

Science and Mathematics Education Centre

**Reality Pedagogy Across Contexts:
Comparing Learning Environments
in the Bronx (New York) and Dresden (Germany)**

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**This thesis is presented for the award of the
Degree of Doctor of Philosophy
of the
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Declaration

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

Signature:

A handwritten signature in black ink, consisting of several overlapping loops and a long horizontal stroke extending to the right.

Date:

December 3, 2012

Abstract

The work presented in this thesis was a response to my observations of differences in learning environments and student attitudes toward science between the Bronx, New York and Dresden, Germany when I was a teacher in these locations. In this thesis, I present reality pedagogy as an approach to teaching that allows students from all backgrounds to be successful in science. Reality pedagogy acknowledges the significance of using cultural referents from student experiences as key points from which pedagogy is enacted. Further, reality pedagogy is meant to provide students with classroom agency by including students in the teaching and learning process.

This study used a mixed-methods exploratory approach to investigate the outcomes of reality pedagogy in terms of changes in students' perceptions of the learning environment and their attitudes toward science. The Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) was administered to 142 students in grades 8–10 at Bronx High School in New York City and the International School of Dresden in Dresden, Germany. The QuALESA was created by combining learning environment scales from the Constructivist Learning Environment Survey (CLES) and the What Is Happening In this Class? (WIHIC) questionnaire with attitude scales from the Test of Science-Related Attitudes (TOSRA). In addition, qualitative data were collected from cogenerative dialogues, classroom observations, and semi-structured student interviews and were used to support findings from the QuALESA.

Because one of the aims of the study was to establish the validity and reliability of the QuALESA, it was administered at the beginning and conclusion of the 2010–2011 academic year in two high school science classrooms in the Bronx and

five high school science classrooms in Dresden. Data analyses supported the factorial validity and reliability of the QuALESA for use with these samples.

Overall changes in student perceptions of the learning environment and attitudes toward science in response to reality pedagogy were also investigated. MANOVA revealed significant improvements between pretest and posttest for six of the seven scales (Involvement, Cooperation, Personal Relevance, Critical Voice, Shared Control, and Enjoyment of Science Lessons). Classroom observations supported the changes revealed by the quantitative data analyses and showed shifts in teaching practices aimed at more involvement of students in the teaching and learning of science. However, when differences between how reality pedagogy manifested itself in classroom in the Bronx and Dresden were also explored in terms of student learning environment perceptions and attitudes toward science, it was found that students in Dresden had significantly higher pretest scores for six scales on the QuALESA. However, these pretest differences between the two locations were no longer present by the time of the posttest.

While the quantitative data indicated that, over time, the perceptions and attitudes of students from the Bronx became more closely aligned with those of students from Dresden, the qualitative data revealed differences in how reality pedagogy was enacted in each geographic area. Students in the Bronx focused more on changing teacher practices to engage students more in science, whereas students in Dresden were more concerned with increasing their roles as co-teachers and sharing control with the teacher.

Finally, when the quantitative data were analyzed to explore associations between students' perceptions of their learning environment and their attitudes toward

science, positive and statistically significant associations emerged between several learning environment scales and the attitude scales.

Overall, the findings of this study add to the body of evidence concerning the effectiveness of employing reality pedagogy as a pedagogical approach to teach science across a variety of contexts.

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Dedication

To my amazing wife and my beautiful daughter.

Thank you for always believing that I could accomplish this task and
for making me strive to be better!

To my father, mother, sister, nieces, and nephew.

Thank you for pushing me to never give up, never be scared, and to take chances!

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Chapter 1

INTRODUCTION & RESEARCH OBJECTIVES

1.1 From Child to Teacher to Researcher

I grew up in a neighborhood of Queens composed primarily of Greeks and Italians, during a time when the street lights coming on meant that it was time to go home, my mother communicated with me by shouting out the window, playing with friends meant being outside, not online, and the neighbors had just as much say in my upbringing as my parents did. I would ride my bicycle down Ditmars Boulevard, past the grocery store and restaurants, listening to the hum of my wheels riding along the concrete sidewalk, always smiling at the friendly faces of the neighborhood. As I approached 31st Street, the elevated train would come into view. That was my cue to turn my bicycle around and ride along the other side of Ditmars Boulevard, back towards my house. Going past the elevated train meant going into unknown territory where faces were no longer familiar. Yet, those faces were still a part of my neighborhood, even if I knew nothing about them.

I am the son of two immigrant parents from Greece, whose goal was to instill in me as much of the Greek culture as they possibly could. To ensure a proper Greek upbringing, I was sent to attend a local Greek parochial school where, for at least three hours a day, I learned the Greek language along with classes on Greek mythology, customs, and religion. On school days, I dressed in my school uniform, gray slacks, white shirt, navy tie, black shoes, while I waited for my mother to signal to me that the school bus had arrived.

My daily journey on the school bus was generally uneventful, except for the few minutes that we spent driving through the unchartered territory on the other side of the elevated train. Every morning, for those few minutes, I felt fear, even if I had the security of being on the school bus. Through observation, I learned that passing the large apartment complex meant that we were crossing back into the safer part of the neighborhood and it would only be a few more minutes before we reached the front entrance of the school. Once inside, I began my daily routine of greeting my friends and teachers. I felt happy, secure, and at ease with everyone around me. Everyone was Greek and we were all bonded by a common language and heritage. Being Greek identified me and it was the only thing to which I could relate – until high school.

Realizing that being knowledgeable in all things Greek was not necessarily the key to a good education, my family and I decided to explore different avenues for high school. I was accepted to a specialized public high school in Brooklyn, a train ride of about an hour and a half from my family's house in Queens. My journey to school was a bit different now as I had no school bus to hide in. Rather, every step I took away from my family's house and the friendly neighborhood faces was a step toward the unknown. In an effort to bury my fear, I began a daily ritual as I approached the elevated train to take the journey deep into Brooklyn: I pulled my pants below my waist, played my music loudly so people knew I was around, and clenched my fists to show my toughness. I maintained the same demeanor throughout the school day and on the train ride back home. Only when I got off the train and began walking back home, did I return to my normal self.

After four years of high school and another four years of university, I entered the profession of teaching. As a new science teacher, my days at work were routine.

Every morning, I would drive over the Triborough Bridge into the East Tremont section of the Bronx, toward the two-storey school building. Walking into the building, I noticed a group of students sitting with each other in the cafeteria. Day after day, week after week, it was this same group of students sitting with each other at exactly the same table. The bell would ring, and that same group of students would come into my class talking about everything else except science. Nearly every day, they pretended not to remember where they had been told to sit in an effort to try to sit with their friends. Every day, I spent the first few minutes trying to separate groups of friends and only then would I give the signal that I was about to begin my lesson. In my mind, I was only doing what I had to do in order to maintain control of my classroom. The conversations would slowly cease and I could begin doing what I was hired to do – teach science to urban youths. Those first few weeks of teaching in the Bronx were strenuous but I managed to carry on. Constant disruptions and disciplinary issues plagued my classroom and I often thought about why I had ever decided to become a teacher. Realizing that teaching science should not be this agonizing, I asked myself: Don't these students want to be successful? Why won't they take responsibility for their learning? Why do I need to be the leader of the classroom? I rationalized that low self-esteem and self-worth, in conjunction with a low socioeconomic status, were to blame for my students' lack of success in school. Therefore, it was my responsibility to get these 'out-of-control' urban students from the Bronx to learn.

In 2008, I departed from the Bronx and secured a position as a teacher at an international school in Dresden, Germany. My reasons for leaving were a mixture of personal and professional, but what I observed in Germany revolutionized the way in which I viewed my former students and school in the Bronx. Personally, I moved on

from the Bronx because of a desire to expand my knowledge of other cultures and to explore places that, as a child, I had always dreamed of. Professionally, I was becoming frustrated with the mantra that urban students could only be successful if provided with a strict and rigid classroom structure. As well, I wanted to flex my creative teaching muscle and get to the business of teaching, without having to worry about students arguing and fighting in my class.

Once in Dresden, I had a rude awakening as my belief, that teaching here would be much easier, quickly dissipated. Armed with the knowledge that most of these students were from wealthy backgrounds, I decided to utilize direct instruction in the form of lecture as my primary teaching tool, interspersed with anecdotes, and the occasional teacher-led demonstration. Within weeks, I was having similar discipline problems to those that I was having in the Bronx. It was at this point that the previously-mentioned revolutionary view of teaching occurred. For the past several years, it had become ingrained in me that the fault was to be put on students for their lack of interest, or ability to succeed, in school. It became clear that the students were not entirely the problem. I reflected on my own teaching practices and decided that it would be necessary to make changes to the methods by which I delivered content. Otherwise, I would be destined for a failing teaching career.

My experiences as outlined above are what compelled me to pursue a career in educational research. As a teacher, I thought that I could teach using rudimentary techniques which proved ineffective. To revitalize my teaching career, I explored the ideas of critical pedagogy (McLaren, 2000) and culturally-relevant pedagogy (Ladson-Billings, 1994), enacting some of the prescribed strategies in my classroom, with limited success. Both of these forms of pedagogy share the common thread of culture and I began to realize the importance of culture to the science classroom. As a

middle-school student, I had a strong link to my Greek culture and I tried to display this as often as I could. As a high-school student, I adopted the persona of a hoodlum in order to hide my fear of the unknown. Yet, as a teacher, the only culture I welcomed was the culture of science teaching while rejecting other forms of culture, primarily because I viewed them as students' attempts to distract me from teaching. Assuming a new attitude towards teaching, I utilized reality pedagogy in the classroom. In its simplest form, reality pedagogy utilizes the most effective qualities from critical pedagogy and culturally-relevant pedagogy and merges them to create an even more effective set of classroom practices. Reality pedagogy is explained in greater detail in Chapter 2, Section 2.7.

As a researcher, my aim was to understand how students across geographic and socioeconomic boundaries make sense of their classroom by examining events and experiences which occurred outside the classroom. I perceived reality as being constructed based on the lived experiences of the participants and that the reality of the classroom environment was unique for each student in that each student brings a different set of experiences into the classroom. Acknowledging this phenomenon has helped me to become a better teacher, yet I understand that my ability to transform teaching practices is limited because innovative teaching methods are often never truly implemented on a broad enough scale to be acknowledged beyond individual success stories. Therefore, the research presented in this thesis utilized comparative classroom action research, involving a learning environment and student attitude questionnaire along with classroom observations and student interviews to investigate the outcomes of the implementation of reality pedagogy on learning environments in different classrooms, in the Bronx and Dresden. Further, through the research presented in this thesis, I attempted to add to the existing body of research that calls

for reality pedagogy to be enacted as a tool to improve instruction in science classrooms.

The remainder of this chapter presents the background of the study, specifies the problem of the study, describes its significance, and presents an overview of the methodology used.

1.2 Background to the Study

Throughout the world, millions of students attending urban schools navigate through the challenges of their neighborhoods, just as I had done as a child, yet many enter the science classroom unprepared for success. I attribute this to the misalignment that exists between the students' world in the neighborhood and their world in the classroom. Ideally, students should be walking into the science classroom ready to be offered a rich, rewarding, and unique learning environment, as well as a content-loaded curriculum that fosters inquiry, real-world learning and self-reflection. Unfortunately, many urban science classrooms focus solely on the content that students need to master within an allotted period of time, while failing to recognize the importance of constructing an effective learning environment and utilizing students' experiences as a vehicle by which to teach science.

The ideal mentioned above does not exist in urban classrooms as statistics supporting an ever-increasing achievement gap in science between urban African-American and Latino students and their suburban white counterparts (Hursh, 2006) as well as between students from the United States and other economically developed countries (Miller & Warren, 2011) constantly linger in the minds of science educators, researchers, administrators, parents, politicians, and a variety of other stakeholders. According to data from the National Center for Education Statistics (NCES) (2006),

attempts at closing these achievement gaps have thus far been unsuccessful. In New York State, it has been reported that minority students in urban areas take fewer science classes and perform worse on standardized science examinations than do their peers in more affluent, suburban schools (Kadamus, 2005). One such example can be seen in the Bronx, one of the sites of this research where the passing rate (grade of 65 and above) for the Living Environment (Biology) Regents Examination is at about 55% compared with an average passing rate of about 85% in neighboring, and more affluent, Westchester County (*New York: The State of Learning, A Report to the Governor and the Legislature on the Educational Status of the State's Schools*, 2005). At the International School of Dresden in Dresden, Germany, another site of this research, the passing rate for the International Baccalaureate Diploma Programme Biology Examination is nearly 100%.

In 2011, the National Center for Education Statistics (NCES) released the report *Comparative Indicators of Education in the United States and Other G-8 Countries: 2011*. This report, a synthesis of four primary sources comparing educational systems across the globe, further elucidates the growing achievement gap, not only within the United States, but between the United States and countries that are the world's most economically developed and among the United States' largest economic partners (Miller & Warren, 2011). While countries such as Italy, Japan, and the United Kingdom are included in this report, I have limited the comparison to Germany and the United States. On average, 15-year-old students in the United States scored lower than their peers in Germany on the combined science literacy scale and on each of the three science literacy subscales of identifying scientific issues, explaining phenomena scientifically, and using scientific evidence (Miller & Warren, 2011). Further, approximately, 18% of 15-year-old students in the United

States, compared to 15% of German 15-year-old students, scored below the lowest proficiency level on the 2009 Program for International Student Assessment (PISA) test, a test designed to assess how well students can apply scientific content to real life situations. Similarly, only 9% of 15-year-old students in the United States, compared to 13% of German 15-year-old students, scored above the highest proficiency level on the 2009 PISA test (Miller & Warren, 2011).

As I considered the differences in achievement between 15-year-old students in Germany and the United States on the 2009 PISA test, as outlined in the previous paragraph, I was able to grasp that finding a single root cause for the low achievement of urban minority students in the United States is not possible because of the multifaceted nature of urban science education. Factors such as less resources, a greater number of inexperienced teachers, and lower funding play a part (Barton and Yang, 2000); however, these cannot be solely responsible for the low achievement of students in urban science classrooms in the United States. After all, the United States, as a whole, had higher figures in comparison to Germany in the categories of teachers' working time, amount of teacher professional development in science, and annual education expenditure per student (OECD, 2011), yet American students scored poorly on the 2009 PISA test.

The comparisons illustrated in this section help to shed light on two issues. The first of these issues is the widening achievement gap in science between urban minority students and their suburban, generally white, counterparts within the United States. The second being the widening gap in science achievement between the United States and Germany, regardless of being classified as urban or suburban. I bring these comparisons up again because often the urban poor in the United States are directly blamed for their academic struggles and disinterest in science. Past

research has generally tied the low achievement rate for urban minority students with issues related to character traits or dispositions associated with being poor that cannot be divorced from a lack of success in school (Perry, Steele, & Hilliard, 2003). This raises the question: If the United States is wealthier than Germany (OECD, 2011) and spends more on education per student (OECD, 2011), then why are students not performing as well on international science assessments? While my goal in this thesis is not to tackle this question head-on, I ask it to reaffirm my stance that, in addition to poorer resources, inexperienced teachers, and lower funding in urban schools, there must be other factors that contribute to urban students' poor achievement in science. Thus, there is a need to investigate current practices and trends in the science classroom that often label urban students as disinterested.

1.3 Statement of the Problem

There are varying operational definitions of what constitutes an effective learning environment. Giroux describes an effective classroom as one where students “can analyze their own lived relations and experiences in a manner that is both affirmative and critical” (1997, p. 108). Goodson describes an effective learning environment as one in which the “teacher and students look together at a topic, each presenting to the other his own perception of it, both feeling their way through dialogue towards a common perception” (1998, p. 36). Based on these definitions, my interpretation of an effective learning environment is one which allows learning to occur through the sharing of experiences and by empowering students to teach each other. It is a classroom model that focuses primarily on interpersonal relationships, community, and the collective development of the group.

Unfortunately, current practices in urban science classrooms often deter students from taking ownership of their learning and, instead, mimic much of the United States' educational history in which classrooms functioned as "large impersonal factory-modeled schools with rigid tracking systems to teach rudimentary skills and unwavering compliance to children of the poor" (Darling-Hammond, 1997, p. 17). Rather than using a strengths-based model that explores using students' talents and interests, existing research often views the performance of urban African-American and Latino students in science using a traditional deficit-based model that focuses on what students are unable to do. Unfortunately, this type of research does not do much to help to raise the amount of useful learning that occurs in an urban science classroom. Rather, it perpetuates the idea that there is a true intellectual deficiency between African-American and Latino students and their white counterparts, and it further marginalizes urban science students.

This study is based upon research involving learning environments, student attitudes and reality pedagogy. A brief history regarding the development of the field of learning environments can be found in Chapter 2, Section 2.2. Research pioneers in this field have developed a range of questionnaires which have proven useful in gaining insight into how students perceive the classroom learning environment. The creation and validation of the most significant questionnaires associated with this study are presented in Chapter 2, Section 2.3. The study of student attitudes is a bit more complex, and unlike the construct of a 'learning environment', researchers do not have an agreed-upon definition from which to work. Hence, for this study, I have adopted the definition of 'attitude' based on ideas presented by Thurstone (1928), whose views and ideas regarding 'attitude' are expanded upon in Chapter 2, Section 2.5. While 'learning environment' and 'student attitudes' are different constructs, a

number of questionnaires have also been developed to assess student attitudes. Section 2.5 provides a description of the primary tool that I used to assess student attitudes toward science, along with past studies that support its reliability and validity. Further, this study draws upon previous research supporting reality pedagogy (Chapter 2, Section 2.7) as a useful and relevant teaching tool (Beers & LaVan, 2005; Emdin, 2007a, 2009; Seiler, 2001). An exploratory approach nested in an interpretive paradigm was used to investigate what can be birthed through the utilization of reality pedagogy as it was implemented across contexts, namely, classrooms in Dresden, Germany and the Bronx, New York. Further, throughout the research, my stance that successful science teaching involves an understanding of how students make sense of their classroom by examining events and experiences which occur outside the classroom, became more and more apparent (Exley, 2008).

Using this framework as a basis, the research reported in this thesis was guided by four overarching research questions:

1. Is the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) valid when used with samples in Dresden, Germany and the Bronx, New York?
2. Is the implementation of reality pedagogy in science classrooms effective in terms of changes in (a) student perceptions of their learning environment and (b) student attitudes? Why?
3. Are there differences between science students from the Bronx and Dresden in terms of (a) their classroom learning environment perceptions and (b) attitudes to science? If so, how can these differences be explained?

4. Is there a relationship between students' perceptions of their learning environment and their attitudes toward science? If so, how can this relationship be explained?

1.4 Significance of the Research

It is my intention that this research has theoretical, methodological, and practical implications for the fields of reality pedagogy, urban science education, and classroom learning environments.

This study is unique in that it marries the three distinct research areas of classroom learning environments, student attitudes, and reality pedagogy. The study of learning environments is relatively new and has only emerged as a field of inquiry within the past 40 years. Research involving classroom learning environments most often has investigated students' perceptions of their classroom learning environment. As described earlier, student attitudes are a bit more difficult to describe, but it is important to note that a student's attitude toward science is able to be altered when exposed to the appropriate experiences, such as engagement with reality pedagogy. The effectiveness of reality pedagogy, a strategy of teaching that involves gaining insight into students' culture, actions, attitudes, and performance, was evaluated using a classroom learning environment and student attitudes framework adapted from previous classroom learning environment and student attitude studies. Thus, the theoretical significance of this research lies in the conjoining of these fields within a single study in an attempt to set a precedent for further research.

My research also affirms the existence of various methodological protocols that were brought together to establish the foundation required for addressing the research questions. One such protocol focuses on the validity and reliability of a

combination of questionnaires used in science classrooms in Dresden and the Bronx as tools to explore student perceptions of the learning environment, as well as student attitudes toward science. Further, this research is methodologically significant because it is one of few studies that compared classroom learning environments across national borders. It explored a wide range of students, urban and international, as opposed to conducting research with a small, confined sample, thus offering “much promise for generating new insights” (Aldridge, Fraser, & Huang, 1999, p. 48). Finally, this research is significant because it combined quantitative and qualitative methods for obtaining data, in order to “maximize the potential of research on learning environments” (Tobin & Fraser, 1998, p. 623).

Hopefully, my research will dispel myths that urban youth are unable to be successful in science and shift the focus to criticizing and transforming the current trends and practices used to teach science to traditionally marginalized students. Along this strand, the practical significance of this research lies in using reality pedagogy and classroom questionnaires to allow traditionally marginalized students greater access to science content and to demonstrate that they too can be successful in a subject traditionally not accessible to them. Finally, this study could have practical implications for higher education teacher preparation programs by encouraging and highlighting the usefulness of reality pedagogy as a relevant tool for science educators.

