aspects of the classroom learning environment that are assessed by the WIHIC. Also, based on a state-wide achievement test in biology, the achievement of this class of at risk students improved throughout the school year until, by the time of the End-Of-Course examination, the class mean for the intervention class was the same as for the school as a whole. Moreover, a follow-up study revealed that most of the students from the intervention class chose to continue

their science studies for two more years and that, more surprisingly, most enrolled in college. Given the magnitude of these students' weaknesses prior to the study, further research is warranted so that these very promising results might be replicated.

Another index of the success of the teachers' involvement in reflecting on their teaching is that all of the Biology teachers subsequently have either enrolled in a Masters degree program or the National Board certification process. These teachers have also all remained at this particular high school, which is extremely unusual in this district.

#### **5.4 SIGNIFICANCE AND IMPLICATIONS**

My study introduced learning environments research in North Carolina. When responses to a widely-applicable classroom environment questionnaire, the What Is Happening In this Class? (WIHIC), were analyzed, past research in many other places was replicated and strong support was provided for the validity and reliability of the WIHIC when used in this State. Other researchers and teachers can have a degree of confidence in using the WIHIC in the future.

The results of my study provide some tentative practical implications for educators wishing to improve their biology students' attitudes and achievement. Subject to replication in future results, my findings suggest that achievement is likely to be higher in more cohesive classes and that attitudes to science are likely to be more positive in more investigative, task-oriented and equitable classes.

Although the intervention phase of my study was of limited scope, still its impressive results are noteworthy and deserve replication in further research. It appears that a teacher's action research can lead to dramatic improvements in classroom environment and achievement on a state-wide test. What is particularly noteworthy is that the students involved in the intervention were those most at risk to fail at school.

The action research component suggests to teachers that all students, even those with a great number of at-risk factors, can succeed in vocabulary-laden, multiple-choice, high-stakes testing situations. American classroom teachers can no longer sit back

and ignore low-performing students in their classes, in order to concentrate on the higher-ability students. President Bush has made it clear that all students are entitled to a high-quality education and deserve a chance to succeed. The strategies employed in the intervention phase in my study were low cost and highly interactive and they could be used by most teachers. These strategies are consistent with the National Science Standards and promote a community approach to learning. Because these techniques were designed to set the students up for success, the students continued to develop self-confidence and motivation to learn. This is consistent with Nolen's (2002) finding that students in science classrooms where teachers are perceived to endorse independent scientific thinking and to desire deep understanding of science concepts had higher achievement and greater satisfaction with their science learning. Developing a classroom community where questions and independent thinking are valued and encouraged is consistent with current thinking in science education reform (Herrenkohl, Palincsar, DeWater & Kawasaki, 1999). This research and other current research on high school learning environments suggest that, if the classroom learning environment is not leading to students' success, then teachers should reevaluate their teaching and create a more positive classroom learning environment. The argument used by many classroom teachers, that novel teaching strategies do not affect student test scores, did not hold up in my study.

## **5.5 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH**

In any educational research study, there are potential problems in generalizing its findings obtained with a specific sample to a broader group of students and schools. My study is no exception. As my research was conducted in one school in North Carolina, its findings could only be generalized to other schools with much caution. Furthermore, the particular school involved in my study is characterized by many problems and has a diverse student population from all over the US, including many students of color and of low socioeconomic status. However, if some successes have been achieved under these difficult circumstances at this school, then perhaps one can be optimistic about replicating the findings at schools with less difficult circumstances. Clearly, it will be important to conduct further studies along similar lines with a variety of students and schools.

Another limit to the generalizability of findings from the intervention phase of the study is that it involved me as a teacher-researcher in my own class. It is important to acknowledge this limitation. Findings from my own class might not be generalizable to other teachers' classes. Therefore, in future research, it will be valuable to investigate whether a range of other teachers can replicate what I achieved with my class in the intervention phase of my study.