1.5 Overview of Methodology

This study uses a mixed-methodology research design in which classroom action research, classroom observations, student interviews and questionnaires were utilized to collect qualitative and quantitative data, respectively. Creswell (2008, p.

552) explains that “the use of both quantitative and qualitative methods, in combination, provides a better understanding of the research problem and questions than either method by itself.” Further, because of the nature of the research problem, using a mixed methodology can allow researchers to “develop a complex picture of social phenomenon” (Greene & Caracelli, 1997, p. 7).

This study extended over one academic year (August 2010 to June 2011) and utilized an exploratory approach that investigated grade 8–10 science classrooms for two distinct populations: Bronx, NY and Dresden, Germany. I selected students at these grade levels because they comprised the majority of the students whom I had ever taught and because of my belief in the importance of establishing and maintaining science interest during a student’s high school career. The first sample consisted of 60 urban science students in grades 9–10 attending a high-needs school in the Bronx borough of New York City. The Bronx is one of the five boroughs that make up New York City. The physical setting of the Bronx can be described as a mural depicting the struggles and successes of individual neighborhoods. Parts of the Bronx are comprised primarily of government housing developments, while others are shoddy single-family homes. Parts enjoy comfortable levels of safety and security, while others have some of the highest crime rates in New York City. Parts have a grassy park to walk through, while others contain no more than a concrete jungle. The Bronx landscape is very diverse, but the students who comprise its schools are less diverse. The student population of this high-need school is predominantly Latino and African-American. A large percentage of these students qualify for free or subsidized lunch, indicating the low socioeconomic status of the neighborhood. Data from this high-need school was obtained with the assistance of a colleague from Teachers College, Columbia University.

The second sample consisted of 82 science students attending the International School of Dresden (ISD), located in Dresden, Germany. Dresden, the capital of Saxony, a German state, can be described as a tapestry of culture. After being left in rubble following bombing in World War II, Dresden was rebuilt and is often referred to as the ‘Silicone Valley’ of Germany for the many computer-related companies having their headquarters or training centers there. Dresden is also referred to as the ‘Florence of Germany’, famous for the Semperopera house and the Zwinger Museum. ISD has approximately 300 students enrolled between grades 6 and 12 and is also located in an urban setting, with the majority of students living in the surrounding suburbs. Students come from a range of countries including Germany, the United States, Australia, Japan, Austria, and Singapore. The sample was one of convenience because I was teaching science at ISD at the time of the study.

In this exploratory study, I took note of the important roles that students play in the classroom and thus utilized them as sources of data, interpreters of data, and sources of change. Each student completed the QuALESA at the beginning (August 2010) and end (June 2011) of the study, thus providing a quantitative source of data. The data collected with the QuALESA underwent validity and reliability testing to ensure that the scores obtained were stable and consistent from one trial to another (Creswell, 2008).

This study also used cogenerative dialogues, semi-structured interviews, and classroom observations made by video and audio recordings of urban-American and German-international science classrooms. These data sources comprised the qualitative component of the study and helped to explain events that were not apparent or obvious through use of the QuALESA (Emdin, 2007a). The data from these sources are presented in Chapter 5 in the form of vignettes that illustrate

potential transformative teaching and learning practices, as well as changes in the learning environment and student attitudes toward science.

The analysis and interpretation of the qualitative data were performed in a manner that minimized threats to rigor and thus focused on the validity and reliability of the data. A quality standard for the qualitative sources of data involved member checking, a procedure in which the participants were given the opportunity to interpret their own actions. The participants then either accepted their actions as being correctly interpreted by the researcher or were given the opportunity to explain the events, thus leading to a reinterpretation. Member checking provided the study with a more accurate representation of the interpretation of qualitative data as researchers can have the tendency to include their biases or to over-interpret an event (Creswell, 2008; Guba & Lincoln, 1989).

1.6 Delimitations of the Study

Regardless of the type of research being conducted, there always exists some degree of bias and invalidity. Fortunately, possessing an awareness of the sources of bias and invalidity allowed a preventive approach aimed at reducing the level of bias present and, thus, there is good reason to be confident that the results of this study are valid and appropriate. I have elected to present this section using two related categories, namely, the boundaries of the study and reasons why the findings might not be able to be applied generally.

The use of humans as research subjects presents certain challenges and limitations. Often, these challenges can be reduced with the selection of an appropriate sample size. The research described in this study was delimited to students in grades 8, 9, and 10 in the International School of Dresden (ISD) in

Dresden and grades 9 and 10 in Bronx High School (BHS) in the Bronx. The participants from both schools make up a relatively small sample size particularly when compared to the total size of the student population in New York City and in Dresden. While the sample was fairly small, it was large enough to permit appropriate data analyses without causing the findings to be invalidated. Further, the demographics of each of these classes are fairly representative of the overall demographics of the school and, in the case of BHS, the overall demographics of the region. However, the sample from ISD is not consistent with many other high schools in the area, but it is comparable to other international schools located throughout Germany. Therefore, caution is justified in generalizing the findings of my study to broader groups of students.

In addition to issues related to sample size and representation, it must be recognized that, as the researcher, I also had the potential of infusing the research with my particular bias. At the beginning of this chapter, I presented my experiences as a child, teacher, and researcher as a means by which to establish my allegiance to urban schools and to science education. While there is the possibility that each of these roles has instilled in me a certain amount of bias, I make no apologies for my experiences. Rather, I utilize the authenticity criteria outlined by Guba and Lincoln (1989) to avoid placing my expectations on the data and to ensure that my research was authentic for all research participants and consumers of this research.

During the span of the research, I resided in Dresden, Germany. Therefore, issues with standardizing procedures associated with data gathering might have arisen because data collected in the Bronx were primarily collected by the individual teacher. Prior to the commencement of the research, guidance and suggestions were shared with the teachers in the Bronx as a means by which to standardize the process

for distributing and collecting data. While this could have led to a variety of methods of questionnaire distribution and collection, I do not believe that the integrity of the data collected was compromised.

As I proceed with the coming chapters, the reader might encounter a certain discourse that is unfamiliar. Some of the terms used are either relatively new in the field of science education research and have not gained general currency or they are general and I wish to use them in a rather specific way. Therefore, in an attempt to allow a fluid reading of the thesis, below are definitions for a variety of terms that the reader might find useful.

Communal: A way of knowing and being that focuses primarily on interpersonal relationships, community and the collective betterment of a group as the fundamental tenet.

Corporate: A way of knowing and being that focuses primarily on a factory or production model for social life. The primary goals are maintaining order and achieving specific, usually quantitative, results.

Reality Pedagogy: A pedagogical practice that involves a merging of the multiple approaches to effective science teaching and learning into a more cohesive and implementable pedagogical approach. It is nested between critical pedagogy and culturally relevant pedagogy – in the sense that it takes tenets from each of those approaches into consideration in the design of lessons and the creation of effective learning environments.

1.7 Chapters in the Thesis

The work described here is a fusion of experience, thought, theory and research presented as a mixed-methods ethnographic study of science teaching and learning in two schools in the Bronx and Dresden. Chapter 1 provided the reader with the background, rationale, design, significance, and delimitations of the study. Each of the chapters that follow expounds the conceptualization, design, implementation, findings, and conclusions of the study.

Chapter 2

In this chapter, I review literature relevant to my study. The literature review is organized into the following sections: history of the field of learning environments; classroom learning environment instruments; types of research involving classroom environment instruments; student attitudes; effective teaching and learning environments; and reality pedagogy. Chapter 2 explores the development of the field of classroom learning environments, the variety of available learning environment and student attitude questionnaires – including the What Is Happening In this Class? (WIHIC) questionnaire (Fraser, Fisher & McRobbie, 1996), Constructivist Learning Environment Survey (CLES) (Taylor & Fraser, 1991), and Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) – and the transformative nature of reality pedagogy.

Chapter 3

In this chapter, I discuss the design and implementation of the study. This chapter begins with an overview of my perspective on educational research in order to provide a better understanding for my selection of methods followed by a discussion

of the ethical implications of the research and a description of the data sources and samples. Further, the selection and subsequent modification of scales from the WIHIC, CLES, and TOSRA for use in my study are described. Also included are descriptions of the qualitative methods used in data collection, such as cogenerative dialogues, semi-structured interviews, and classroom observations made by video and audio recordings of urban-American and German-international science classrooms. The methods described above are grounded in an analysis of students' social life and ways of knowing and were being utilized in an effort to meet the goal of improving success in science. This section is followed by a description of the quantitative data analyses that were employed and which are presented in Chapter 4. Chapter 3 concludes with an in-depth discussion of the biases and limitations associated with the study.

Chapter 4

This chapter presents the results and subsequent analyses of the quantitative data collected through administration of the QuALESA, a questionnaire created from combining specific learning environment scales from the CLES and the WIHIC, and attitude scales from the TOSRA. This chapter reports the analyses of the data undertaken to answer each of the research questions for this study.

Chapter 5

In this chapter, I present insights based on the qualitative data collected from classroom observations, semi-structured student interviews, and cogenerative dialogues. These data were obtained in an effort to validate and provide further insight into some of the findings from the quantitative data analyses, including

changes in student perceptions of their learning environment associated with using reality pedagogy, as well as differences between science students from the Bronx and Dresden in terms of their classroom learning environment perceptions.

Chapter 6

In this chapter, I synthesize the main ideas and findings from throughout the thesis. The chapter helps bring the thesis to a close by describing and discussing the significance of the study, associated limitations and biases, implications of the findings and the next steps for this field of research.

Chapter 2

REVIEW OF THE LITERATURE

2.1 Introduction to the Chapter

A literature review serves several purposes, including, but not limited to, documenting how a study might add to existing literature, to provide evidence that a particular study is of relevance, sharing results of related past studies, and providing a foundation for comparing the findings of one's own research with results from previous studies (Creswell, 2008).

This chapter explores the theoretical and empirical literature pertinent to the three main areas of focus for this study: learning environments, attitudes toward science, and reality pedagogy. While these are the main foci, other supporting areas of research have been included to get a clearer and more holistic picture of the problem and literature. This chapter is thus broken down into the following sections: history of the field of learning environments (Section 2.2), classroom learning environment instruments (Section 2.3), types of research involving classroom environment instruments (Section 2.4), student attitudes (Section 2.5), effective teaching and effective learning environments (Section 2.6), and reality pedagogy (Section 2.7).

Prior to this study, other research combining the dimensions of social fields, learning environments, urban science education, and reality pedagogy had not been undertaken. Therefore, being familiar with the relevant literature pertaining to each

dimension is crucial for assembling a joint framework which can be used to make sense of the findings and address the following research questions:

1. Is the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) valid when used with samples in Dresden, Germany and the Bronx, New York?
2. Is the implementation of reality pedagogy in science classrooms effective in terms of changes in (a) student perceptions of their learning environment and (b) student attitudes? Why?
3. Are there differences between science students from the Bronx and Dresden in terms of (a) their classroom learning environment perceptions and (b) attitudes to science? If so, how can these differences be explained?
4. Is there a relationship between students' perceptions of their learning environment and their attitudes toward science? If so, how can this relationship be explained?

A keyword search associated with the above areas of study revealed further sub-topics which are present in the literature: achievement gap, co-teaching, social interactions, corporatization, community, constructivism, and differentiated instruction in the classroom. The literature review was completed with the use of the following sources: the Curtin University library electronic database, the Educational Research Information Center (ERIC), EBSCO host, JSTOR Journal Storage, City University of New York College Libraries, and the New York State Education Department website.

2.2 History of the Field of Learning Environments

This section of the literature review delves into the field of learning environments by a careful examination of its development through history. The study of learning environments is relatively new and has only emerged as a field of inquiry within the past 40 years. It stemmed from the foundation previously built by Lewin and Murray during the 1930s. Lewin (1936), a social psychologist best known for the development of field theory and the associated formula, $B = f(P, E)$, suggests that an individual's behavior at a given moment is a function of his/her environment at that moment along with the individual's personal characteristics. During this time period, Murray (1938) also conducted a study in which he exposed humans to a range of life-like stresses in order to observe their behaviors and reactions to the applied environment. At the conclusion of the experiment, Murray and his team compiled their observations in an attempt to reconstruct the subject's personality. Generalizations were also made regarding which specific environmental stresses would trigger a specific human behavior. Neither of the studies carried out by Lewin or Murray were directly tied to the exploration of the impact of the classroom environment on student learning outcomes. However, their findings laid the practical framework for future researchers to investigate the relationship between the environment and human behavior through an educational lens.

Since the 1960s, several researchers have investigated the relationship between behavior and the environment as laid out by their predecessors and have applied it to a variety of settings. During this time, it had become well established that there existed a relationship between human behavior and the environment. However, much of the research undertaken by personality theorists of the time focused more on the variables of their subjects rather than environmental variables. A

central idea of the time was that man was the active agent in a relatively passive environment (Moos, 1973). In stark contrast to this idea was the model proposed by Getzels and Thelen (1960) which viewed the classroom as a social system with the occurrence of numerous interactions among students, as well as between students and their classroom environment. Craik (1970), having noticed that the influence of the physical environment on behavior had received little study, began to investigate how changes of physical properties of an environment, such as heating, ventilation, layout and color, could influence behavioral measures, including social interaction and willingness to explore.

Research undertaken by Moos (1973) also addressed some of the deficiencies apparent in the research of his time. In his research, Moos (1973) described a minimum of six different, yet interrelated, perspectives that can be used to describe any given environment. These perspectives can include, but are not limited to, viewing an environment from its geographic location, its architectural (man-made) characteristics, its organization, the personalities of the people who already comprise it, and the social climate. One such example of the influence of the environment on human behavior has been described by Wolfgang (1958) who explored human behavior in relation to climate variables. He reported a positive correlation between the occurrence of homicides and hot weather during summer months. Moos (1974) extended his previous research by investigating the relationship of various human environments, particularly those of psychiatric hospitals, correctional institutions, military basic training companies, and university residences, and how these environments were perceived by the actors within them.

Moos was not the only researcher making contributions to the field of learning environments during this time. Work undertaken by Mitchell (1969) and Stern (1970)

also contributed to our current understanding of the relationship that exists between a person and his/her environment. Mitchell (1969) was able to conclude that, by carefully observing how individuals interact with their environment, their behavior during similar circumstances in the future can be predicted. Stern (1970), drawing on Murray's work, took it a step further and introduced a theory of a person-environment fit. The basic premise of this theory is that one cannot understand the process of development without first understanding the joint contributions of both the person and his/her environment. In addition, he specified that the achievement of desired student outcomes can be enhanced if the environment that is being provided fits the personal needs of the individual.

Soon after, learning environments began to be viewed through an economic perspective. Walberg (1981) proposed a model of educational productivity in which learning outcomes are a function of the various factors that comprise the environment. He proposed that, by investigating economic models such as those in agriculture and industry, the academic achievement of students can be explained and even predicted. In a mathematical sense, Walberg (1981) proposed that learning is a function of many variables, including student ability and motivation, instructional quantity and quality, home and classroom environments, and age. He argued that, if any of these factors is either absent or not fully developed, the learning of a child is greatly reduced because learning is a multiplicative function of all these factors.

2.3 Classroom Learning Environment Instruments

This section of the literature review examines how the research pioneers of this field have developed a range of questionnaires which have proven useful in gaining insight into how students perceive the classroom learning environment. Our

ability to study learning environments has been enhanced by the creation and validation of a variety of questionnaires. Implementation of questionnaires in research about learning environments has provided researchers with a powerful new tool: the ability to investigate the classroom learning environment through the eyes of the participants or milieu inhabitants (*beta press*) rather than the eyes of an external observer (*alpha press*) (Murray, 1938). According to Fraser (1986), a 'classroom learning environment' is defined as the shared perceptions of the students and the teachers in a particular environment. Any environment can be broken down into two primary features: the physical space and the interactions of individuals within that space. Typically, learning environment researchers have shown the greatest interest in investigating the relationships among students as well as relationships between students and teacher in the classroom. This trend began with the Learning Environment Inventory (LEI) in the late 1960s and has expanded greatly since then. Because many other classroom learning environment instruments have emerged since then, those most relevant to the issues in this thesis are overviewed in Table 2.1 and described below.

The LEI was originally developed in the late 1960s in conjunction with evaluation and research related to Harvard Project Physics (Walberg & Anderson, 1968). The LEI was developed to allow students to assess their own learning environment (social climate) because teacher observations had proven inconclusive at the time and it was believed that social environment is a chief psychological determinant of academic learning (Fraser, Anderson & Walberg, 1982). The LEI was born out of an initial questionnaire, the Classroom Climate Questionnaire, which was successfully field tested, yet found to have some shortcomings related to its unsuitability for extensive research studies and, more importantly, the presence of a

Table 2.1 – Scales from Eight Learning Environment Instruments for Secondary/Higher Education Settings Classified According to Moos' Scheme

Instrument	Year Developed & Author(s)	Items per Scale	Scales Classified According to Moos' Scheme		
			Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	1968 Walberg & Anderson	7	Cohesiveness Friction Favoritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganization Democracy
Classroom Environment Scale (CES)	1974 Moos	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organization Rule Clarity Teacher Control Innovation
Individualised Classroom Environment Questionnaire (ICEQ)	1979 Rentoul & Fraser	10	Personalization Participation	Independence Investigation	Differentiation
College and University Classroom Environment Inventory (CUCEI)	1986 Fraser & Treagust	10	Personalization Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualization
Questionnaire on Teacher Interaction (QTI)	1990 Creton, Hermans, & Wubbels	8-10	Helping/Friendly Understanding Dissatisfied Admonishing		Leadership Student Responsibility and Freedom Uncertain Strict
Science Laboratory Environment Inventory (SLEI)	1995 Fraser, Giddings, & McRobbie	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	1991 Taylor & Fraser	7	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In this Class? (WIHIC)	1996 Fraser, Fisher, & McRobbie	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity

Table adapted from Fraser (2012)

number of weak scales. Development of the LEI addressed these two concerns. Fraser, Anderson, and Walberg (1982) analyzed LEI data using internal consistency reliability and discriminant validity methods and found the instrument to be reliable and valid. Further, the LEI contained 15 climate scales, which had already been found to be relevant as predictors of the social climate within a classroom (Fraser, Anderson & Walberg, 1982). The 15 scales of the learning environment explored by the LEI are cohesiveness between students, diversity of interests, formality of rules, speed of instruction, material/physical environment, friction between students, student goal direction, favoritism from the teacher, difficulty of content, apathy to failure, democracy in decision making, frequency of cliques in the classroom, student satisfaction, disorganization of the teacher, and competitiveness among students (Fraser, Anderson & Walberg, 1982). A major finding associated with the use of the LEI was that student perceptions of the learning environment were a significant factor in determining student achievement beyond general academic ability. Students who viewed their learning environment positively and indicated so when responding to the LEI, had greater academic success, had better attitudes toward the subject matter, and engaged more often in non-required activities related to the subject matter (Walberg, Singh & Rasher, 1977).

During the 1970s, Moos (1974) wrote extensively about the development of methods for the systematic description and classification of environments, in part, because of a number of studies that demonstrated substantial differences in the behavior of the same individual when placed in different environments. Guided by this background, Moos investigated human behaviors in a variety of environments, not all of which were formal learning situations. Examples of such environments included psychiatric hospitals, correctional institutions, military basic training

companies, and university residences. Moos' findings, including his argument that three overarching categories are responsible for the characterization of difference psychosocial environments (Moos, 1974), led to the development of the Classroom Environment Scale (CES) (Trickett & Moos, 1973). The final version of the CES consisted of nine dimensions, each aligned with one of Moos' three general categories: Relationship Dimension, which measures the nature and intensity of personal relationships; Personal Development Dimension, which measures the directions in which personal growth and self-enhancement occur; or the System Maintenance and Change Dimension, which measures the extent to which the environment maintains clear objectives and control and responds to change (Aldridge, Fraser, & Fisher, 2003). The nine dimensions assessed by the CES are Involvement, Affiliation, Teacher Support, Task Orientation, Competition, Order and Organization, Rule Clarity, Teacher Control, and Innovation (Trickett & Moos, 1973). Many of these dimensions have been found to be important qualities of the classroom learning environment and, thus, can also be found in more contemporary classroom environment instruments. Trickett and Moos (1973) analyzed the CES for intercorrelations among the subscales and discriminant validity and found the instrument to be valid and reliable. Another study by Fisher and Fraser (1983) further validated the use of the CES for samples in Australia. Major findings associated with the use of the CES pointed to significant relationships between classroom environment and student satisfaction and moods (Trickett & Moos, 1974) as well as student absences and grades (Moos & Moos, 1978).

As researchers began to better understand the psychosocial dimensions of classroom learning environments, it became clear that there were differences between the learning environment of a conventional classroom and the learning environment

of an inquiry-based or individualized classroom. Hence, Rentoul and Fraser (1979) developed the Individualised Classroom Environment Questionnaire (ICEQ) as an extension from the LEI to measure learning environment dimensions which differentiate conventional classrooms from individualized ones through students' and teachers' perceptions of their classrooms. After field testing, a total of five dimensions appeared on the final version of the ICEQ: Personalization, Participation, Independence, Investigation, and Differentiation (Fraser, 1990). Data collected from initial administration of the ICEQ were analyzed through internal consistency and discriminant validity methods and supported the validity and reliability of the ICEQ for use in assessing the learning environment of inquiry-based classrooms (Rentoul & Fraser, 1979). Fraser and Fisher (1982) used and further validated the ICEQ in a study aimed at predicting students' outcomes from their perceptions of their classroom learning environment.

The previously-mentioned learning environment instruments have primarily been used to assess the climate of secondary classrooms, thus prompting Fraser and Treagust (1986) to develop the College and University Classroom Environment Inventory (CUCEI) to examine the learning environments of small tertiary education classrooms also referred to as seminars. Because of similarities between such seminar-type classrooms and high school classrooms, the CUCEI was developed to be consistent with prior secondary school learning environment instruments. Thus, many of the seven scales included in the CUCEI (Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation, and Individualization) stem from scales which already were considered to be relevant as predictors of student outcomes within the secondary classroom (Fraser & Treagust, 1986). The CUCEI was validated as a learning environment instrument using internal consistency and

discriminant validity methods performed on data collected from higher education institutions in Western Australia and Illinois, USA (Fraser & Treagust, 1986). Nair and Fisher (2001) used the CUCEI to investigate the transition of senior secondary school students to higher education institutions and found that students perceived their classroom more negatively when they moved from the lower level of schooling to the higher level.

The Questionnaire on Teacher Interaction (QTI) was developed in the 1980s to investigate students' and teachers' perceptions of interpersonal teacher behavior (Wubbels & Brekelmans, 2012). Wubbels and Brekelmans (2005) describe interpersonal teacher behavior as behaviors that are expressed between the teacher and students during personal communication in the classroom. The QTI was developed from prior work on personality and communication and relies on two overarching dimensions of teacher behavior, namely, a proximity dimension (cooperation – opposition) and an influence dimension (dominance – submission) (Leary, 1957). These two dimensions are represented as a system of axes and further divided into eight equal sections, each of which identifies a specific teacher behavior. The eight teacher behaviors measured by the QTI are Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing, and Strict (Wubbels, 1993). The QTI has been used extensively to investigate interpersonal teacher behaviors and has thus been validated as a learning environment instrument a number of times (den Brok et al., 2003; Fisher & Rickards, 1998; Goh & Fraser, 1996; Newby, Rickards, & Fisher, 2001; Wubbels & Levy, 1993).

The QTI has been used in a variety of countries and translated into several languages other than Dutch, the language in which the QTI was originally created.

Other languages into which the QTI has been translated include English, French, German, Hebrew, Russian, Slovenian, Swedish, Norwegian, Finnish, Spanish, Mandarin Chinese, Singapore Chinese, and Indonesian (Wubbels & Brekelmans, 2012). Further, researchers have also developed an economical short version and a student version of the QTI to accomplish the aims of their studies (Wubbels, 1993). In 2006, den Brok, Brekelmans, and Wubbels conducted a study comparing the structure of the traditional QTI with the structure of a version of the QTI modified to measure teachers' relations with individual students. This was in contrast to many traditional studies involving the QTI, which generally explored student perceptions about the relationship of the teacher with the students as a class. Den Brok, Brekelmans, and Wubbels (2006) concluded that, generally, teachers were perceived to have more Influence and more Proximity in their relations with individual students than with the entire class. The QTI was also used by Brekelmans, Wubbels, and van Tartwijk (2005) to study the effect of teacher experience and age on teacher communication style. The researchers reported that, according to students, teachers' behaviors with regard to the influence dimension changed greatly during the first six years of their professional career. Further, teachers' behaviors on the proximity dimension remained consistent until the tenth year of teaching, when they waned slightly. Overall, using these two pieces of evidence, the researchers were able to suggest that teachers with about 6–10 years of experience had the best relationships with their students in terms of promoting student achievement and positive attitudes.

In Australia, the QTI was used to investigate how closely aligned are students' perceptions of their teacher's interactions and the teacher's perception of his/her interactions. Results of the study indicated differences between the perceptions of teachers and their students. Teachers believed that they demonstrated more leadership

and helping/friendly behavior than their students thought. There were also differences in teacher actual and ideal perceptions, suggesting that teachers perceived ideal teacher interactions as being more positive than they actually were (Rickards & Fisher, 2000).

Another study conducted in the Netherlands explored relationships between interpersonal teacher behavior and student achievement and attitudes. The study concluded that interpersonal teacher behavior accounted for a large amount of the differences in achievement even though the students in the various classes had the same ability levels. The study also suggested that, while differences in academic outcomes might be due to the use of different curricula, or to the age or experience of the teacher, it is necessary to consider interpersonal teacher behavior as a factor (Wubbels, 1993). Both of these studies, as well as a similar study by Levy, Rodriguez, and Wubbels (1992), suggest that teachers who practice behaviors associated with being strict, show leadership, and are friendly are likely to achieve positive academic outcomes.

Previous classroom learning environment instruments had been developed and used to measure dimensions of the general classroom. However, science courses are unique in that they are affiliated with laboratory experiences that require different methods of instruction. The Science Laboratory Environment Inventory (SLEI), an extension of the LEI, was developed by Fraser, Giddings, and McRobbie (1992, 1995) to assess a specific classroom learning environment, in this case, laboratory classrooms at the upper-secondary and higher-education levels. According to Fraser, Giddings, and McRobbie (1992, p. 1), this new tool was intended to provide researchers with “feedback about students’ views of laboratory settings and to investigate the impact of laboratory classes on student outcomes.” The SLEI boasts

five scales to assess the science laboratory environment: Student Cohesiveness, Open-Endedness, Integration, Rule Clarity, and Material Environment (Fraser, Giddings, & McRobbie, 1992; 1995). Data collected from a sample of 5,447 students in 269 high school and university laboratory classrooms across Australia, USA, Canada, England, Israel, and Nigeria were analyzed through factor analysis, internal consistency and discriminant validity methods. Results from these analyses indicated that the SLEI had satisfactory validity and reliability for assessing the science laboratory environment (Fraser, Giddings, & McRobbie, 1991, 1995), prompting researchers to use the SLEI to assess the science learning environment in numerous countries including Singapore (Wong & Fraser, 1996), Korea (Fraser & Lee, 2009), Tasmania (Henderson, Fisher, & Fraser, 2000), and the United States (Lightburn & Fraser, 2007).

The final two instruments listed in Table 2.1 are the Constructivist Learning Environment Survey (CLES) and the What Is Happening In this Class? (WIHIC) questionnaire. As these two surveys were used in my research, it was appropriate that a more extensive review of them be provided. Thus, the literature relevant to the history, formulation, validation, and use of these two surveys follows in the next two sections (Sections 2.3.1 and 2.3.2). In these next sections, it is apparent that both of these surveys have a strong factor structure, have proven reliability in a variety of global classroom settings and in a variety of languages, and offer quick and effective ways of assessing students' perceptions of the classroom learning environment. For these reasons, the CLES and WIHIC were selected as the two classroom learning environment questionnaires from which scales were taken for inclusion in the final instrument used in this study (see Chapter 3, Sections 3.6.1.1 and 3.6.1.2).

2.3.1 *Constructivist Learning Environment Survey (CLES)*

Taylor and Fraser (1991) developed the Constructivist Learning Environment Survey (CLES) in the early 1990s as a means of assisting “researchers and teachers to assess the degree to which a particular classroom’s environment is consistent with a constructivist epistemology, and to help teachers to reflect on their epistemological assumptions and reshape their teaching practice” (Fraser, 2007, p. 107). In developing the CLES, a means by which innovative teaching methods could be assessed, was introduced. Particularly, the CLES was developed with the understanding that, in order for students to learn, they must play an active role in their learning and thus, as described by Dorman and Adams (2004), engage in a cognitive process in which they marry existing knowledge to the world around them.

The CLES boasts five scales with a total of 36 items: Personal Relevance, Uncertainty, Critical Voice, Shared Control, and Student Negotiation (Fraser, 2007). The CLES has five frequency response alternatives namely, Almost Never, Seldom, Sometimes, Often, and Very Often. A small number of the items are scored in the reverse manner. The CLES presents these items in blocks with the first set of items referring to Personal Relevance, the second set referring to Uncertainty of Science, and so on. The scales are unique in that they are useful in determining whether specific dimensions of a constructivist classroom exist and provide a basis for the investigation of the usefulness of an innovative teaching method (Nix, Fraser, & Ledbetter, 2005).

Researchers have used the CLES to measure students’ perceptions of constructivist learning environments in classes in science, mathematics, humanities, English, and in classes with an emphasis on the use of technology to deliver the curriculum. The CLES has also been used to numerous times to evaluate the

effectiveness of education reforms, innovative curricula, and teacher development programs. Additionally, the CLES has been translated into various languages and used in cross-national studies designed to account for culture and language differences when comparing constructivist learning environments in different countries. Examples of such studies and others are presented in this section.

In Texas, Dryden and Fraser (1998) cross-validated the CLES among a sample of 1,600 students in 120 grade 9–12 science classes. In this study, the CLES was used to assess the success of an urban reform initiative aimed at promoting constructivist teaching and learning in high school science classrooms.

In Korea, Kim, Fisher, and Fraser (1999) translated the CLES into Korean and used the newly-translated version to investigate the extent to which a new general science curriculum, reflecting a constructivist view, influenced the learning environment in grade 10 science classes. The Korean version of the CLES was found to be valid and reliable. Further, students in grade 10 science classes perceived a more constructivist learning environment than grade 11 students who had not been exposed to the new curriculum, suggesting that efforts at curriculum reform had produced some changes in student perceptions of the learning environment.

Also in Korea, Lee, Fraser, and Fisher (2003) used a combination of the QTI and the CLES in a study inspired by the desire to move Korean education away from being examination driven and towards the use of a constructivist approach in the Korean curriculum. The objectives of the research were to describe the way in which students perceived their interactions with their teacher, to determine the degree to which students felt they were being immersed in constructivist approaches, and to compare the emphasis on constructivist approaches for the three different streams of humanities, science oriented, and science independent. The study replicated the

original five-factor structure of a Korean-language version of the CLES among 440 grade 10 and 11 science students in 13 classes and revealed significant differences between how students from the different streams perceived their learning environment. Students in the science-independent stream perceived their class more favorably than did students from the other streams. In addition, a constructivist epistemology seemed to be apparent primarily in classes of students in the science-independent stream.

Wilks (2000) modified the CLES by adding two scales, Political Awareness and Ethic of Care, to create the GPCLES. The GPCLES was used with students studying English (referred to as General Paper) in junior college in Singapore. The modified survey was administered to 1046 students in 48 classes to assess the degree to which the learning environment of General Paper classes complement the educational ideals and objectives of constructivism. The GPCLES displayed good factorial validity and internal consistency reliability, thus confirming its validity as an effective instrument for assessing constructivist dimensions in a classroom learning environment.

Aldridge, Fraser, Taylor, and Chen (2000) translated the CLES into Chinese for use in Taiwan and then in a cross-national study of high school science classrooms, administered the English version to 1,081 students in 50 classes in Australia and 1,879 students in 50 classes in Taiwan. Data analysis supported each scale's internal consistency reliability, factor structure and ability to differentiate between classrooms for the CLES in both languages. A comparison of CLES scale mean scores in two countries revealed that Australian students perceived more Critical Voice and Student Negotiation and less Personal Relevance, Uncertainty and Shared Control than students in Taiwan.

Aldridge, Fraser, and Sebela (2004) used a slightly modified version of the CLES to investigate constructivism in mathematics classrooms in South Africa and to provide feedback to teachers engaged in action research aimed at promoting constructivist teaching and learning. The CLES was modified by making slight changes in wording to accommodate use in mathematics classes as well as to ensure understanding by South African students. The CLES was administered to 1,864 students in 43 intermediate and senior classes in South Africa, and was found to be a valid and reliable instrument for that population and for mathematics classes. Further, the CLES was viewed as a good tool to use in providing feedback to teachers as posttest scores indicated notable improvements in students' perceptions of the learning environment after the teacher had engaged in the activities outlined in the feedback.

In Minnesota, Johnson and McClure (2004) investigated the use of the CLES as part of a longitudinal study for providing insights into the classroom learning environments of beginning science teachers. In the first year of the study, the CLES was administered to 290 upper elementary, middle, and high school science teachers and preservice teachers. Exploratory factor analysis and internal consistency reliability analysis, as well as examination of each item and of participants' questions and comments about them, led to a shortened, revised version of the CLES. The five original scales were retained, but the number of items in each scale was reduced from six to four, the single negatively-worded item was eliminated, and some of the other items were reworded. The revised second-generation CLES consisted of a total of 20 items, thus giving rise to the new questionnaire named, CLES 2(20). Throughout the four years of the study, the CLES 2(20) was given to teachers and their students and,

in most cases and for all scales, teachers' perceptions of the classroom environment were more positive than were those of their students.

In 2004, Oh and Yager, used the previously developed and validated Korean version of the CLES as part of an action research project which involved creating constructivist learning environments in grade 11 earth science classes. The Korean version of the CLES was administered to a sample of 136 Korean students in a longitudinal study of the development of constructivist classrooms and students' attitudes. Researchers uncovered improvements in students' responses to CLES items over the course of the study. Additionally, the study revealed that students' attitudes to science became more positive as their classrooms became more constructivist (Oh & Yager, 2004).

A modified version of the CLES, the Comparative Student Form of the Constructivist Learning Environment Survey (CLES-CS), was designed for secondary school students and is useful in that it has students compare two classrooms: THIS classroom environment referring to the student's current class; and OTHER classroom environment referring to other classes at the same school (Nix, Fraser, & Ledbetter, 2005). The CLES-CS utilizes the same scales as the CLES but differs slightly in its format. The CLES-CS is designed with two response blocks, each with the same items, presented in side-by-side columns to illustrate the comparative nature of the survey (Nix, Fraser, & Ledbetter, 2005). Nix, Fraser, and Ledbetter (2005) used the CLES and the newly-constructed CLES-CS to investigate the effectiveness of an innovative teacher development program in increasing the degree to which the principles of constructivism are evident in the classroom in Texas, USA. The researchers sampled 1079 students in 59 classes taught by 12 teachers, from eight public schools and two private parochial schools. Students of teachers who were a

part of an innovative teacher development program aimed at increasing levels of constructivism in the classroom perceived their learning environment more favorably than did students of teachers who were not part of the program. In addition, the researchers advocated the use and effectiveness of the teacher development program that was used as part of the study (Nix, Fraser, & Ledbetter, 2005).

In Taiwan, Chuang and Tsai (2005) used the CLES as a basis for developing the Constructivist Internet-based Learning Environment Survey (CILES), designed to assess dimensions of constructivism in Internet-oriented learning environments and preferences for such learning environments. The questionnaire was administered to 727 Taiwanese junior and high school students, all with Internet experiences. Factor analysis showed satisfactory reliability of the CILES for use with this sample. The study revealed that students showed stronger preferences for learning environments that integrated complex, real-life problems along with relevant content knowledge. Further, there were no apparent differences in how male and female students felt towards Internet-based learning environments. Finally, students with moderate Internet experience were more critical towards Internet-based learning environments than students with great experience with the internet.

Spinner and Fraser (2005) used the CLES to evaluate the effectiveness of an innovative mathematics program, which enables teachers to use constructivist ideas and approaches. The CLES was administered to 109 students, divided among two groups of fifth-grade students from the same school, as pretests and posttests over an academic year. Collected data underwent analysis in order to identify items whose removal would enhance each scale's internal consistency and discriminant validity. For the sample involved in this study, it was determined that some items and one scale from the CLES had to be removed to improve the internal consistency and

discriminant validity. Further analysis confirmed the validity and reliability of a refined 18-item version of the CLES in which the Personal Relevance scale was omitted altogether, as well as six items from other scales. The study concluded that students engaged in the innovative mathematics program experienced more favorable changes in terms of their perceptions of the classroom learning environments as indicated by their responses to the CLES.

In California, Ogbuehi and Fraser (2007) used a shortened version of the CLES, among other learning environment scales, to assess the effectiveness of using innovative instructional strategies for enhancing the classroom environment, students' attitudes and conceptual development in mathematics. The shortened form of the CLES was administered to 661 students from 22 classrooms in four inner city schools. Data analyses supported the factor structure, internal consistency reliability, discriminant validity and the ability to distinguish between different classes for the shortened form of the CLES when used with middle-school mathematics students in California. The study revealed that students who experienced the innovative instructional strategy with an emphasis on aspects of constructivism viewed their learning environment more positively than students in the control group.

In 2009, Peiro and Fraser translated the CLES into Spanish and administered a modified CLES in English and Spanish to a sample of 739 grade K–3 science students in Miami, USA. Analyses of data collected from the respondents supported the validity of the modified English and Spanish versions for use with young children. The researchers reported strong, positive associations between students' attitudes and the nature of the classroom environment. Further, a three-month classroom intervention led to large and educationally-important changes in the classroom environment (Peiro & Fraser, 2009).

In Malaysia, Luan, Bakar, Mee, and Ayub (2010) used the CLES as the basis for development of the CLES – ICT, an instrument specifically designed to explore students' preferences toward the constructivist learning environment for a discrete Information and Communications Technology (ICT) subject. The original scales from the CLES were translated into the Malay language and modified to specifically assess ICT courses, rather than science courses, for which the CLES was originally designed. A total of 440 Malaysian secondary school students responded to the newly-constructed CLES – ICT. Data from respondents were analyzed to support the instrument's internal consistency reliability, factor structure, discriminant validity and its ability to differentiate between ICT classrooms.

The section above describes only a sample of studies that have used the CLES to gather quantitative data collection as a basis to investigate constructivist dimensions of the classroom learning environment. The CLES was selected as a learning environment instrument for my study because of the salience of scales as well as its proven validity and reliability in other similar studies. The CLES has been used extensively to investigate constructivist classroom practices and has thus been validated as a learning environment instrument a number of times (Aldridge, Fraser, & Sebela, 2004; Aldridge, Fraser, Taylor, & Chen, 2000; Dorman, Adams, & Ferguson, 2001; Dryden & Fraser, 1998; Lee, Fraser, & Fisher, 2003; Nix, Fraser, & Ledbetter, 2005; Ogbuehi & Fraser, 2007; Spinner & Fraser, 2005; Taylor, Fraser, & Fisher, 1997). In addition, there have been many other studies that have made use of the CLES but whose primary research goals were not necessarily the validation of the CLES with a large sample (Beck, Czerniak, & Lumpe, 2000; Cannon, 1995; Harwell et al., 2001; Ozkal, Tekkaya, Cakiroglu, & Sungur, 2009; Shirvani, 2009).

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

The What Is Happening In this Class? (WIHIC) questionnaire is a fairly new learning environment instrument developed by Fraser, Fisher and McRobbie (1996). The WIHIC is unique in that it was developed by combining scales from a wide range of existing questionnaires with additional scales to address contemporary dimensions of the learning environment. In doing so, the WIHIC is said to “bring parsimony to the field of learning environments” (Aldridge, Fraser, & Huang, 1999, p. 49).

The original version of the WIHIC boasted nine scales, with a total of 90 items. After undergoing field testing, the WIHIC was downsized to seven scales, with 10 items per scale with a total of 70 items. Further field testing led to revising the WIHIC to seven scales, each with eight items and a total of 56 items that measure across the three dimensions described by Moos (1974). The seven dimensions include Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation, and Equity. The items in the questionnaire are organized in blocks by scale. For example, items pertaining to Student Cohesiveness come first, followed by items pertaining to Teacher Support, and so on. All items are scored 1, 2, 3, 4, and 5, respectively, for the frequency of responses Almost Never, Seldom, Sometimes, Often, and Almost Always (Aldridge, Fraser, & Huang, 1999).

By its very nature, the WIHIC is a versatile instrument whose purpose is to measure students’ perceptions of their classroom environment, but which can be easily modified to align with the goals of a particular study (Fraser, 2007). For example, researchers have used the WIHIC to measure students’ perceptions of classes in geography, mathematics, biology, and chemistry, and classes with an emphasis on the use of technology to deliver the curriculum. The WIHIC has also been used to investigate relationships between the learning environment and

educational variables including academic efficacy and information technology. Further, researchers have used data collected from the WIHIC to investigate gender differences in perceptions of the learning environment from within the same classroom situation. The WIHIC has also been used in cross-national studies designed to account for culture and language differences when comparing learning environments in different countries. Finally, the WIHIC has also been used extensively to study the existence of associations between classroom learning environment factors and subject-specific attitudes. Examples of such studies and others are presented in this section.