As the Leave No Child Behind act is implemented across the US, there will be an increase in the number of teachers and administrators searching for cost-efficient strategies to help their students to achieve success in high-stakes tests. These educators could benefit from using ideas from the field of classroom learning environment research and from modifying them to fit their specific needs. Schools in which some students are not making adequate yearly progress will be required to draft a school plan aimed at improving the academic achievement of their students. Perhaps using feedback from classroom learning environment questionnaires will be one useful approach for these schools.

In North Carolina, a science test will be implemented in Grades 5 and 8 by 2007. Currently, in the state of North Carolina, no testing in science is done until students undertake biology at the high school level. Elementary and middle school teachers who will be affected by these tests are filled with trepidation about preparing their students. Classroom learning environment research possibly could be conducted as one way of guiding them in designing classroom settings that will help their students to succeed. Many states across the country are scrambling to design and implement statewide testing in science at the elementary, middle, and high school levels. Therefore it is now timely for State School Superintendents and local administrators to turn to the literature for guidance in how teacher-researchers can conduct their own projects.

Research on learning environments has been conducted over several decades, but much of this work has depended largely on a single administration of surveys assess individual students' perceptions (Goh, Young, & Fraser, 1995). Much of this work has focused on psychosocial dimensions of classroom organization and interpersonal relationships (Fraser, 1994, 1998a). When doing research on achievement as



exhibited on high-stakes tests, researchers have become interested in students' perceptions of the reasons for learning stressed in their classrooms and schools (e.g., Anderman & Young, 1994; Meece, Blumenfeld, & Hoyle, 1988; Nolen & Haladyna, 1990b). More recently, Nolen (2002) has reported research on the relationships among individuals' motivation, learning strategies, and achievement, while simultaneously considering the relationships of aspects of the classroom climate to these variables.

Hopefully this research will open the door to more teacher-researchers analyzing feedback on their classroom learning environments as a basis for improving student learning in their classrooms. With the facility to administer classroom learning environment questionnaires electronically and analyze the responses quickly, there are likely to be many more applications of these techniques for the purpose of informing teachers and school districts about the most beneficial types of staff development and teacher preparation. As the diversity of the student populations in public schools increases and the expectations of all students are increased, teachers increasingly will need to improve their effectiveness in the classroom. My research supports the notion that classroom learning environments can be improved by teachers who receive feedback, support and training (Woods & Fraser, 1996).

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## Appendix A

### WHAT IS HAPPENING IN THIS CLASS? ACTUAL

This questionnaire is part of research into the aspects of learning environment that you experience in your classroom. Many times teachers think they know what the environment is in their classroom, but this questionnaire is designed to get your opinion. Please be truthful because we are planning to use this information to help us improve your learning and enjoyment of science. Your answers will not affect your grade or your teacher in any way. Your name will not be used in any manner. Answer the questions based upon your experience in this particular biology classroom. If you were transferred from another class for any reason, limit your answers to the class in which you are now assigned.

Name \_\_\_\_\_ Student Number \_\_\_\_\_  
Teacher \_\_\_\_\_ Period \_\_\_\_\_  
Age \_\_\_\_\_ Race \_\_\_\_\_ Sex \_\_\_\_\_ Class Type \_\_\_\_\_

If you would like to make any general comments about your experience in this biology classroom use the space below.

## What is happening in this biology classroom?

### Student questionnaire

SC	almost never	seldom	some- times	often	almost always
1. I make friendships among students in this class.	1	2	3	4	5
2. I know other students in this class.	1	2	3	4	5
3. I am friendly to members of this class.	1	2	3	4	5
4. I work well with other class members.	1	2	3	4	5
5. I help other class members who are having trouble with their work.	1	2	3	4	5
6. In this class I get help from other students.	1	2	3	4	5
TS	almost never	seldom	some- times	often	almost always
7. The teacher takes a personal interest in me.	1	2	3	4	5
8. The teacher goes out of his/her way to help me.	1	2	3	4	5
9. The teacher considers my feelings.	1	2	3	4	5
10. The teacher is interested in my problems.	1	2	3	4	5
11. The teacher moves around the class to talk with me.	1	2	3	4	5
12. The teacher's questions help me to understand.	1	2	3	4	5
IN	almost never	seldom	some- times	often	almost always
13. I discuss ideas in class.	1	2	3	4	5
14. I give my opinions during class discussion.	1	2	3	4	5
15. The teacher asks me questions.	1	2	3	4	5
16. I ask the teacher questions.	1	2	3	4	5
17. I explain my ideas to other students.	1	2	3	4	5
18. My ideas and suggestions are used during the classroom discussions.	1	2	3	4	5