In Brunei Darussalam, Riah and Fraser (1998) used specific scales from the WIHIC in combination with other learning environment instruments to examine students' perceptions of the classroom learning environment of chemistry classes. A sample of 644 chemistry students from 35 classes in 23 secondary government schools responded to the adapted scales from the WIHIC. Numerous data analyses were performed, thus establishing the validity and reliability of WIHIC scales when used in conjunction with other learning environment instruments to assess the nature of the learning environment in chemistry classes. Further, the study revealed that this sample of students perceived their chemistry classroom learning environments favorably, and that female students perceived the learning environment of their chemistry class more favorably than did male students.

Aldridge, Fraser, and Huang (1999) used a modified version of the WIHIC as part of a mixed-methods, cross-national comparison of the nature of classroom environments in Taiwan and Australia. The WIHIC was translated into Chinese for use in Taiwan and administered to a sample of 1,879 grade 7–9 students from 50 classes in 25 schools in Taiwan. An English version of the WIHIC was administered

to 1,081 grade 8 and 9 general science students from 50 classes in 25 schools (urban and rural) in Western Australia. The data collected were analyzed to provide information regarding the reliability and validity of the WIHIC in each country. Data collected supported the validity and reliability of both the English and Chinese versions of the WIHIC for all scales. The study revealed similarities in the learning environments of classrooms within Australia, as well as in the learning environments of classrooms within Taiwan. However, when learning environments from Australian schools were compared to the learning environments of schools in Taiwan, subtle, yet stark, differences were uncovered. Some of these differences included Australian students consistently perceiving their learning environment more favorably than students in Taiwan and students in Taiwan expressing a significantly more positive attitude toward science than did students in Australia.

In Korea, Kim, Fisher, and Fraser (2000) used the WIHIC and the QTI to investigate students' perceptions of the classroom learning environments and teachers' interactional behavior. The WIHIC was translated into Korean prior to its administration to 543 students in 12 schools. Data collected from the sample were used to check the internal consistency reliability, discriminant validity, factor structure and the ability of the WIHIC to differentiate between the perceptions of students in different classrooms. Data analyses supported the acceptance of the Korean version of the WIHIC and its ability to be used in cross-cultural studies in Korea. The study also reported positive relationships of classroom environment and interpersonal teacher behavior with regard to students' attitudinal outcomes. The study also explored differences in perceptions due to gender and found that males perceived their learning environments and their teachers' interpersonal behavior more favorably than did females in the same class. Furthermore, students preferred greater

teacher support and involvement in the teaching/learning process, as well as greater levels of cooperation with other students.

Dorman (2001) used a combination of scales from the WIHIC and the CLES to conduct one of the first studies of associations between classroom psychosocial environment and academic efficacy using a sample of 1055 mathematics students from Australian secondary schools. The final instrument consisted of ten learning environment scales. One scale was specifically designed to assess students' academic efficacy related to mathematics-related tasks. Data analyses provided further validation data of scales from the WIHIC in their ability to be used across a variety of educational contexts. Results of the study indicated that classroom environment was positively linked with academic efficacy and further demonstrated that classroom environment is a strong predictor of student outcomes.

In Ontario, Canada, Raaflaub and Fraser (2002) used a modified version of the WIHIC to investigate psychosocial factors in the learning environment where laptop computers were being used in the study of mathematics and science. Factor structure, internal consistency reliability, discriminant validity and the ability to distinguish between different classes and groups were used as criteria by which to assess the modified WIHIC's reliability and validity. The questionnaire was administered to 1,172 students with the collected data supporting the validity and reliability of the WIHIC for use in grade 7–12 mathematics and science classrooms where laptop computers are used. Further, the study revealed significant differences in responses to the WIHIC between male and female students and between the subject disciplines of mathematics and science.

In 2003, Dorman conducted a study to show that the WIHIC scales could be applied to a wide population by using a cross-national sample of 3980 students in

grades 8, 10, and 12 from the United Kingdom, Canada, and Australia. He employed an array of analyses including reliability analyses, exploratory factor analyses and confirmatory factor analyses to study the structure of the WIHIC. Through such analyses, Dorman (2003) was able to further verify the validity and reliability of the WIHIC as a valid measure of classroom environment. A more recent study conducted by Dorman (2008), used multitrait-multimethod modeling to validate ‘actual’ and ‘preferred’ forms of the WIHIC. The ‘actual’ form of the WIHIC is useful in identifying the perceptions that individuals presently hold regarding the learning environment they are presently experiencing. In contrast, the ‘preferred’ form of the WIHIC asks the individual to respond to items indicating characteristics of the learning environment that they would prefer. Dorman administered both forms of the WIHIC to 978 secondary school students from Australia and, using a multitrait-multimethod approach within a confirmatory factor analysis framework, was able to show the consistent validity of the WIHIC as a measure of classroom environment.

In Australia, Aldridge and Fraser (2008) used all seven of the original WIHIC scales and added three new dimensions to encompass the introduction of an outcomes focus and information communications technology (ICT) in the classroom, thus giving rise to the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI). The TROFLEI was administered to 1035 students in 80 grade 11 and 12 classes spanning all disciplines at Sevenoaks Senior College. Data collected from this sample and subsequently analyzed revealed that the TROFLEI, and hence the WIHIC, was valid and reliable at the high school level across a number of different subjects. Further, Aldridge and Fraser (2008) reported that there were some associations between dimensions of the learning environment, students’ achievement, and academic efficacy for classrooms emphasizing an outcomes focus

and ICT. In 2004, Aldridge, Dorman and Fraser administered actual and preferred forms of the TROFLEI to 2,317 students from 166 grade 11 and 12 classes from Western Australia and Tasmania. Data collected from this sample were used to further establish the validity and reliability of the actual and preferred forms of the TROFLEI. Additionally, the data supported the ability of the scales on the actual form to differentiate between the perceptions of students in different classrooms.

In India, Koul and Fisher (2005) used an English version of the WIHIC to collect data from 1,021 science students from 31 classes in seven co-educational private schools. The study investigated differences in perceptions of classroom learning environments because of the cultural backgrounds of students. The cultural background of the student was determined by the language that the student and his or her parents normally spoke at home broken down into the following four categories: Hindi, Kashmiri, Dogri, and Punjabi. The data collected were analyzed and confirmed the WIHIC's validity and reliability for use with samples in India. Further, the researchers concluded that the Kashmiri group of students had the most positive perceptions of their classroom learning environment while the Dogri group had the most negative perceptions of their classroom learning environment. Upon closer examination, the difference in learning environment perceptions between the two cultural groups was attributed to the group's status in the community and the value placed on education by each group.

Zandvliet and Fraser (2005) used the WIHIC in a cross-national study to investigate how technology-rich classrooms affected students' perceptions of the learning environment in British Columbia, Canada and Western Australia. A sample of 1404 students in 81 randomly-selected senior high school technology-rich classes in 24 schools in Australia and Canada completed the questionnaire. Previously,

Zandvliet (1999) used the data collected from this sample to assess the reliability and validity of the WIHIC. Factor and item analyses resulted in the retention of all items from the selected WIHIC scales, which were also deemed to be good independent measures of the different psychosocial dimensions of the learning environment. Internal consistency reliability and discriminant validity further supported the reliability and validity of the WIHIC. The results of the study revealed that students generally perceived their learning environment positively when engaged in technology. Additionally, a number of statistically significant and independent associations between physical and psychosocial factors and further, between psychosocial factors and students' satisfaction with learning, were present.

In South Africa, Aldridge, Laugksch, Seopa, and Fraser (2006) adapted relevant dimensions and items from the WIHIC as the basis for the development of the Outcomes Based Learning Environment Questionnaire (OBLEQ). The OBLEQ was designed to measure the impact of a science outcomes-based learning environment on students' perceptions of their learning environment in classrooms within Limpopo Province, South Africa. Further, because English was the second language for students in this sample, the questionnaire was translated from English into the local language, North Sotho. After field testing, the refined OBLEQ was administered to 2,638 learners in 50 grade 8 science classes in 50 schools. Data collected from these administrations were analyzed to determine the validity and reliability of the OBLEQ and, therefore, also the WIHIC. The factor structure of the OBLEQ indicated that two scales were being responded to in the same manner, warranting their collapse, yielding a total of six scales. Further, the internal consistency reliability for each of the scales was satisfactory and comparable with similar studies, further indicating the OBLEQ's reliability as a learning environment

instrument. The study revealed statistically significant associations between student attitudes and all six scales of the OBLEQ at the individual level and for four scales at the class level. Further, findings indicated that students preferred a more favorable learning environment than their perceptions of the one that they were actually in.

In Florida, Allen and Fraser (2007) used a modified version of the WIHIC which aimed to gather the perceptions of grade 4 and 5 students along with the perceptions of their parents regarding the science classroom learning environment. A total of 520 students and 120 parents responded to the modified WIHIC, in both an 'actual' and 'preferred' form. Factor and item analyses, conducted separately for 'actual' and 'preferred' data, indicated that the same version of the modified WIHIC could be used to assess young students' and their parents' perceptions of the learning environment. Further data analyses supported the WIHIC's internal consistency reliability and ability to differentiate between the perceptions of students in different classrooms. Findings from the study indicated that, whereas students were generally satisfied with the learning environment of their science classroom, parents wished for greater teacher support. Additionally, both students and parents preferred a more positive classroom environment than the one perceived to be actually present.

In New York, Wolf and Fraser (2008) used the WIHIC to assess the effectiveness of inquiry-based laboratory teaching in terms of differences in students' perceptions of the classroom learning environment. In order to establish the validity and reliability of WIHIC scales for use in the United States, the questionnaire was administered to 1,434 students in 71 classes from 14 public schools and four private schools in eight states. Once the validity and reliability of WIHIC scales were established for use with a sample in the United States, a subsample of 165 students in eight seventh-grade physical science classes within a single middle school in Long

Island, New York, participated in an action research study. Analyses of the data revealed that students in inquiry classes perceived a statistically significantly greater amount of Student Cohesiveness than did students in the non-inquiry classes.

Khoo and Fraser (2008) used a modified six-scale version of the WIHIC, adapted to assess the learning environment of a computer application course in Singapore, to investigate adults' perceptions of a computer classroom environment. This study was unique in that it was one of the first to use a learning environment instrument to evaluate computer education programs and use adult learners as the sample. When the modified WIHIC was administered to 250 working adults attending courses in five computer education centers in Singapore, it was found to be valid and reliable for assessing students' perceptions of computer classroom environments. Data analyses supported the instrument's factorial validity, internal consistency reliability, and ability to differentiate between classrooms. Further, factor analysis supported a five-scale structure rather than a six-scale structure for the questionnaire, resulting in the removal of one of the original scales. Adults in the computer classes perceived their learning environments favorably and were satisfied with the overall structure of their course, with no significant differences between the two genders or age groups.

Pickett and Fraser (2009) used a modified form of the WIHIC as part of a mixed-methods study to investigate the classroom learning environment, achievement, and student and teacher attitudes associated with a two-year mentoring program in science for seven first-year, second-year, and third-year grade 3–5 teachers. The study also aimed to investigate how the mentoring program affected the teachers in terms of their level of confidence, knowledge, and valuing of teaching science, their active learning in science, their success in creating a positive classroom

learning environment, and their reflective practice in teaching science. Pickett and Fraser (2009) administered the modified WIHIC to 573 students in grades 3–5. Data analyses provided support for a six-scale version of the WIHIC in terms of its factor structure, internal consistency reliability, and ability to differentiate between classrooms. Results of the study indicated small changes in students' perceptions of their learning environment and large differences in student achievement in science between a pretest and a posttest given in the second year of the mentoring program.

Chionh and Fraser (2009) used the WIHIC to investigate the classroom environment in geography and mathematics classes in Singapore. Data were collected from a sample of 2,310 Singaporean grade 10 students in 75 geography and mathematics classes in 38 schools. Factor analyses led to the elimination of one of the original eight scales altogether, leaving seven scales with a total of 70 items. Further analyses supported the WIHIC's internal consistency reliability, and ability to differentiate between classrooms, indicating the wide applicability of the WIHIC across national boundaries, for two separate school subjects and in both an actual and a preferred form. The study revealed associations between students' perceptions of the classroom learning environments of geography and mathematics and their learning outcomes. One such association showed that students typically displayed higher achievement in classes where students perceived greater student cohesiveness. Further, according to Chionh and Fraser (2009), greater differences were apparent between students' actual and preferred classroom environments rather than between the classroom environments for geography and mathematics.

In South Africa, Aldridge, Fraser, and Ntuli (2009) modified scales from the WIHIC to make them suitable for use with primary school students. This modified version of the WIHIC was named the WIHIC–Primary and included the scales of

Teacher Support, Involvement, Task Orientation, and Equity. The WIHIC–Primary was first translated into the IsiZulu language and then administered to 1,077 South African students to assess preferred and actual classroom environments. Statistical analyses of the collected data supported the factorial validity and internal consistency reliability of the actual and preferred versions of the WIHIC–Primary as well as its ability to differentiate between classrooms. The study also revealed large differences between students’ perceptions of the actual and preferred learning environment. With regard to the scales of Involvement, Task Orientation, and Equity, students preferred a more favorable learning environment from the one that they actually perceived. This information was used to provide teachers enrolled in a distance-education in-service course with the opportunity to reflect on their practice and use the feedback from the questionnaire to reduce the gap between their students’ perceptions of actual and preferred learning environment.

Fraser, Aldridge, and Adolphe (2010) used a modified version of the WIHIC in a cross-national study of classroom environments in Australia and Indonesia. Prior to administration, the WIHIC was translated into Bahasa Indonesian for use with the Indonesian sample. A sample of 1,161 students in 36 classes split between Australia and Indonesia responded to the modified version of the WIHIC. Statistical analyses of the collected data resulted in the elimination of two scales, resulting in a 55-item, six-scale instrument. Further analyses of the revised version of the WIHIC in the form of internal consistency reliability, discriminant validity, and a check of the scales’ abilities in distinguishing between the perceptions of students in different classes supported scale reliability and validity for both the English and Bahasa Indonesian forms of the modified WIHIC. The study further added to the literature calling for more cross-national studies as it was shown that there were differences

between countries and between genders in students' perceptions of the classroom environments. The study also revealed generally positive associations between the classroom environment and student attitudes toward science in both countries.

Giallousi, Gialamas, Spyrellis, and Pavlatou (2010) developed the three-scale How Chemistry Class is Working (HCCW) using two scales from the WIHIC. The researchers had the HCCW translated into the Greek language for use in Greece and in Cyprus. A total of 1,394 Greek and 225 Cypriot grade 10 students responded to the questionnaire. Resulting data analyses supported the factor structure of the newly-constructed questionnaire. The study revealed that Cypriot students generally perceived their chemistry classroom environments more positively than their Greek counterparts.

The section above describes only a sample of studies that have used the WIHIC to gather quantitative data as a basis for investigating the classroom learning environment. Other studies that have made use of the WIHIC and have added to its validity and reliability include those carried out in Indonesia with university students (Margianti, Fraser, & Aldridge, 2001; Soerjaningsih, Fraser, & Aldridge, 2001), in Singapore (Chua, Wong, & Chen, 2011), in Malaysia (Zandvliet & Man, 2003), and in various regions of the United States (den Brok, Fisher, Rickards, & Bull, 2006; Martin-Dunlop & Fraser, 2008; Moss & Fraser, 2001; Sinclair & Fraser, 2002). Additionally, besides the WIHIC being translated and validated into the languages of Taiwan, Indonesia, Greece, South Africa, and Malaysia, it has also been recently translated into and validated in Arabic for use in the United Arab Emirates (Afari et al., in press; MacLeod & Fraser, 2010).

Section 2.3 describes a variety of historically important classroom learning environment instruments that have emerged over the last several decades. These

learning environment instruments have been used in a wide range of studies, whose aims are often different. While the specific aims of certain studies might be different, the overall objectives of the studies could be classified into 12 distinct types of research. The next section of this chapter identifies these 12 areas of past research involving classroom learning environments and describes in greater detail those areas relevant to my study.

2.4 Types of Research Involving Classroom Environment Instruments

There is a variety of classroom environment instruments from which researchers are able to select in order to accomplish the aims of their studies. Fraser (1998, 2012) identifies 12 primary areas of research that have been carried out using classroom environment instruments: associations between outcomes and environment; evaluation of educational innovations; differences between students' and teachers' perceptions of the same classrooms; whether students achieve better in their preferred environment; teachers' use of learning environment perceptions in guiding improvements in classrooms; combining quantitative and qualitative methods; links between different educational environments; cross-national studies; the transition from primary to high school; and incorporating educational environment ideas into school psychology, teacher education and teacher assessment. The main emphasis of each of these areas of research is described in Table 2.2. Of these 12 areas, three are highly relevant for my study and therefore are described in greater detail in the following sections: associations between student outcomes and environment (Section 2.4.1); evaluation of educational innovations (Section 2.4.2); and cross-national studies (Section 2.4.3).

2.4.1 Associations between Student Outcomes and Environment

Investigations of associations between student outcomes and environment have a strong tradition in learning environment research and have most often been carried out through the implementation of classroom environment instruments. Research of this nature has been replicated for a variety of outcome measures, using many of the available classroom environment instruments, and a variety of samples spanning numerous countries, languages, school subjects and grade levels (Fraser, 2012).

The SLEI has been used numerous times to investigate associations between the science laboratory environment and students' cognitive and affective outcomes. Such studies were carried out by Fraser and McRobbie (1995) for a sample of approximately 80 senior high school chemistry classes in Australia, 489 senior high school biology students in Australia (Fisher, Henderson, & Fraser, 1997) and 1,592 grade 10 chemistry students in Singapore (Wong and Fraser, 1996).

Studies using the QTI as a tool to investigate associations between student outcomes and perceived patterns of teacher–student interaction have also been conducted by Fisher, Henderson, and Fraser (1995) using a sample of 489 senior high-school biology students in Australia and by Goh, Young, and Fraser (1995) with 1,512 primary-school mathematics students in Singapore. In Turkey, a translated version of the QTI was used in conjunction with a science attitude questionnaire developed by Fraser (1981) to investigate associations between teacher–student interpersonal behavior and students' attitudes to science for a sample of 7,484 grade 9–11 students from 278 classes in 55 public schools in 13 major Turkish cities (Telli, den Brok, & Cakiroglu, 2010).

Table 2.2 – Areas of Past Research in the Field of Learning Environments and Their Emphases

Research Area	Main Emphasis of Research
Associations between Student Outcomes and Environment	Investigation of associations between perceptions of psychosocial characteristics of a classroom and students' cognitive and affective learning outcomes
Evaluations of Educational Innovations	Process criteria used in the evaluation of educational criteria are obtained via classroom learning environment instruments
Student – Teacher Differences	Investigation of perceived differences between the students and teacher in a classroom situation. Differences could be between actual or preferred environments
Person – Environment Fit	Research into whether student achievement depends on the similarity between preferred and actual classroom environment
Teacher Improvement	Instruments provide feedback information for use in five-step procedure for reflecting upon, discussing, and attempting to improve classroom environment
Combining Research Methods	Research involving the use of both quantitative and qualitative methods in the same study in order to identify salient features of the environment studied
School Psychology	Research instruments can be used to identify areas of classroom life and differences that impact the mental and emotional welfare of students
Links between Environments	Attempts to identify connections and influences of multiple environments involved in the educational process, both in and out of the formal school
Cross-national Studies	Unique abilities to investigate the similarities and differences between the educational environments of various countries, as well as to question the practices and beliefs of a given country
Transitions between Grade Levels	Research on the effect of students moving from one level of education to another, such as from primary to junior high school
Teacher Education	Opportunities to include the topic of learning environments in programs for the preparation and training of future educators
Teacher Assessment	Dimensions of learning environments can yield insight into present teaching methods and focus, as well as possible effectiveness from the student perspective

In 2009, Dorman and Fraser administered the TROFLEI to 4,146 high school students from Western Australia and Tasmania to investigate associations between classroom environment and student affective outcomes (attitude to subject, attitude to computer use, academic efficacy) through various lenses including: gender; grade level; and home computer and Internet access. Confirmatory factor analysis supported the 10-scale structure of the TROFLEI. Additionally, use of structural equation modeling of TROFLEI data with this sample established associations between students' affective outcomes and their classroom environment perceptions. According to their model, Dorman and Fraser (2009) reported that improving the classroom environment has the potential to improve student outcomes.

In addition to the studies in this section, Chapter 2, Section 2.3 previously has reviewed an array of other studies that have involved the validation of the CLES (Section 2.3.1) and the WIHIC (Section 2.3.2) and their use in investigating associations between classroom learning environment and various student outcomes.

Primarily, the findings from this type of research point to consistent and positive associations existing between the classroom environment and student achievement and attitudes. Generally, if a learning environment is perceived as positive, then student outcomes are more favorable (Fraser, 2002). Haertel, Walberg, and Haertel's (1981) meta-analysis suggests that better achievement on a variety of outcome measures was found consistently in classes perceived as having greater Cohesiveness, Satisfaction and Goal Direction and less Disorganization and Friction. While many of the outcomes presented in the studies in this section are cognitive in nature, my study used measures of students' attitudes towards science as an outcome related to the classroom learning environment. The use of student attitudes as an outcome is explored in greater detail in Section 2.5.

2.4.2 *Evaluation of Educational Innovations*

Educators often speak of the various methods that they use to teach students in their classroom. Some educators prefer a teacher-centered model of instruction, while others prefer a student-centered model and still others prefer something in between. These different models of teaching utilize specific strategies and techniques which might not have been previously practiced. Educators refer to these emerging practices as educational innovations. However, not every educational innovation can be deemed worthy of employing on a large scale. Fortunately, there are researchers who carry out studies aimed at evaluating the effectiveness of educational innovations by investigating their effect on the students' perceptions of their learning environment as well as using other criteria for effectiveness.

Maor and Fraser (1996) used a classroom environment instrument to evaluate the use of a computerized database by exploring changes in students' perceptions of their learning environment. The study revealed that students perceived their classes as becoming more inquiry-oriented during the use of the computerized database. Similar studies yielding similar results were carried out in Singapore, where students' perceptions of the classroom learning environment were used to evaluate the effectiveness of computer-assisted learning (Teh & Fraser, 1994) and computer application courses for adults (Khoo & Fraser, 2008).

In California, Martin-Dunlop and Fraser (2008) used a combination of scales from the WIHIC and the SLEI to evaluate the effectiveness of an innovative science course offered at a large urban university for improving prospective elementary teachers' perceptions of laboratory learning environments and attitudes toward science. The instrument was administered to 525 females in 27 classes. The science course in which the teachers were enrolled blended a guided open-ended approach to

investigations along with cooperative learning groups. Analyses of the data revealed statistically significant differences in the participants' responses between students' perceptions of the innovative course and their previous courses for all seven scales. Effect sizes for the learning environment scales, reported in terms of the number of standard deviations, ranged from 1.51 standard deviations for Student Cohesiveness to 6.74 standard deviations for Open-Endedness. The scale of Material Environment was associated with the second largest gains, after Open-Endedness, with an effect size of 3.82 standard deviations. These large effect sizes attest to the effectiveness of the innovative science course by supporting significant differences between students' perceptions of the learning environment before and after participation in the course.

Wolf and Fraser (2008) conducted a mixed-methods study in which they administered the WIHIC to a subsample of 165 students in eight seventh-grade physical science classes within a single middle school in Long Island, New York. The students were also participants in an action research study during which they were interviewed for qualitative feedback. The study aimed to evaluate the effectiveness of using inquiry-based laboratory activities in terms of learning environment perceptions, students' attitudes and students' achievement. The sample was divided into two groups: an inquiry group and a non-inquiry group. Data analyses supported the effectiveness of the innovation in terms of the presence of greater Student Cohesiveness within the inquiry group compared with the group receiving non-inquiry instruction. Small differences, albeit not statistically significant, were also found for the other learning environment scales in favor of the group receiving inquiry instruction.

Many of the past studies that have evaluated an educational innovation have primarily focused on evaluating the effect of implementing a type of technology on

the learning environment. Descriptions of other studies that have involved evaluating an educational innovation using the CLES and the WIHIC can be found in Sections 2.3.1 and 2.3.2, respectively. Fraser (1998, 2002, 2007) notes that most evaluations of technology innovations in the classroom have resulted in changes in how students perceive their classroom environments in terms of Involvement, Teacher Support, Task Orientation, and Equity. However, Fraser (2007, p. 112) asserts that “Despite the potential value of evaluating educational innovations and new curricula in terms of their impact on transforming the classroom learning environment, only a relatively small number of such studies have been carried out around the world.” Therefore, the present study aimed to fill this gap in learning environment research. However, in my study, the educational innovation involved was neither technology- nor curriculum-based. Rather, the innovation involved a new perspective on what effective science instruction looks like and how teachers can enact effective science instruction in the form of reality pedagogy (discussed in Section 2.7). Thus, the effectiveness of reality pedagogy was evaluated, at least in part, based on changes in students’ perceptions of their learning environments.

2.4.3 *Cross-national Studies*

Oftentimes, it is taken for granted that a learning environment perceived in a certain way could be perceived differently by someone on the other side of the globe. The need for educational research that crosses national boundaries is great. Fraser (2002, p. 16) describes the importance of this type of research by explaining that “there usually is greater variation in variables of interest (e.g. teaching methods, student attitudes) in a sample drawn from multiple countries than from a one-country sample. Secondly, the taken-for-granted familiar educational practices, beliefs, and

attitudes in one country can be exposed, made ‘strange’ and questioned when research involves two countries.”

Most cross-national studies involving learning environments have involved comparisons between Australia and Asian countries, including Taiwan (Aldridge, Fraser, & Huang, 1999; Aldridge, Fraser, Taylor, & Chen, 2000), Singapore (Fisher, Goh, Wong, & Rickards, 1997) and Indonesia (Fraser, Aldridge, & Adolphe, 2010). However, as nations seek to learn more about differing educational systems, the concept of cross-national studies has expanded to include studies comparing learning environments in the United Kingdom, Canada, and Australia (Dorman, 2003), British Columbia, Canada and Western Australia (Zandvliet & Fraser, 2005), and Greece and Cyprus (Giallousi, Gialamas, Spyrellis, & Pavlatou, 2010). As researchers have investigated the perceptions of students in each of the countries, findings have helped to explain some of the differences in students’ responses to learning environment instruments between countries, and highlighted the need for caution when interpreting differences between the questionnaire results from two countries with cultural differences.

One such cross-national study, conducted by Aldridge, Fraser, and Huang (1999), compared the nature of classroom environments in Taiwan and Australia using a modified version of the WIHIC. Besides providing the opportunity to further confirm the validity and reliability of the WIHIC, the study uncovered differences between learning environments in Australian and Taiwanese schools. Further, this study revealed a relationship between the structure of the learning environment, socio-cultural factors and the education system of the country, which could have alluded researchers, had a cross-national study not been undertaken. This study is detailed more extensively in Chapter 2, Section 2.3.2.

My research adds to the growing number of cross-national studies and is unique in that it compared two often-overlooked geographical areas for inclusion in cross-national studies: Europe and the United States. In particular, my research focused on comparing the learning environment of science classrooms at the International School of Dresden with science classrooms at Bronx High School.

2.5 Student Attitudes and the Test of Science Related Attitudes (TOSRA)

Understanding the concept of ‘attitude’ is relevant to my study because my research focused on exploring changes in attitudes, differences in attitudes between geographic areas, and associations between students’ attitudes toward science and their perceptions of the learning environment. Unlike the concept of a ‘classroom learning environment’ which is defined by the interactions between students and their teacher in the classroom, there is no singular accepted definition of ‘attitude’, because attitudes cannot be directly measured or observed (Mueller, 1986). Hence, because of the abstract nature of this concept, researchers have struggled to create a uniform definition of ‘attitude’ and it is difficult to review the literature. It is therefore crucial that a researcher adopts a definition of attitude with which he or she is comfortable and that can be applied consistently within the framework of a study. For the purpose of my study, I adopted Thurstone’s (1928, p. 531) definition of ‘attitude’ as “the sum total of a man's inclinations and feelings, prejudice or bias, pre-conceived notions, ideas, fears, threats, and convictions about any specified topic”. Measurement of attitude, therefore, can be accomplished by measuring the intensity of positive or negative affect for or against a psychological object to which an opinion has been expressed (Thurstone, 1928). It should also be pointed out that attitude toward an object is able to be learned and changed with exposure to the appropriate experiences.

If it were not believed that attitudes could be altered, then research in the field of learning environments associated with attitudinal outcomes would not be worth pursuing. Thurstone (1928) asserts that, when an individual expresses a certain attitude, caution must be taken because this does not necessarily imply that the individual will act in accordance with the opinions associated with the attitude. The implication here is that a measurement of an individual's attitude, while likely to be genuine as to what the individual believes, does not necessarily hold any value for predicting that individuals' actions.

Our ability to investigate student attitudes towards a specific academic subject has been enhanced by the creation and validation of a variety of instruments. For this study, the Test of Science Related Attitudes (TOSRA) was selected as the instrument to collect data about students' attitudes towards science. The remainder of this section goes into greater depth regarding the reliability and validity of the TOSRA. Additionally, a synthesis of studies that have used the TOSRA to gather data on students' attitudes towards science is presented.

One of the aims of my study was to evaluate the effectiveness of reality pedagogy in terms of students' attitudes toward science and perceptions of the classroom learning environment. However, a student's attitude toward science is quite different from a student's perception of the learning environment, therefore, making it necessary to include in my study an instrument whose specific purpose is to measure students' science-related attitudes. Klopfer (1971) asserts that students who enjoy their science learning experiences in school will develop a positive attitude toward science. He also argues that an individual's ability to live successfully in the contemporary world is dependent on his or her holding well-informed positive attitudes toward science. While holding this belief, Klopfer (1971) recognized that

the relationship between science and attitudes can be broken into two strands: attitudes to science; and scientific attitudes. Klopfer (1971, p. 443) describes attitudes to science as learning “to value science for its contributions to man’s intellectual growth and to society”. Scientific attitudes, however, are related to “the processes of scientific inquiry as a valid way to conduct one’s thinking” and include “honesty, open-mindedness, suspended judgment, self-criticism, and commitment to accuracy” (Klopfer, 1971, p. 443).

Using this attitude framework developed by Klopfer, the Test of Science Related Attitudes (TOSRA) was developed in the early 1980s by Fraser (1981) to assess science-related attitudes among secondary school students. The TOSRA contains a total of 70 items divided into seven distinct scales: Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. The scales are classified using Klopfer’s (1971) two overarching categories (attitudes to science and scientific attitudes), but these two categories are further broken down into six sub-categories. Table 2.3 has been adapted from Fraser (1981) and shows each of the seven scales in the TOSRA and the relevant pairing to Klopfer’s descriptors. The TOSRA has the advantage of yielding a separate score for a range of different attitudinal outcomes rather than a single overarching score for attitude (Fraser, 1981). Each item follows a Likert scaling format and is scored 1, 2, 3, 4, and 5, respectively, for the responses of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. Some items are negatively worded and therefore are scored in reverse (Fraser, 1981).

While the TOSRA was developed to measure an array of students’ science-related attitudes, researchers have been able to select specific scales which most

Table 2.3 – Overview of Student Attitude Scales in the TOSRA and Their Classification According to Klopfer (1971)

TOSRA Scale Name	Klopfer (1971) Classification
Social Implications of Science	Manifestation of favorable attitudes towards science and scientists (Attitudes to Science)
Normality of Scientists	Manifestation of favorable attitudes towards science and scientists (Attitudes to Science)
Attitude to Scientific Inquiry	Acceptance of scientific inquiry as a way of thought (Scientific Attitudes)
Adoption of Scientific Attitudes	Adoption of ‘scientific attitudes’ (Scientific Attitudes)
Enjoyment of Science Lessons	Enjoyment of science learning experiences (Attitudes to Science)
Leisure Interest in Science	Development of interest in science and science-related activities (Attitudes to Science)
Career Interest in Science	Development of interest in pursuing a career in science (Attitudes to Science)

closely align with the specific goals of their study. For example, researchers have used modified versions of the TOSRA to measure students’ attitudes towards mathematics, geography, chemistry, Spanish, and classes that are technology-rich (Fraser, 2012). The TOSRA was selected as an instrument for my study for a variety of reasons. First, the TOSRA is unique when compared with other attitude instruments because, rather than producing a single overall score for attitude, it is able to yield a separate score for each of the distinct attitudinal scales. This unique characteristic allows researchers to obtain a ‘profile’ of attitude scores for groups of students (Fraser, 1981), allowing the TOSRA to be used in other academic disciplines besides science and allowing researchers to select scales applicable to their study. The TOSRA was also selected as an instrument for my study because of the salience of its scales and its proven validity and reliability in other similar studies. Examples of such studies and others are reviewed in this section.

During initial field testing of the TOSRA, Fraser (1981) administered the questionnaire to 1,337 students ranging from grades 7–10 in 44 classes from 11 different schools in Sydney, Australia. Data analysis indicated that each TOSRA scale had good internal consistency reliability. A test – retest reliability was also estimated based on data collected from a sub-sample of 328 grade 8–9 students in four of the schools. These students responded to the TOSRA a second time approximately two weeks after the first administration. Results supported the test–retest reliability for all TOSRA scales. Analysis of scale intercorrelations in order to check discriminant validity indicated slight correlations between scales, but all seven dimensions were kept.

The TOSRA has also been cross-validated through administration to five new samples of secondary science classes in Australia and the United States. Such cross-validation provides additional support for the validity of the TOSRA for use with Australian students, and supports the cross-cultural validity of the TOSRA for use with students in the United States (Fraser & Butts, 1982; Lucas & Tulip, 1980; Schibeci & McGaw, 1981).

In Singapore, Wong and Fraser (1996) investigated associations between students' perceptions of their chemistry laboratory classroom environment and their attitudes towards chemistry. The Chemistry Laboratory Environment Inventory (CLEI), a modified form of the SLEI, was used to investigate students' perceptions of their chemistry laboratory learning environment, whereas the Questionnaire on Chemistry-related Attitudes (QOCRA), a modified version of the Test of Science-Related Attitudes (TOSRA), was used to assess the students' attitudes to chemistry. Both questionnaires were administered to 1,592 final-year secondary school chemistry students in 56 classes in 28 schools in Singapore. Of the seven TOSRA scales, only

three were used: Attitude to Scientific inquiry; Adoption of Scientific Attitudes; and Enjoyment of Science Lessons. However, to align with the goals of the study, the scales were renamed: Attitude to Scientific Inquiry in Chemistry; Adoption of Scientific Attitudes in Chemistry; and Enjoyment of Chemistry Lessons. Further, the items associated with each of these scale were modified by replacing the word 'science' with 'chemistry' throughout. Data analyses revealed good reliability for each of the scales of the QOCRA and significant associations between the nature of the chemistry laboratory classroom environment and the students' attitudinal outcomes. In 1997, Wong and Fraser engaged in a multi-level analysis of the results obtained from the study conducted the previous year. In terms of reliability, the class means for the QOCRA for the Singaporean sample was compared to reliability results reported previously for the original TOSRA (Fraser, 1981), indicating that the results for the present study were generally comparable to those for the original version (Wong & Fraser, 1997).

Aldridge, Fraser, and Huang (1999) used an eight-item scale adapted from the TOSRA to assess student satisfaction in terms of enjoyment, interest, and anticipation for science classes in Taiwan and Australia. This scale, combined with scales from the WIHIC, was translated into Chinese to compare the nature of classroom environments in Taiwan and Australia. The questionnaire was administered to a sample of 1,879 grade 7–9 students from 50 classes in 25 schools in Taiwan. An English version of the questionnaire was administered to 1,081 grade 8–9 general science students from 50 classes in 25 schools (urban and rural) in Western Australia. The study revealed that, despite the fact that students in Australia held more favorable perceptions of the learning environment, students in Taiwan expressed a significantly more positive attitude toward science. This anomaly prompted the researchers to

more closely examine the perceptions and attitudes held by student through qualitative data collection, in an attempt to uncover plausible explanations for the differences.

Aldridge and Fraser (2008) used only a single scale from the TOSRA in combination with the TROFLEI to investigate student attitudes towards a technology-rich learning environment. The results suggested that three scales from the TROFLEI, Teacher Support, Equity, and Young Adult Ethos account for a significant amount of variance in students' attitudes towards their subject. Additionally, the study revealed positive significant associations between the Attitude to Subject scale and between students' perceptions of their learning environment as assessed by the 10 TROFLEI scales.

Fraser, Aldridge, and Adolphe (2010) used the TOSRA and the WIHIC to investigate the relationship between the learning environment and students' attitudes in Australia and Indonesia. Three scales selected from the TOSRA (Normality of Scientists, Attitude to Scientific Inquiry, and Career Interest in Science) were translated into Bahasa Indonesia for use with the Indonesian sample. Data were collected from a sample of 1,161 students in 36 classes split between Australia and Indonesia. Results from the data analyses attested to the TOSRA's satisfactory internal consistency reliability and discriminant validity for both the Indonesian and Australian versions. Further, results indicated strong positive associations between students' attitudes and their perceptions of their classroom learning environment for samples from both countries.

Modified versions of the TOSRA for use in other academic disciplines have also been created. In Texas, a modified version of the TOSRA, the Test of Geography Related Attitudes (TOGRA), was designed to measure student attitude on

four distinct scales: leisure interest in geography; enjoyment of geographic education; career interest in geography; and interest in place. The TOGRA was validated with a sample of 388 ninth-grade World Geography students (Walker, 2006).

The TOSRA has also been modified to assess Spanish-related students' attitudes by rewording statements from the TOSRA and translating them into the Spanish language resulting in the Test of Spanish Related Attitudes (TOSRA—L₁) (Adamski, Fraser, & Peiro, in press). Only two of the original seven scales from the TOSRA were chosen for the TOSRA—L₁. The two scales chosen were the Adoption of Scientific Attitudes and Enjoyment of Science Lessons scales, which were renamed as Cultural Attitudes and Enjoyment of Spanish Lessons. The TOSRA—L₁ was administered to 223 grade 4–6 Spanish-speaking students in nine Spanish classes in South Florida. Statistical analysis supported the factor structure of the TOSRA—L₁ questionnaire. The internal consistency reliability of the TOSRA—L₁ was also supported.

Spinner and Fraser (2005) developed the Test of Mathematics-Related Attitudes (TOMRA) from the TOSRA and used it with the two samples to assess students' attitudes toward mathematics. Modifications to the TOSRA involved slightly changing the wording of the scales and items to be consistent with mathematics rather than science. For example, the scale Normality of Scientists was changed to Normality of Mathematicians and the item "Science lessons are fun" was changed to "Mathematics lessons are fun." Data analyses revealed that the internal consistency reliability of the TOMRA was satisfactory for all scales except Normality of Mathematicians for the second sample. Further, discriminant validity analysis suggested that the scales of the TOMRA displayed reasonable independence from the other scales. Ogbuehi and Fraser (2007) administered the TOMRA along with two

modified learning environment instruments to a sample of 661 students from 22 classrooms in four urban schools in California. The study aimed to evaluate the effectiveness of using innovative instructional strategies for enhancing the classroom environment and students' attitudes toward mathematics. The study revealed positive associations between perceptions of classroom learning environment and students' attitudes to mathematics. Further, students who experienced the innovative instructional strategies held more positive attitudes toward mathematics than students who did not.

In 2005, Mink and Fraser used attitude scales similar to the TOMRA along with a classroom learning environment instrument in an evaluation of K–5 mathematics program called Project SMILE (Science and Mathematics Integrated with Literature Experiences). The attitude instrument used consisted of three scales: Attitude to Reading, Attitude to Writing, and Attitude to Mathematics. The effectiveness of the program was measured by the extent to which the classroom implementation of Project SMILE positively influenced the classroom environment and students attitudes toward reading, writing and mathematics. The attitude instrument was administered to a sample of 120 grade 5 mathematics students in Florida. According to Mink and Fraser (2005), the attitude scales exhibited satisfactory internal consistency reliability and discriminant validity. Further, the implementation of SMILE was found to have a positive impact on the students of the teachers who participated in the program in that students' attitudes to mathematics and reading improved.

The section above describes only a sample of studies that have used the TOSRA to gather quantitative data as a basis to investigate students' attitudes toward a subject. The TOSRA has been used to evaluate innovations (Lott, 2003), to

compare the attitudes of different groups of students (White & Richardson, 1993; Joyce & Farenga, 2000) and to explore associations between the learning environment and students' attitudes (Fraser & Fisher, 1982).

2.6 Effective Teaching and Effective Learning Environments

While the previous sections of this chapter have explored learning environments and student attitudes, this section reviews literature about the characteristics of effective teaching in science (Section 2.6.1) and effective learning environments (Section 2.6.2). The effectiveness of reality pedagogy in my study was judged by comparing the outcomes of reality pedagogy to the descriptions provided by past researchers in these two areas along with the effect upon students' perceptions of the learning environment and their attitudes toward science.