<b>IV</b>	<b>almost never</b>	<b>seldom</b>	<b>some- times</b>	<b>often</b>	<b>almost always</b>
19. I explain the meaning of statements, diagrams, and graphs.	1	2	3	4	5
20. I am asked to think about the evidence for statements.	1	2	3	4	5
21. I carry out investigations to answer questions coming from discussions.	1	2	3	4	5
22. I find out answers to questions by doing investigations.	1	2	3	4	5
23. I carry out investigations to answer questions which puzzle me.	1	2	3	4	5
24. I carry out investigations to answer the teacher's questions.	1	2	3	4	5
<b>TO</b>	<b>almost never</b>	<b>seldom</b>	<b>some- times</b>	<b>often</b>	<b>almost always</b>
25. I know the goals for this class.	1	2	3	4	5
26. I am ready to start this class on time.	1	2	3	4	5
27. I pay attention during this class.	1	2	3	4	5
28. I try to understand the work in this class.	1	2	3	4	5
29. Getting a certain amount of work done is important to me.	1	2	3	4	5
30. I know how much work I have to do.	1	2	3	4	5
<b>CO</b>	<b>almost never</b>	<b>seldom</b>	<b>some- times</b>	<b>often</b>	<b>almost always</b>
31. I cooperate with other students when doing assignment work.	1	2	3	4	5
32. I share my books and resources with other students when doing assignments.	1	2	3	4	5
33. I learn from other students in this class.	1	2	3	4	5
34. I cooperate with other students on class activities.	1	2	3	4	5
35. When I work in groups in this class, there is teamwork.	1	2	3	4	5
36. I work with other students on projects in this class.	1	2	3	4	5

<b>E</b>	<b>almost never</b>	<b>seldom</b>	<b>some- times</b>	<b>often</b>	<b>almost always</b>
37. The teacher gives as much attention to my questions as to other students' questions.	1	2	3	4	5
38. I get the same amount of help from the teacher as do other students.	1	2	3	4	5
39. I am treated the same as other students in this class.	1	2	3	4	5
40. I receive the same encouragement from the teacher as other students do.	1	2	3	4	5
41. My work receives as much praise as other students' work.	1	2	3	4	5
42. I get the same opportunity to answer questions as other students.	1	2	3	4	5

Student cohesiveness \_\_\_\_\_

Task orientation \_\_\_\_\_

Teacher support \_\_\_\_\_

Cooperation \_\_\_\_\_

Involvement \_\_\_\_\_

Equity \_\_\_\_\_

Investigation \_\_\_\_\_

## Appendix B

### WHAT IS HAPPENING IN THIS CLASS? PREFERRED

This questionnaire is part of research into the aspects of learning environment that you experience in your classroom. Many times teachers think they know what the environment is in their classroom, but this questionnaire is designed to get your opinion. Please be truthful because we are planning to use this information to help us improve your learning and enjoyment of science. Your answers will not affect your grade or your teacher in any way. Your name will not be used in any manner. Answer these questions about the “perfect” biology classroom, according to your own unique needs.

Name \_\_\_\_\_ Student Number \_\_\_\_\_  
Teacher \_\_\_\_\_ Period \_\_\_\_\_  
Age \_\_\_\_\_ Race \_\_\_\_\_ Sex \_\_\_\_\_ Class Type \_\_\_\_\_

If you would like to make any general comments about your experience in this biology classroom use the space below.