2.6.1 Effective Teaching in Science

According to much educational research, effective science teaching requires offering students a rich, rewarding, and unique learning environment that recognizes the importance of students' social agendas while concurrently delivering accurate subject content that fosters inquiry, real-world learning and self-reflection (Beers & LaVan, 2005; Seiler, 2002; Tobin, Treagust, & Fraser, 1988). Achieving this level of complexity with teaching is a perpetual issue for science educators primarily because teachers find it challenging to deliver content in ways that engage students and echo their culture and prior experiences. Yet, it is exigent for teachers to implement the general recommendations of much science education research presented in this section, especially during a time when there is an increasing need for individuals who

are able to contribute to the ever-changing frontiers of science and technology (Simmons et al., 2005).

Frank McCourt (2005), in his novel *Teacher Man*, expressed that, as a teacher:

You'll be teaching spelling, vocabulary, grammar, reading comprehension, composition, literature. You can't wait to get to the literature. You'll have lively discussions about poems, plays, essays, novels, short stories. The hands of one hundred and seventy students will quiver in the air and they'll call out, Mr. McCourt, me, me, I wanna say something. (p. 5)

Yet, throughout much of his novel, McCourt echoes that this overly-optimistic view of teaching is not a reality in most classrooms and how, for many years, he considered himself to be a mediocre and ineffective teacher who continuously failed to engage his students in academic work until he reached a moment of brilliance. McCourt's epiphany began with his recognition of a student ritual: the forging of excuse notes. McCourt explored this ritual by allowing his students access to the vast amounts of forged excuse notes he had collected over the school year and then used these notes as an entry point for a writing assignment: write an excuse note for any famous figure in the world at present or in history. McCourt explained that, for what seemed to be the first time in his teaching career, students were engaged with a writing assignment.

Emdin (2009) explains that, in some classrooms, a teacher's classroom management could appear to be nearly impeccable, with markers including students being well-behaved, raising their hands routinely, and answering questions when prompted, yet students report that they were in fact not engaged, not actively participating, and not interested in what was going on in the classroom. The underlying issue here is that these classrooms typically involve a linear transfer of knowledge from the teacher with minimal and often superficial reciprocation by the student. Emdin (2009) explains that the most likely reason for this is that:

...true markers of participation, those that are expressed in places outside of the classroom, are not accepted within the classroom. These markers of participation—deep involvement in the preparation of the experience, showing excitement through increased volume of speech and heightened use of gestures, having synchrony in movement, and having a ‘rhythm’ of the conversation—which are key identifiers of deep involvement in activities outside of the classroom are not seen in the classroom. In many instances, these same markers of participation are often misidentified as an exhibition of poor behavior within classrooms. (p. 5)

The descriptions provided by McCourt and Emdin might appear unrelated at first glance. For example, neither McCourt nor Emdin make a specific reference to science teaching, however, a closer examination reveals that the two are actually linked by common threads: the teacher’s recognition and understanding of student rituals; and acknowledgement of rituals in the classroom in an attempt to unite content with students’ everyday experiences, thus setting a context for learning. These actions feed back into research conducted by Beers and LaVan (2005), Emdin (2007a), Seiler (2002), and Tobin, Treagust, and Fraser (1988) which argues that because science is often taught as a collection of facts with little relevance to the lives of students, it is necessary to weave culture and context into the teaching and learning of science.

2.6.2 *Effective Learning Environments: Corporate Goals Through Communal Practices*

In Bloom’s (1988) *The Closing of the American Mind*, one of the primary arguments laid out is that education would be much more effective if it were set up like the Marine Corps, with knowledge being instilled through drill and repetition. Critics often describe Bloom’s idea as one:

...in which you just march the students through a canon of ‘great thoughts’ that are picked out for everybody. So some

group of people will say, 'Here are the great thoughts, the great thoughts of Western civilization are in this corpus; you guys sit there and learn them, read them and learn them, and be able to repeat them. (Chomsky, 2003, p. 26)

Educators can travel as far back as John Dewey to interrogate academic works that support classroom practices that run counter to the ones described by Bloom and enacted by corporate classroom teachers. Dewey described education as a process of doing, not repeating, and, in so doing, denounced instructional approaches that do not provide spaces for students to make organic, personal connections to the classroom instruction. He maintained that cognitive potential happens when we bring together our experiences and their meaning with actions that test those meanings in the world (McCarthy, 2000). Despite our knowledge of how students are best engaged, many urban classrooms continue to use a corporate scheme with students disallowed from making decisions that affect their learning.

The fundamental tenets of a corporate classroom are derived from a factory model in which the objective is the production of a specific product (in many cases in education, success on a standardized achievement examination) rather than the social interaction and process of investigation that accompanies the learning of a scientific topic:

He realized that what it meant is, what's valued here is the ability to work on an assembly line, even if it's an intellectual assembly line. The important thing is to be able to obey orders, and to do what you're told, and to be where you're supposed to be. The values are, you're going to be a factory worker somewhere, maybe they call it a university, but you're going to be following somebody else's orders, and just doing your work in some prescribed way. And what matters is discipline, not figuring things out for yourself, or understanding things that interest you – those are kind of marginal: just make sure you meet the requirements of a factory. (Chomsky, 2003, p. 28)

Students in a corporate classroom feel that content is being imposed on them by an authoritarian teacher whose classroom practices contribute to the reproduction of hegemony and thus render them unable to see any relevance in retaining the information after an assessment (Braa & Callero, 2006; Chomsky, 2003). This is especially the case in urban science classrooms where teaching and learning is often complicated by issues such as strict curriculum and classroom management issues, both which can be detractors to effective instruction (Darling-Hammond, 1997). Therefore, educators who set up corporate classrooms teach science with a particular focus on the delivery of concepts, laws, and principles that are perceived to be the essential pieces of knowledge needed by students in order to make deeper connections later. Corporate classrooms fail to teach science as an inherently investigatory, critical, theory-driven process for developing models and structures, but rather rely on teaching students compliance to existent classroom protocol and strict adherence to science rules and laws (Braa & Callero, 2006; Emdin, 2007a). This includes the belief that the teacher is always right, the administrator sets all the school rules, and the student must be subservient to the aforementioned parties. Generally, students in this type of classroom have very little freedom in taking ownership of the learning experience; their opportunities to be actively engaged are reduced along with the chance to display their academic abilities (Emdin, 2007).

Formation of a communal classroom serves as the pedagogical response to corporate classroom structures. In a communal classroom, the responsibility for learning is shared among all the students and the teacher, while simultaneously immersing the students in a large amount of content connected to their experiences (Perkins, 2004). According to Seiler and Elmesky (2007), in the communal classroom, the teaching and learning of science is viewed as a social process that

values students' ways of knowing. For example, Ladson-Billings states that "...in-class recognition of out-of-class excellence encourages students to perceive of excellence broadly" (1994, p. 99) and explains that "the search for an approach to research that better represents indigenous and community knowledge remains a worthwhile one" (2003, p. 51). Emdin (2007a) asserts that corporate goals (success on standardized examinations) do not have to be sacrificed in order to attain a communal classroom. When the focus is the creation of a class-wide learning experience, students begin to show greater interest, thus improving examination scores and mastery of the subject matter.

Discussions between teacher and students define what certain communal practices look like. For example, if a group of students agree that obtaining a general consensus constitutes a communal practice, then the opposite, in this case, the yelling out of orders by the teacher, is considered a corporate practice (Emdin, 2007a). Figure 2.1 further describes the relationship and dichotomy between corporate and communal practices.

CORPORATE	Yelling out orders	Teacher as leader
COMMUNAL	Getting a general consensus	Teacher as facilitator

Figure 2.1: Heuristic Describing a Relationship Between Corporate and Communal Practices (Adapted from Emdin, 2007a)

Practices affiliated with communal classrooms make use of students as agents of change. Such practices require the involvement of both teacher and students in discussions regarding what effective science instruction looks like. Such discussions require mutual respect, trust, and the opportunity to question. Conversely, corporate practices assume that the noise accompanying such discussions leads to chaos in the classroom and is a method for students to postpone learning. Ladson-Billings (1994)

argues that effective teaching requires that information is not simply delivered, but is presented in a context that results from discussions between teacher and student.

2.7 Reality Pedagogy

This section of the literature review explores reality pedagogy as an approach to transform corporate classroom environments into communal classroom environments. Reality pedagogy can be broken down into five components, each of which is described in this section. The theoretical framework that led to the development of each of these components is described as well. Finally, studies that have utilized reality pedagogy, or its components, are reviewed.

Reality pedagogy involves a merging of multiple approaches to effective science teaching and learning into a more cohesive and implementable pedagogical approach. It is nested between critical pedagogy and culturally-relevant pedagogy – in the sense that it takes tenets from each of those approaches into consideration in the design of lessons and the creation of effective learning environments.

Critical pedagogy, which is focused on the attainment of social justice and equality, and the political implications of curriculum and other subtle nuances of classroom operations, allows teachers to teach science with an awareness of the larger implications of their classroom practices (McLaren, 2000). For example, a science educator who is a critical pedagogue would deliver a topic like DNA not only by teaching the Watson and Crick model, but also by discussing the under-discussed impact of Rosalind Franklin's work on the topic. In a critical pedagogue's instruction, the political reasons related to sexism that relate to the lack of recognition that Franklin received in the creation of the DNA model, together with both the historical

and contemporary role of sexism in science, are conveyed while science content is accurately delivered.

Ladson-Billings (1994) describes culturally-relevant pedagogy as empowering students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes. Lee (2003) describes culturally-relevant science pedagogy as instruction that focuses on the linguistic and cultural norms of students' lives and their consideration in the delivery of science content. In both of these descriptions, the focus is on the teacher's identification of students' culture, acceptance of it, and use of referents from it in the instruction of students.

Reality pedagogy involves the development of teachers' ability to understand the realities of student lives so that the cultural referents used in instruction are reflective of students' realities and not teachers' perspectives of them. It provides opportunities for teachers to immerse themselves in the students' local culture, and then work with students to accurately use the information from these realities in their instruction. Through this process, the political underpinnings to teaching and learning get revealed to the teacher experientially (Emdin, 2010, 2012). Thus, through the provision of opportunities provided by reality pedagogy for the teacher to be a part of student activities, practices, and rituals, a more accurate reflection of student culture in the classroom is delivered. Cobern (1996) argues that these realities, experiences, and artifacts that students have are what make them to feel, think, and act in particular ways. When educators and researcher try to understand the connections between students' realities and the ways in which they feel, think, and act, this sheds light on how educators can coordinate activities and/or use analogies that prompt certain desired student behaviors such as increased participation, increased leadership and higher motivation in class (Cobern, 1996).

Reality pedagogy also acknowledges the significance of using referents from student experiences as key points from which pedagogy is enacted. In addition, reality pedagogy functions to provide agency to students by making them a part of the teaching and learning process. In this sense, it allows students to be a part of the decision-making process by expanding their roles in the classroom. Lastly, it provides larger themes/tools/overarching goals that teachers can aim for on the path toward meeting the needs of students in urban science classrooms (Emdin, 2010, 2011).

The path toward enacting reality pedagogy goes beyond the provision of general recommendations given to teachers to involve the strategic enactment of certain practices that relate to the quality of instruction in the classroom. These practices have been developed from years of research conducted in classrooms in two urban cities in the Northeastern United States: New York City and Philadelphia (Bayne, 2007; Beers, 2005; Beers & LaVan, 2005; Emdin, 2007a,b, 2010; Seiler, 2001, 2002; Seiler & Elmesky, 2007; Sirrakos, 2007; Tobin, Elmesky, & Seiler, 2005; Tobin & Roth, 2005). In these studies, certain practices were enacted as a means for improving urban science instruction, and then evaluated for their effectiveness. While certain practices that the researchers implemented did not positively affect classroom instruction, in many instances, certain practices were deemed significant in helping teachers to effectively teach science.

A study of these successful practices indicated that there were three paths to successful urban science teaching (Emdin, 2009). However, further study uncovered that the earlier three dimensions, without a focus on content and context, would not reach their potential as facilitators of successful classroom practice. Therefore, the three initial dimensions were combined with a specific focus on content and context

in order to provide a single comprehensive approach to urban science instruction. These foci for urban science teaching are cogenerative dialogues, coteaching, cosmopolitanism, context studies, and content understanding – which have been referred to as the 5 Cs for urban science education (Emdin, 2010, 2011).

2.7.1 The 5 Cs for Urban Science Education

The cogenerative dialogue was initially developed by Roth, Lawless and Tobin (2000a) as a practice of debriefing lessons for the purpose of improving teaching and learning by providing participants with opportunities to talk about specific lessons, teaching strategies, and subject matter pedagogy. Originally, individuals included in the cogenerative dialogue were the teacher and the researchers and eventually it was extended to include students.

Cogenerative dialogues consist of out-of-class conversations populated by four to six students, each holding a slightly different outlook on the classroom and their teacher. During these conversations, there are established norms about equal turns at talk among participants, mutual respect, and co-generating something that the entire group of participants can improve about the science classroom (Roth, Lawless, & Tobin, 2000a). Oftentimes, these conversations revolve around the ways in which the lesson is taught and the way in which the class is structured. When they occur regularly (at least once a week), students begin to provide insightful critique into the science instruction. According to Tobin (2006, p. 138), this “can lead to resolutions for enacting teaching in particular ways, rationale for events and practices, and commitments to practices that emerge and conform to particular values and ethics.”

As the use of cogenerative dialogues grew, the realization that they functioned as fields in which culture was being produced, transformed, and reproduced, all while

supporting the expression of agency, became apparent (Roth & Tobin, 2004). Emdin (2007a, 2007b) observed that the agreed-upon understanding, or culture, being produced during the cogenerative dialogues was being enacted in other fields, such as other subject areas, the cafeteria, and outside of the school building, implying that the cogenerative dialogue was a porous field that could be used to bridge cultural, racial, and ideological misalignments and address critical issues in science classrooms. This is possible because of what Bourdieu (1986, 1990) refers to as an ‘accumulated history’ which allows individuals with agency in the same field to exchange different forms of social capital.

This strand of the 5 Cs provides information to teachers on how students make sense of the classroom, allows students to see that their thoughts and opinions about teaching are valued, and concurrently helps students to develop positive intergroup attributes that inevitably benefit them in science (Emdin, 2010). Figure 2.2 below shows the 5 Cs of reality pedagogy and the importance of cogenerative dialogues to reality pedagogy. The cogenerative dialogue was placed at the center of the diagram because it is only through students’ participation in cogenerative dialogues that the other components of reality pedagogy could be accomplished.

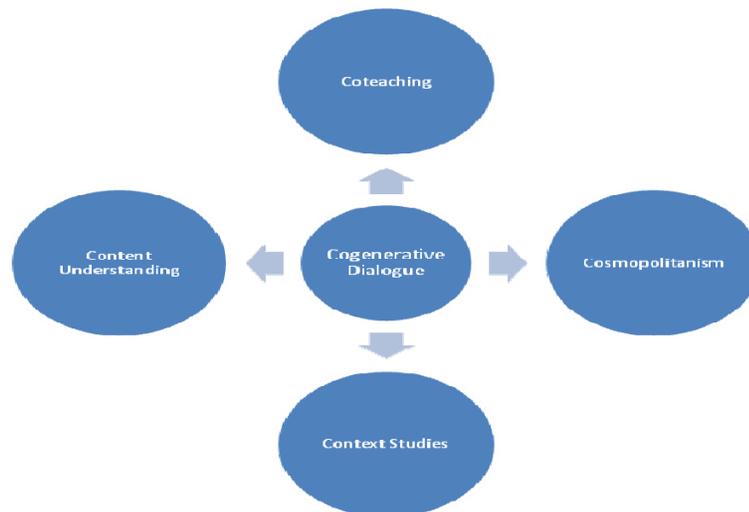


Figure 2.2: The 5 Cs of Reality Pedagogy

One of the most important aspects associated with the formation of an effective learning environment is the development of a relationship based on trust, respect and understanding between teacher and students. A teacher's ability to form these relationships with students is a difficult task that often requires the construction of new strategies for action and interaction with them. These new interactions are generally based on the acknowledgment of a new social capital that can be brought into the classroom. Plainly, a student will become more interested in a teacher's class when the teacher takes an interest in the student's social culture outside the classroom (Beers, 2005).

Terms such as 'team teaching' (Murata, 2002) and 'peer teaching' (Bullough et al., 2003) have traditionally been interchanged with the term 'coteaching'. Coteaching, which is the second of the 5 Cs, is a process that allows the student to take on the role of teacher and it is important to note that, for the scope of this literature review and study, the term 'coteaching' is not synonymous with 'team teaching'. Traditional versions of coteaching generally involve interprofessional collaboration between teachers at different stages of their careers (Tobin & Roth, 2005) or from different disciplines, such as a specific content area and special education, with the goal of improving dialogue among teachers and teacher practice (Reinhiller, 1996). Coteaching, as used in this study, and when linked to cogenerative dialogues, extends beyond the goals of traditional coteaching by positioning students from various backgrounds as the professionals in the distinct areas that affect the classroom (Emdin, 2010). In this process, students are asked during cogenerative dialogues to be responsible for decisions about effective teaching and their peers' learning, to make decisions about what practices the teacher enacts, and then to step in if the teacher is not effectively enacting the practices agreed upon during cogenerative

dialogues (Tobin & Roth, 2005). In this process, students are seen as the experts and, consequently, they see themselves as such. This level of coteaching can be attained through two processes called the Buddy System or Student as Teacher (Emdin, 2011). Both of these processes result in students connecting to their peers and enacting the responsibilities of the teacher. With the Buddy System, higher-performing students partner up with lower-performing students and a space is created in the class where these groups can meet and support each other with the learning of scientific content. The Student as Teacher arrangement allows students to co-plan with the teacher, review the topic that will be taught in class, collectively decide on assignments, and then teach the lesson to their peers.

Cosmopolitanism, the third strand of the 5Cs, is a philosophical understanding that focuses on the notion that all of humanity are citizens of the world. According to Appiah (2006), the boundaries that exist between cultures are morally irrelevant and, thus, each person has a responsibility for ensuring that all people are treated fairly and equally. While cogenerative dialogues more broadly focus on developing plans of action for improving the classroom, and coteaching involves the expansion of the role of the student to include that of teacher, cosmopolitanism is the focus on developing deep connections with students across racial, ethnic, linguistic and gender categories so that they can get the most from their classroom experience (Emdin, 2011, 2012). In order to enact cosmopolitanism in the classroom, there first must be an acknowledgment of the multiple cultures existing in the classroom. For example, the teacher can acknowledge that there is a culture of science, a culture of urban youth, a culture of teaching, a culture of Latino students, a culture of African American students, a culture of international students, etc. (Emdin, 2010). Once the various cultures are brought forward, students are invited to work together to breach possible

cultural misalignments that might exist. By beginning with an acknowledgement of the differences that exist without placing a value on any one particular culture, the teacher makes it clear from the beginning of the academic year that there is a collective responsibility to make sure that everyone learns about how to support each other in learning science. In doing so, classroom stakeholders take every opportunity to ensure that everyone is connected to teaching and learning in the classroom, and there becomes established a norm in which students and teachers can hold each other responsible for teaching and learning (Emdin, 2007b).

The fourth C in the set of tools for urban science education is content understanding. The use of the term here refers to science content as it is conventionally used – referring to the subject matter that is supposed to be taught in the classroom. However, this view of content also refers to teachers' comfort with finding multiple ways to deliver the content. In reality pedagogy, knowledge of the science content must accompany an understanding of how to engage in conversations with students about it. Therefore content knowledge is married to pedagogical content knowledge as it is targeted towards a specific demographic of student (Magnusson, Krajcik, & Borko, 1999; Shulman, 1986). Emdin (2012) asserts that the goal here is not to change science or re-establish which topics are parts of the curriculum, but rather to shift understanding about how specific science topics in the classroom can best be delivered.

The final dimension of reality pedagogy is context studies, referring to a focus on the spaces outside of the classroom of which students are a part, the use of both physical and symbolic artifacts from these out-of-school spaces in the classroom, and interrelated phenomena such as cultural traditions and ways of knowing and being (Emdin, 2011). Context, in relation to reality pedagogy, requires an understanding of

the artifacts that make up students' lives, and a level of comfort with these artifacts that makes it easy for the teacher to pull the context (through artifacts) into the classroom. Artifacts can be either tangible phenomena (such as rocks from a local park or an object that students use in their everyday lifeworlds) or symbolic (such as stories about the neighborhood or information about the history of students' neighborhoods) (Emdin, 2007a, 2007b, 2011). The practice of connecting students' artifacts with learning bridges the divide between school and their real lives, allowing subject matter to be more relevant and the teacher to be more effective (Emdin, 2011).

Seiler (2001) points out that one of the downfalls of urban classroom teachers is their lack of understanding of urban minority students' lifeworlds. Teachers often disregard and devalue the culture that students bring into the classroom. The porous nature of the classroom often allows the addition of one's own experiences for the purpose of enhancing the lesson by making it more interesting and adding relevance. Unfortunately, the experiences that are brought into the classroom are generally those of the teacher, whereas students often get shut down when trying to offer their experiences. Discussion of student experiences is often perceived as a method for the postponement and avoidance of doing work in class. Therefore, when students try to offer their culture to the classroom environment, teachers quickly react and feel the need to have to "settle students and regain control" (Beers & LaVan, 2005, p. 149).

2.7.2 Research Involving Reality Pedagogy

Research involving various forms of reality pedagogy has been carried out by researchers who have taken a step back from focusing on how to decrease the achievement gap between urban minority and suburban white students and, instead, have examined the methods by which urban science students are taught and why they

are generally labeled as being disinterested in science. The creation and implementation of student-emergent curricula, the breaking down of the negative perceptions associated with the experiences of urban students, and the formation of student social capital in the classroom have all been accomplished through reality pedagogy.

Certain dimensions of reality pedagogy were used by Roth, Lawless, and Tobin (2000b) to investigate the classroom practices of a number of preservice and inservice teachers. Specifically, the gap between the theories of teaching provided by teacher education programs and the use of these ‘teaching techniques’ in the classroom was explored. Roth, Lawless, and Tobin argued that, because there is no ‘time out’ during teaching practice, a teacher relies heavily on his or her own cultural dispositions to generate appropriate actions or reactions to classroom occurrences. The researchers asserted that coteaching allowed the members of the classroom community to continuously engage in transforming their cultural dispositions, often used as a response, through critical analysis during debriefing sessions. The study concluded by suggesting coteaching as a strategy for bridging the gap between research and praxis.

Seiler (2001) used certain dimensions of reality pedagogy in her research involving students as curriculum designers and teacher educators. She allowed students to explore science using their own interests including drumming, rapping, and the World Wrestling Federation. These student interests were paralleled with science topics including the physics of sound, motion, force and the anatomy of human joints. This practice allowed a student-emergent curriculum in which student suggestions for topics and learning approaches were taken into consideration and aligned with science standards. Ultimately, use of the student-emergent curriculum as

a method of teaching led to positive changes in the overall structure and practices of the classroom (Seiler, 2002; Seiler & Gonsalves, 2010).

Tobin, Roth, and Zimmerman (2001) used the reality pedagogy dimensions of cogenerative dialogues and coteaching in an ethnographic study describing the experiences of a new teacher who had been assigned to an urban high school in Philadelphia. Cogenerative dialogues and coteaching were used to provide the teacher with shared experiences that became the topic of their professional conversations with their peers, the researchers, university supervisors, and high school students. The study reported that outcomes of the teacher's immersion in cogenerative dialogues and coteaching resulted in the enactment of a curriculum that was culturally relevant to her African-American students, acknowledged their minority status with respect to science, and enabled them to pursue the school district standards.

Another study by Beers and LaVan (2005) was conducted at Charter High, a small charter high school in an urban section of Philadelphia. The study took place in an introductory earth science class with the majority of students repeating the course. Initial observations identified the negative history that the students had experienced with the teacher, as well students being resentful of having to retake the class. LaVan, the primary researcher, worked with Beers, the cooperating teacher, to implement cogenerative dialogues and monitor their effects on students' science interest and performance. This study took a slightly different approach by integrating video to record each class session. Then, during the cogenerative dialogue, the videotape was shown and critiqued by those involved. Initial video of the class compared to video at the conclusion of the study showed a drastic transformation in the structure of the class and the overall attitude of the students towards learning science. A student

participant in the cogenerative dialogues pointed out that the conversations benefited the classroom and the individual student in that it gave him:

...a chance to hang out with and get to know teacher and Students in a very real way. We get to build social capital and have fun at the same time. We are not sitting there being fake, but talking about interesting things that relate to all of us. (Beers & LaVan, 2005, p. 162)

The teacher and researcher of this study concluded that:

...students were able to develop skills associated with science fluency while discussing issues that were important to them. Discussions generally encourage students to use multiple and varying resources (human, symbolic, and material) while observing, describing, and communicating understandings of the circumstances to others, supporting ideas with evidence, and listening to others' perspectives. (Beers & LaVan, 2005, p. 162)

Many past studies have used certain aspects of reality pedagogy to help to prepare teachers for positions in typically low-achieving, urban school environments. Martin (2005) used cogenerative dialogues as a means by which to improve science curricula in an urban magnet school for high-achieving youth. As a teacher-researcher, Martin set up several cogenerative dialogue groups to function independently in her classroom where students could discuss curriculum and recommend alternatives and changes to the teacher. Martin (2005) alluded to the importance of students' ability to request and schedule cogenerative dialogues and to have input into who participates. She also reported that the teacher's involvement in cogenerative dialogues provided the ability to deliberately and thoughtfully integrate the recommendations made by students into the daily classroom instruction.

Functioning as both the teacher and researcher, Emdin (2007a, 2007b) investigated reality pedagogy in a grade 9 physics classroom in New York High School in New York City. Emdin noticed within the first few weeks of the school

year that most of the students were lost in the subject matter and that some had already given up on learning. Students' actions included ignoring the teacher, not participating, having their heads on the table and sleeping during the lesson. Emdin used the multiple dimensions of reality pedagogy to compare students' attitudes and actions both inside and outside the classroom. While acknowledging the importance of exchanging social capital, Emdin concluded that students in corporate classrooms are typically not given a chance to display their academic abilities. For example, Emdin described a student who, although very good at multi-tasking, was immediately reprimanded and labeled as being unfocused when he attempted multi-tasking in another teacher's classroom. Emdin concluded that reality pedagogy allowed students to promote their social capital in the classroom, thus creating a link between communality and academic success. When the focus was the creation of a class-wide learning experience, students typically began to show greater interest, thus improving achievement and mastery of the subject matter. Further, the multiple dimensions of reality pedagogy were helpful in identifying allegiances to either corporate or communal ideologies and facilitating self-reflection of both students and teachers.

As noted, many past studies that have researched the effects of reality pedagogy have primarily used low-achieving, urban minority youth as the population of interest. Martin (2005) conducted one of the few studies of reality pedagogy using high-achieving urban minority youth. My study was unique in that it did not focus only on a single type of student population. Rather, this study explored and compared the outcomes of reality pedagogy for two distinct populations, which is something that had not been previously undertaken. The two populations of students are described in greater detail in Chapter 3, Section 3.5.

2.8 Summary of the Literature

The three overarching fields of study expounded on in this literature review, namely, research into learning environments, attitudes towards science, and reality pedagogy, are time-tested and relevant to many of the issues and trends appearing in science education today.

In this chapter, it became evident that the field of learning environments has a rich history and has been integrated into a plethora of educational studies. Learning environment researchers have built on the work of those before them, such as Lewin (1936), Murray (1938), and Moos (1973). As the field of learning environments grew and developed, a diverse range of research areas involving learning environments emerged. For this study, the research areas involving associations between student outcomes and environment, evaluation of educational innovations, and cross-national studies of cultural differences in education were most relevant and therefore were reviewed more extensively. However, a brief description of each of the other research areas is provided in Table 2.2. Research into each of these research areas has been assisted by the creation and validation of a number of questionnaires which measure students' perceptions of various psychosocial dimensions of the learning environment. This chapter reviewed literature pertaining to a number of important questionnaires, including the Constructivist Learning Environment Survey (CLES) and the What Is Happening In this Class? (WIHIC) survey which were used as part of this study. Much of the literature review about these questionnaires focused on establishing their validity and reliability.

In addition to exploring students' perceptions of the learning environment, because this study also examined students' attitudes toward science, I also reviewed relevant literature about attitudes. While there are varying operational definitions of

attitude, I chose to work within Thurstone's (1928) framework, which suggests that attitudes can be measured by exploring the intensity of positive or negative affect for or against a psychological object to which an opinion has been expressed. In order to measure attitudes, this study used Fraser's (1981) Test of Science Related Attitudes (TOSRA), based on Klopfer's (1971) attitude framework. A number of studies that used the TOSRA were reviewed including those with a focus on associations between the learning environment and student attitudes, attitudinal differences based on gender and geographic location, and relationships between students' attitudes toward science and their level of achievement. Additionally, as with the CLES and WIHIC, the literature review also focused on the validity and reliability of the TOSRA across a number of research studies.

Finally, this chapter also reviewed literature pertaining to effective learning environments as a way of introducing reality pedagogy, whose fundamental idea is to encourage teachers to appreciate students' cultural experiences and the importance of utilizing those experiences in teaching and learning. The literature reviewed in this chapter described the five components of reality pedagogy: cogenerative dialogue, co-teaching, cosmopolitanism, content, and context. Further, studies that have used some or all of these components were reviewed to add credibility to the use of reality pedagogy as a tool to transform the learning environment. In this study, the effects of reality pedagogy were explored across classrooms in Dresden, Germany and the Bronx, New York.

The three areas presented in this literature review have gained much credibility in the field of education because of the work of numerous key researchers. Yet, there are gaps in the literature that my study attempted to fill. First, the CLES, WIHIC, and TOSRA have undergone limited validation and use in New York and

none at all in Germany. Thus, this study expanded the geographical range of validity and applicability for these instruments. Second, while each of these three areas of study is unique and significant in its own right, the study presented here is a first attempt at combining all three areas. This study is also unique in that it expanded the geographical range of reality pedagogy. For example, previously reality pedagogy had primarily been investigated in urban cities in the USA, such as Philadelphia and New York City. However, this was the first study that investigated reality pedagogy outside of the USA, specifically in Dresden, Germany. Finally, this study moved past the traditional research methods used to investigate reality pedagogy. Reality pedagogy as a whole or its individual components has typically been evaluated using qualitative data-collection methods. However, by combining scales from two learning environment questionnaires and a student attitude questionnaire, this study was able to include quantitative data in evaluating the effectiveness of reality pedagogy in each geographic area.

The next chapter of this thesis provides the reader with a better understanding of the methods used to conduct this study. The theoretical framework which guided the research along with ethical considerations are presented. Additionally, information regarding the study's sample and data sources is given. Finally, a description of the data analyses and instruments used for data collection, along with the limitations and biases of the study, are presented.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction to the Chapter

In a guide for educational researchers, Anderson (1998, p. 3) explains, “How you see the world is largely a function of where you view it from, what you look at, what lens you use to help you see, what tools you use to clarify your image, what you reflect on and how you report your world to others.” This statement describes fairly accurately this chapter, which explores the methods used in carrying out the study in an effort to provide the reader with a better understanding of the inner workings of the research, while giving greater meaning and credibility to the gathered data.

The methodology was guided by the four overarching research questions described in Chapter 1 of this thesis. First, this study attempted to validate the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) for use with samples in Dresden, Germany and the Bronx, New York. This study also attempted to investigate the effectiveness of reality pedagogy in science classrooms in terms of changes in student perceptions of their learning environment and student attitudes. Additionally, my study attempted to identify and explain differences between students from the Bronx, NY and Dresden, Germany in terms of their perceptions of the learning environment in science classrooms and their attitudes toward science before and after engagement with reality pedagogy. Further, I was also interested in exploring associations between students’ perceptions of their learning environment and their attitudes toward science. Essentially, all these

research aims circled around attempting to further validate reality pedagogy as a worthwhile tool for creating a learning environment that fosters inquiry and student interest in science.

Based on the aims of the study, a multidimensional research design was implemented to increase understanding of the effect of reality pedagogy, giving special attention to the complexities and subtle nuances of the science learning environment and students' attitudes toward science. Noting that the field of learning environments is broad in terms of both substance and methods, it was of great significance that the most appropriate methods to address the multiple facets of the science learning environment and students' attitudes toward science were selected. Thus, the methods selected and the reasoning behind their selection are addressed in this chapter.

This study used a mixed-methodology research design, drawing upon questionnaires, classroom action research, and ethnographies as methods for data collection. Learning environment and student attitude instruments offered an economical way to gather data, but the data gathered by such instruments sometimes overlook the intricacies involved with regard to why students respond to particular items in a certain manner. Conducting interviews with students can be used to fill in some of these missing details, but they can be time consuming. Further, classroom observations allow the researcher to be embedded in the research, but they have the downfall of the researcher's bias influencing judgment (Denzin, 1994). When each of these data-collection tools is used in isolation, its weaknesses become apparent but, when used in conjunction with other data-gathering tools, their weaknesses can be reduced and their strengths prevail.

Accomplishing the goals of the study required combining a variety of scales from three existing questionnaires into a single instrument to be validated for use with this sample. These data, when combined with the qualitative data from cogenerative dialogues, classroom observations, and student interviews, served as the foundation upon which the research questions were investigated.

This chapter is organized under the following headings:

- Section 3.2 – Perspectives of the Research: Paradigms, Epistemology, and Ontology
- Section 3.3 – Ethical Issues and Considerations
- Section 3.4 – Combining Quantitative and Qualitative Research Methods
- Section 3.5 – Data Sources and Sample
- Section 3.6 – Instruments Used for Data Collection
- Section 3.7 – Data Analyses
- Section 3.8 – Limitations and Biases of the Study
- Section 3.9 – Summary of Research Methods.

3.2 Perspectives of the Research: Paradigms, Epistemology, and Ontology

According to Anderson (1998), there exists a common belief that a researcher's choice of paradigm is determined by the type of data collected. On the contrary, I believe that my perspective on research was guided by the foundational assumptions that I possessed regarding education rather than the data that I was collecting. As the research described here commenced and progressed, the narrow theoretical framework with which I was initially working evolved and grew. Observation after observation, questionnaire after questionnaire, dialogue after

dialogue, my researcher and educator lenses were constantly being transformed. In this section, I describe the research perspectives or guiding light that led to my selection of methods.

Willis (2007) describes a paradigm as a thought pattern that guides beliefs about what constitutes legitimate research, the methods with which research should be conducted, and how the conclusions of research should be used. Epistemology deals with exploring what we know about the world, which ultimately depends on the way in which we perceive it to begin with, how we can find truth behind what we know, and how we can justify what it is that we think we know (Willis, 2007). Further, according to Willis (2007), ontology is the part of a paradigm concerned with how reality is perceived and with trying to define what constitutes something as being real or not. For example, adopting a paradigm that values the use of the scientific method to explain physical properties must first be nested in the perception that these physical properties actually exist. There exist various ontological positions which each have a different way of explaining our perceptions and what is real. I have taken care to define these terms here because I want to be clear that, even though two researchers might align with a specific paradigm, their views on research can be subtly different if their ontologies are not aligned. Therefore, if I can convey my own ontological and epistemological allegiances, my selection of methods to investigate the research questions that I posed become more credible.

Before this study began, I was forced to reflect upon and deconstruct my own beliefs about the current practices in place for teaching science to urban minority and international school youth. Almost simultaneously, I began thinking about what I hoped to accomplish with my research, how I intended to conduct my research, and what I intended to do with the results of my research. As answers to these questions

materialized and I compared major research paradigms typically governing science education research, I found myself wavering in between the paradigms of interpretivism and critical theory, primarily because my research aimed to try to understand how students make sense of their classroom by examining events and experiences that occur outside the classroom.

Interpretivism is characterized by a concern for the individual and asserts the idea that, regardless of the research methods used, humans cannot come to know the world as it really is. This paradigm emphasizes approaches aimed at understanding the nature of people's participation in social and cultural life, which are in contrast to approaches typically used in the natural sciences that attempt to obtain precise, numerical data to support or reject a hypothesis (Cohen, Manion & Morrison, 2000). Rather, researchers aligned with an interpretivist paradigm use qualitative data including journals, audiotapes and interviews to interpret events, contexts, and situations as a means of analyzing the meanings that people confer upon their own and others' actions. Accomplishing this requires the researcher to work with the subjects rather than being an external observer. Furthermore, researchers adopting this paradigm do not construct a theory as occurs in other paradigms, but rather allow for the emergence of a theory after the data have been collected (Glaser & Strauss, 1967). The theory is not perceived as a universal truth but rather as a collection of individual meanings which "yield insight and understanding of people's behavior" (Cohen, Manion & Morrison, 2000, p. 23). Even though the theory that emerges is not considered to be universal, it can be used to understand how a reality at one time and place can be compared to a reality in another time and place.

There are certain advantages in using approaches associated with the interpretive paradigm. Researchers working in an interpretivist framework share their

initial interpretations of the data with the participants in an effort to cross-validate their interpretations to be sure that their acquired knowledge is valid from the perspectives of all involved parties. However, even with this quality standard in place, researchers are limited in their understanding because of the continued threat of being unable to completely liberate themselves of their own biases (Mulholland & Wallace, 2003). Further, because the methods undertaken by such researchers focus on the individual rather than the world at large, findings are of practical interest.

As with all paradigms, there are also some associated limitations to these approaches stemming primarily from the fact that data collected are not quantitative and thus subject to interpretation. Thus, limitations of the interpretive paradigm include difficulty in making generalizations about the research, the possibility of over-interpreting the results, and problems with verifying data. For example, Rex (1974) explains that social reactions can be the product of the individual's definitions of the situation yet, because of the fact that those individuals can be falsely conscious, it is the duty of the researcher to seek an objective perspective which might not necessarily be that of any of the participating individuals at all. Further, Rex (1974) argues that interpretivist researchers have deviated extensively from the foundations of scientific procedures of verification and have thus given up hope of discovering useful generalizations about behavior.

While interpretivism aims to interpret the world, it does not offer a complete account of social behavior because it fails to take into account the political and ideological contexts of educational research. Critical theory is an educational paradigm that is explicitly political and has the aim of emancipating individuals and groups from oppression and creating a social democracy in which all are equal. Unlike interpretivism, which focuses on observing and understanding social

phenomena, critical theory aims to change situations by examining the relationship between school and society and by bringing equality to areas such as the social construction of knowledge and curricula, the definition of worthwhile knowledge, and the legitimacy of the interests served by educational institutions (Cohen, Manion & Morrison, 2000). Therefore, studies aligned with a critical theory paradigm are not necessarily concerned with verifying or constructing a theory, but rather are focused on actions that are informed by reflection and aim to emancipate the oppressed. Critical theorists typically approach their research using two primary methods: ideology critique and action research. The purpose of ideology critique is to uncover the interests of those in a position of power to show to the oppressed how they might be acting to perpetuate a system which keeps them either empowered or disempowered (Habermas, 1972). Action research allows the participants to provide their experiences to the researcher while also being actively engaged with the researcher from the initial design to the final presentation of results and discussion of their implications (Cohen, Manion & Morrison, 2000).

Critical theory researchers believe that the world is an unjust place in which there are those in power and those who are disempowered. An advantage of working within this paradigm is that the researcher is able to focus the research at different levels, whether it is justice for entire societies, groups or individuals. In addition, the use of action research allows the realization of emancipation, which would not generally be feasible via other methods of obtaining data. Generally speaking, the goal of emancipation in itself is an advantage in that participants are able to be free from the oppressor and can begin to assert their own freedom in their actions based on previous reflection of those actions (Grundy, 1987). Thus, the perception of reality in

critical theory is what drives the necessity for critical theory to promote individual freedoms within a democratic society.

As with other paradigms, there are associated limitations to these approaches. For example, researchers can be unsure as to whether or not their action researchers experience the expected emancipation attributes associated with action research in part because of the difficulty in defining emancipation (Ginns et al, 2001). On another level, critics of this paradigm often claim that the use of critical theory as a paradigm is attached to the advancement of a particular political agenda (Cohen, Manion & Morrison, 2000).

Reality, as I interpret it and as the thread that binds this study, can be constructed based on the lived experiences of the participants. Surely, the reality of the classroom learning environment is unique for every student, as each brings a distinct set of experiences into the classroom. Therefore, it becomes of great value for the researcher to work with the subject in order to interpret specific events and gain a deeper understanding of specific occurrences. In a similar vein, the research was designed to evoke change in the way in which science classes are taught by inviting students to share their experiences outside the classroom. This target nests this research between the interpretive and critical theory paradigm as it explored students' perceptions and issues related to schooling in an attempt to generate profound descriptions and a theory and to focus on social change by empowering and emancipating urban youth from failure in science.

3.3 Ethical Issues and Considerations

As I reflect on the nature of educational research associated with interpretivism and critical theory, I find it vital to address the ethical practices that

have guided the work presented in this thesis. Greene (1995) notes that, when educational researchers and teachers are prompted to engage in critical exercises of their own practices, they have traditionally found it challenging to move past the barriers of their own beliefs. Breaking down these barriers allows the researcher to investigate the contexts of schooling beyond the classroom and to uncover practices that allow an expansion of the ways in which students are utilized in research.