## What is happening in this biology classroom?

Preferred Student questionnaire

SC	almost never	seldom	some- times	often	almost always
1. I would make friendships among students in this class.	1	2	3	4	5
2. I would know other students in this class.	1	2	3	4	5
3. I would be friendly to members of this class.	1	2	3	4	5
4. I would work well with other class members.	1	2	3	4	5
5. I would help other class members who are having trouble with their work.	1	2	3	4	5
6. I would get help from other students.	1	2	3	4	5
TS	almost never	seldom	some- times	often	almost always
7. The teacher would take a personal interest in me.	1	2	3	4	5
8. The teacher would go out of his/her way to help me.	1	2	3	4	5
9. The teacher would consider my feelings.	1	2	3	4	5
10. The teacher would be interested in my problems.	1	2	3	4	5
11. The teacher would move around the class to talk with me.	1	2	3	4	5
12. The teacher's questions would help me to understand.	1	2	3	4	5
IN	almost never	seldom	some- times	often	almost always
13. I would discuss ideas in class.	1	2	3	4	5
14. I would give my opinions during class discussion.	1	2	3	4	5
15. The teacher would ask me questions.	1	2	3	4	5
16. I would ask the teacher questions.	1	2	3	4	5
17. I would explain my ideas to other students.	1	2	3	4	5
18. My ideas and suggestions would be used during the classroom discussions.	1	2	3	4	5

IV	almost never	seldom	some- times	often	almost always
19. I would explain the meaning of statements, diagrams, and graphs.	1	2	3	4	5
20. I would be asked to think about the evidence for statements.	1	2	3	4	5
21. I would carry out investigations to answer questions coming from discussions.	1	2	3	4	5
22. I would find out answers to questions by doing investigations.	1	2	3	4	5
23. I would carry out investigations to answer questions which puzzle me.	1	2	3	4	5
24. I would carry out investigations to answer the teacher's questions.	1	2	3	4	5
TO	almost never	seldom	some- times	often	almost always
25. I would know the goals for this class.	1	2	3	4	5
26. I would be ready to start this class on time.	1	2	3	4	5
27. I would pay attention during this class.	1	2	3	4	5
28. I would try to understand the work in this class.	1	2	3	4	5
29. Getting a certain amount of work done would be important to me.	1	2	3	4	5
30. I would know how much work I have to do.	1	2	3	4	5
CO	almost never	seldom	some- times	often	almost always
31. I would cooperate with other students when doing assignment work.	1	2	3	4	5
32. I would share my books and resources with other students when doing assignments.	1	2	3	4	5
33. I would learn from other students in this class.	1	2	3	4	5
34. I would cooperate with other students on class activities.	1	2	3	4	5
35. When I work in groups in this class, there would be teamwork.	1	2	3	4	5
36. I would work with other students on projects in this class.	1	2	3	4	5

E	almost never	seldom	some- times	often	almost always
37. The teacher would give as much attention to my questions to other students' questions.	1	2	3	4	5
38. I would get the same amount of help from the teacher as do other students.	1	2	3	4	5
39. I would be treated the same as other students in this class.	1	2	3	4	5
40. I would receive the same encouragement from the teacher as other students do.	1	2	3	4	5
41. My work would receive as much praise as other students' work.	1	2	3	4	5
42. I would get the same opportunity to answer questions as other students.	1	2	3	4	5

Student cohesiveness \_\_\_\_\_

Task orientation \_\_\_\_\_

Teacher support \_\_\_\_\_

Cooperation \_\_\_\_\_

Involvement \_\_\_\_\_

Equity \_\_\_\_\_

Investigation \_\_\_\_\_



## Appendix C

### SCALE ASSESSING ATTITUDES TO SCIENCE

A	strongly agree	agree	not sure	disagree	strongly disagree
43. I enjoy reading about things which disagree with my previous ideas.	1	2	3	4	5
44. Science lessons are fun.	1	2	3	4	5
45. I am curious about the world in which we live.	1	2	3	4	5
46. School should have more science lessons each week.	1	2	3	4	5
47. Finding out about new things is unimportant.	1	2	3	4	5
48. Science lessons bore me.	1	2	3	4	5
49. Science helps to make life better.	1	2	3	4	5
50. Science is man's worst enemy.	1	2	3	4	5