Reflection and reassessment are exercises in which researchers should continuously engage because research practices that might have once been deemed acceptable are now considered unethical. A contemporary example of this involves Nazi doctors, described as ethical and respectable citizens, conducting experimental research projects with complete disregard for the well-being of their research subjects. Looking back on such events, it is easy to conclude that these doctors were not acting ethically. However, while looking back at these events might reveal the obvious atrocities committed, we must remain cognizant that, at the time when this research was being conducted, those involved probably perceived their experiments as necessary and indispensable.

Regardless of the discipline, researchers must decide which of their methods or actions constitute ethical behavior and which do not. As illustrated in the example of the Nazi doctors, the idea of what it means to act ethically can change over time as a person's notion of what is ethical changes. Therefore, I advocate research practices that hold the ethical treatment of students under similar scrutiny to research as in any other field that uses humans as subjects. I put forth this statement, not because I believe that educational researchers are blatantly unethical, but rather because researchers often adopt the dominant ideology of their time without critically analyzing any inherent issues that might be attached. This is evident in my previous

work with teachers and educational researchers when urban minority science students were viewed through a deficit lens and student abilities to be successful in science were questioned. Holding onto this notion is unethical as it exposes an already-marginalized population to harm by probably damaging their perceptions of themselves. The negative assessments of these students probably stem from their being a part of an urban minority community. This begs the questions as to the effect that such perceptions from a teacher/researcher would have on how a student perceives his/her ability to be successful in the science classroom.

When educational researchers conduct school-based studies, their primary concern should center on the safe and fair treatment of those individuals upon whom they are conducting the research. The idea that students are simply being observed or being asked questions and not engaging in medical-based research should not excuse researchers from ensuring that participants have all the relevant information regarding the research. This should be an exhaustive endeavor in order to ensure that participants are protected from “any potential harm or abuse of power as a consequence of that research” and “that participants are fully aware of how the research will affect them” (Howitt, 2008, p. 4). Before any data could be collected, I undertook the task of obtaining ethics approval from Curtin University’s Human Research Ethics Committee (HREC). To complete this task, I consulted with and sought advice from my supervisor, Dr Barry Fraser, who has over 20 years experience in supervising graduate and postgraduate students in the field of learning environments. The aim of any ethical review board involving humans is to ensure that research participants are not put at risk of harm, are not disadvantaged, and are made aware that they may withdraw from the study at any time without repercussion. The sections that follow form a discussion with regards to actions that were taken to

ensure that this study complied with the aims of the HREC. In addition, I present a fusion of my thoughts, in addition to those posed by Emdin (2007b), on how cogenerative dialogues can be used to extend the notion of what it means to treat educational research participants ethically.

3.3.1 Gathering Informed Consent to Participate in Research Projects

In an attempt at transparency, principals, teachers, parents, and students were fully informed of the aims and objectives of this research, along with the potential risks and benefits, before any data were collected. Students (see Appendix A), parents (see Appendix B), and teachers (see Appendix C) were provided with role-specific Information Sheets that stated the purposes of the intended research and an Informed Consent Form. These documents were written using appropriate and clear (non-specialist) language specific to the intended audience. As this study was being conducted with individuals whose native language might not have been English, these documents were translated into German and Spanish by translators based in Germany. As described by Brislin (1970), these documents underwent an independent back translation from German and Spanish back to English. The primary purpose of these documents were to make participants (teachers and students) and the parents of participants, who were minors, aware that participation was voluntary and that they could choose to terminate their participation in the study at any time without prejudice or negative consequence (Howitt, 2008; Strike et al., 2002).

Along with written information sheets and consent forms, three information sessions (two for parents, teachers, and school administrators and one for students) were held prior to the start of the study to allow participants and other concerned parties the opportunity to ask questions regarding the research. During these

information sessions, appropriate information was made available to make clear how the aims of the study were to be accomplished, my position as the classroom teacher and researcher, and how the results of the study would be used.

3.3.2 Protection of Privacy and Confidentiality of Records

To ensure the privacy of all participants and schools involved, no identifiable information was included in this thesis. Raw data that used actual names were only available to me and my supervisor. For qualitative data, pseudonyms were deliberately used for all participants and schools to ensure confidentiality. Any information that could possibly identify a participant was removed and replaced by a numerical code, providing me with the ability to re-identify a specific individual and link him/her to a questionnaire response. This was a necessary procedure in order to be able to later perform a statistical analysis that involved linking a student's responses to questionnaire items at the beginning to those at the end of the academic year.

Raw data collected during this study were in the form of paper copies of learning environment/student attitude questionnaires, video recordings of classroom observations, and audio tapes from student interviews. As raw data were being collected and before being transferred to an electronic format, they were kept in a personal safe to ensure student confidentiality. As completed questionnaires were converted to an electronic format, they were destroyed. Audio tapes of interviews were erased once they were transcribed. Video tapes of classroom observations were uploaded to a computer and then erased from the video camera. As data were being collected and converted to electronic formats, they were stored on a password-protected personal computer and backed up weekly on an external hard drive. In

accordance with Curtin University policy, upon completion of the doctoral degree, all processed data from questionnaires, classroom observations, and interviews will be stored at Curtin University in a secure way for a period of five years before being destroyed.

3.3.3 Risk of Harm to Subjects or to Groups in the Community

The potential harm of educational research can seem almost insignificant in comparison with other types of research. However, throughout this study, I strived to ensure that the research protocols and the ethical treatment of students were just as strictly scrutinized because the potential harm of educational research, like medical studies, could have social and psychological consequences. It becomes a researcher's moral directive to guarantee, to the extent possible, that the welfare, rights, beliefs, perceptions, customs and cultural heritage of the participants are honored. Accomplishing this requires effective, open and transparent lines of communication between the researcher and participants.

One means of ensuring that participants were afforded unconditional fairness was to assure them that no aspect of the research was to be used in determining any marks for school work. Further, because students attend school to participate in the learning process, detracting from the educational experience in the classroom could be deemed unethical. Therefore, data were collected in a manner that caused minimal disruptions to the students' school routine. Questionnaires were administered to student participants twice during an academic year at times when curriculum pressures were least and during class time, and administration took only approximately 15 minutes. The researcher provided guidance to the classroom teacher in advance as to how the questionnaires should be administered. The

classroom teacher was responsible for reading out the instructions to the students, reminding them the purpose of completing the questionnaires, and assuring them that there were no correct or incorrect answers to questionnaire items.

Keeping with the theme of causing minimal disruption to the school routine for students, semi-structured interviews were conducted at various times during the school day, according to agreements made by the researcher and the participant. In cases where the semi-structured interview was to take place before or after school, parents were notified to obtain permission. Similarly, the cogenerative dialogues aspect of reality pedagogy occurred once a week during the students' lunch hour. Students were able to bring their lunch to the cogenerative dialogue to ensure that they were not missing an opportunity to eat. Additionally, as part of the information sheets given to parents prior to the beginning of the study, parents were given the option of being present at any meeting between the researcher and a participant.

While participants engaged in the research process, they might have divulged information that they had not intended. Therefore, in an effort to minimize risk and harm to participants, they were given free access to uninterpreted and interpreted data collected from them in an effort to ensure its accuracy and validity, as well as to provide the opportunity to retract any information that they might not have intended to provide (Howitt, 2008; Strike et al., 2002).

3.3.4 Cogenerative Dialogue as a Tool to Achieve Ethical Practice

While conducting educational research in fields such as science classrooms, researchers might engage in certain practices that they do not view as naturally being unethical. This section examines some of these practices and explores how

cogenerative dialogues can be used to bring these practices to light and to achieve a greater sense of ethicality in the research.

In this research, cogenerative dialogues served as an avenue for open discourse regarding teaching and learning in the science classroom with participants being given opportunities to reflect on their shared experiences in the science classroom and with the understanding that no voice is privileged over another. Participants in cogenerative dialogues were entrusted with cogenerating a plan of action for the improvement of their classroom and to take collective responsibility for the results of the dialogue. During cogenerative dialogues that took place in Dresden, my role as researcher transformed to that of facilitator. In this capacity, I sometimes began the dialogue with a mention of certain events that I had observed during class. Participants were free to expand on the conversation that had opened up or to discuss other concerns that they felt might be more pertinent for the collective betterment of the learning environment, hence involving them in the research at a deeper level.

The previous paragraph depicts a situation that is typically in stark contrast to how educational research has traditionally been carried out. Most educational research involves students being ‘researched on’ rather than ‘researched with’ (Emdin, 2007b). In such scenarios, the researcher is engaged in an unequal power relationship with students, resulting in students feeling that they are of lower status than the researcher. When these sentiments are perpetuated, students question their importance to the research process because it is generally understood that they are not expected to be able to suggest research questions, conduct research of their own or question research products (Emdin & Lehner, 2006). Further, this unequal power relationship often results in an understanding that the knowledge possessed by students is not valued by the researcher, thus resulting in distrust and wariness of the

researcher's methods. According to Emdin (2007b), there exists the possibility that students mistrust what the researcher might represent and question the researcher's genuine interest in their well-being if students associate the researcher with negative practices or experiences. Hence, students were rightfully apprehensive about engaging in this research study as it involved a shift in power that they had never previously experienced.

However, consistent engagement in cogenerative dialogues helped to address such subverted ethical practices by elevating students' roles from just being research subjects to the status of co-researchers in the study. Furthermore, the sharing of power in the classroom that accompanies involvement in cogenerative dialogues provided students with the opportunity to shift their beliefs about the classroom and negative perceptions they might have had about their ability to succeed in the science classroom, thus adding to the authenticity of the research as described by Guba and Lincoln (1989).

3.3.5 Ethical Issues Associated with Cogenerative Dialogues

As a school-based researcher, I was obligated to continuously pursue justice and beneficence for the participants by minimizing potential risks and unjust burdens associated with the study (Howitt, 2008). One such approach to treating students justly and with unconditional fairness was to ensure that all students had an opportunity to engage in cogenerative dialogues. This became a concern when a cogenerative dialogue is typically designed to accommodate 4 – 6 students at a time and there are 25 – 30 students in a class. Student involvement became a balancing act, yet my obligation lay in the fact that all students involved must benefit to the greatest possible extent from the results of the research. Guba and Lincoln (1989)

shed light on this issue and explained that true ethical and authentic research requires that as many participants as possible be given the opportunity to participate in, inform, and benefit from the research.

While conducting cogenerative dialogues, two other ethical concerns arose. The first of these concerns was related to acts of peer pressure from students to either participate or withdraw from engagement in cogenerative dialogues. Such actions threaten the legitimacy of informed consent and can detract from authenticity criteria put forth by Guba and Lincoln (1989). Essentially, the idea of beneficence for all would address such a concern but acts of coercion by peers would be harmful and outweigh any perceived benefits. Prolonged student engagement is another concern that could cause unethical practice in the research. Ideally, students involved in cogenerative dialogues should develop a sense of camaraderie with the rest of the class, yet students engaged for an extended period of time might revert to a state of selfishness and regard themselves as better than those students who are not involved in cogenerative dialogues. This is a consequence of the seemingly insular nature of the cogenerative dialogues. However, prolonged engagement was addressed by setting a limit on the number of cogenerative dialogues in which students can directly participate before being asked to induct a new participant into the conversation.

I believe that I made explicit my ethical obligations to the students with regard to being unbiased, accurate, and honest. However, at this juncture, the under-discussed impact of cogenerative dialogues on educators, who are also participants in the study but not necessarily a part of cogenerative dialogues, and ethical obligations to them, must also be addressed. Beneficence and justice for all is not only the duty of the researcher, but all parties involved in the research. Therefore, it must be noted that cogenerative dialogues must be structured in a manner that avoids them being

used as an arena to talk ill of a specific teacher's practices and/or educational philosophies, but rather a time to combine ideas to create a classroom nested in communality and mutual understanding. In this way, it became my obligation to ensure that teachers were treated fairly and that no unjust burdens fell onto teachers as a result of the cogenerative dialogues.

3.4 Combining Quantitative and Qualitative Research Methods

Tobin and Fraser (1998) use the analogy of multiple windows to describe how learning environments could be viewed from a multitude of perspectives, each which could provide further insight to specific issues occurring within them. However, using any single method of research to explore the learning environment is likely to snap an incomplete picture of what is actually occurring. Therefore, Creswell (2008, p. 552) explains that, "the use of both quantitative and qualitative methods, in combination, provides a better understanding of the research problem and questions than either method by itself." Further, a mixed-methods approach is useful when one type of data just might not be sufficient to address the research problem and when one source of data can be used to elaborate on or complement another source of data (Aldridge & Fraser, 2000; Creswell, 2008; Fraser & Tobin, 1991).

While both qualitative and quantitative data-collection methods make clear and significant contributions to the evaluation of the classroom environment, one type of data alone might not be sufficient for drawing conclusions that are convincing to the consumers of research (Tobin & Fraser, 1998). Therefore, numerous researchers in past studies have employed both qualitative and quantitative methods to accomplish their research aims. Manzanal, Barreiro, and Jiménez (1999) investigated the relationship between student attitudes toward environmental protection and

engagement in ecology fieldwork using both quantitative and qualitative methods. Similarly, Aldridge, Fraser, and Huang (1999) investigated classroom environments in Taiwan and Australia using multiple research methods. While these two studies represent only a small sample of the many studies that have explored learning environments and attitudes using multiple research methods, Tobin and Fraser (1998, p. 639) assert that they “cannot envision why learning environment researchers would opt for either qualitative or quantitative data” and that they “advocate the use of both in an effort to obtain credible and authentic outcomes.”

Quantitative data involve the use of numerical information in studying and describing objects and their relationships. When collecting quantitative data, the researcher assumes that there exists an objective reality that can be systematically explored and compared (Boslaugh & Watters, 2008). In contrast, qualitative data collection emphasizes a phenomenological view that uses an individual’s perception of a situation to construct an analysis of reality (Tobin & Fraser, 1998). Depending on the nature of the study, these two methods of data collection can be used in a variety of combinations. Morgan (1997) describes four general ways of combining the two types of data, based upon which one is primary and which is secondary, and upon which one is used first and which is used second. Understanding these combinations allows researchers to best select which data-collection method is considered more comprehensive than the other and which will function in a confirmatory manner of the other.

Because of the nature of the research problems presented in this thesis, using mixed methods allowed me to use the data to “develop a complex picture of social phenomenon” (Greene & Caracelli, 1997, p. 7). This exploratory study combined quantitative and qualitative methods to explore the differing ‘grain sizes’ associated

with learning environment research (Fraser, 1999). Questionnaires provided a reasonably inexpensive and efficient way to gather data about students' perceptions of the learning environment and their attitudes toward science from a large 'coarse grain' sample of students (Aldridge & Fraser, 2000). Each student involved in the study completed a questionnaire assessing the learning environment and student attitudes toward science at the beginning (August, 2010) and end (June, 2011) of the study, thus providing the study with a quantitative source of data. Qualitative data, including cogenerative dialogues, semi-structured interviews, and classroom observations of urban-American and German-international science classrooms, provided additional validity for a smaller 'fine grain' sample of students and plausible explanations for phenomena that were not able to come to light through use of the questionnaire assessing the learning environment and student attitudes toward science.

Moving between 'fine grain' and 'coarse grain' data allows triangulation of data (Fraser & Tobin, 1991). The idea of triangulation is nested in the belief that a single type of data can contain too much error to be reliable by itself. Therefore, triangulation combines information from several types of measurement to arrive at an acceptable understanding of the situation being studied (Boslaugh & Watters, 2008).

3.5 Data Sources and Sample

3.5.1 Overall Demographics of Research Areas and Sites

Dresden, Germany has a population of approximately 525,000 people, of whom 90% are German, 5% are from other European countries, and 5% are from other Non-European countries (*Focus on Dresden*, 2011). Since the reunification of Germany in 1990, Dresden has regained importance as one of the cultural,

educational, political and economic centers of Germany. Dresden has 133 municipal schools, 36 independent schools, and three state-run schools. Among these three types of schools are scattered a variety of primary, secondary, special, and vocational schools (*Schools in Figures*, 2011).

New York City (NYC) has an estimated population of 8.1 million people, of whom approximately 36% are foreign born (United States Census Bureau, 2011). The population of NYC is spread across five boroughs: the Bronx, Brooklyn, Manhattan, Queens, and Staten Island. Throughout these five boroughs, there are as many as 800 different languages or dialects of languages being spoken, making NYC one of the most linguistically-diverse cities in the world. NYC is considered a melting pot of cultures and ethnicities, thus lacking a dominant group from a particular country or region of origin. Hence, depicting demographics is a bit more complex, and demographics are typically shown by race, not country of origin. In NYC, it is estimated that 33% of the population are white (non-Hispanic), 23% are black (non-Hispanic), 15% are Asian and 29% are Hispanic (of any race) (United States Census Bureau, 2011). The NYC public school system is the largest in the United States and serves about 1.1 million students. These children are spread across more than 1,200 separate primary and secondary schools and approximately 900 privately-run secular and religious schools. The Bronx is located north of Manhattan and has an estimated population of 1.4 million, of which about 11% are white (non-Hispanic), 31% are black (non-Hispanic), 3% are Asian, 53% are Hispanic (of any race), and 2% are multiracial or identify with another race. According to the United States Census Bureau (2011), approximately 28% of Bronx inhabitants are living at or below the poverty level, illustrating the socioeconomic struggles with which many of these individuals have to cope.

3.5.2 Demographics and Descriptions of Schools Involved in this Research

The International School of Dresden (ISD) consists of a primary and secondary school and falls into the independent school category. ISD was founded in 1996 by government and community leaders from the City of Dresden and State of Saxony. The school is a non-profit organization designed to meet the needs of a growing expatriate community. ISD is an International Baccalaureate World School and, as such, its program is regularly evaluated and assessed. Enrolled at ISD are approximately 550 students from over 40 nations, of which approximately 300 are in the secondary school (grades 6–12). Students come from a range of countries, including Germany, United States, and Japan, as well as from diverse socioeconomic settings. Table 3.1 shows the ethnic breakdown of the students in ISD. This table enables us to see the diverse nature of the students involved, which is not indicative of the diversity of the city of Dresden. The sample is not consistent with many other high schools in the area, but it is comparable to other international schools located throughout Germany.

Table 3.1 – Demographics of the International School of Dresden

Country/Region of Origin	Percentage Enrolled
Germany	60%
Other European Countries	12%
North America: U.S.A. & Canada	8%
Japan	6%
Other Asian Countries	3%
Russia	2%
Middle East	5%
Australia/New Zealand	2%
Central and South America	2%

Bronx High School (BHS) is a public school located in the Bronx and one of the sites of this research. BHS was founded in 2004 with the purpose of providing

students with an academically-rigorous education in preparation for college and entry into health-related careers. BHS is a small school setting with approximately 350 students spanning grades 9–12. Unlike the geographic diversity that encompasses the Bronx, the student population of BHS is predominantly Latino and African-American. Further, the vast majority of these students (close to 90%) qualify for free or reduced-cost lunch, indicating that they come from socioeconomic backgrounds indicative of traditionally marginalized students. Table 3.2 shows the breakdown of students enrolled in BHS and enables us to see the racial homogeneity of the students involved. The sample is consistent with many other high schools in the area, as well as with the overall demographics of the Bronx.

Table 3.2 – Demographics of the Bronx High School

Ethnicity/Race	Percentage Enrolled
Hispanic or Latino	63%
African American	32%
White or Other	5%

Because this study explored the learning environment in science classrooms, as well as student attitudes toward science, it should be noted that these two schools have different science curricula. ISD uses the International Baccalaureate Middle Years Programme (IBMYP) in science for students aged 11 to 16 years, which provides a theoretical framework geared toward students embracing and understanding the connections between traditional subjects and the real world. As such, science courses in grades 8–10 are integrated with an infusion of earth science, biology, chemistry, and physics at each grade level. The science curricula at BHS are not integrated and are largely dictated by the requirements for graduation of the State of New York. At BHS, students begin by taking a year-long course in Conceptual

Physics, followed by Chemistry, Biology, and finally an elective of either Anatomy and Physiology or Microbiology.

While the way in which the sciences are structured in each school is slightly different, the size range of the two schools in this study is similar enough so that any variations caused by having selected vastly different sized schools could be eliminated. Further, the small size of both schools contributes to an overall small science department. Science teachers in both schools had an informal but good relationship with each other, thus allowing a fluid exchange of ideas and best practices.

3.5.3 Selection of Sample for this Research

This study explored science classrooms for two distinct populations of students from the Bronx, NY and Dresden, Germany. The sample consisted of students from grades 8–10 primarily because students at these grade levels comprise the majority of the students whom I have ever taught and because of my belief in establishing and maintaining science interest during a student’s high-school career.

A total sample of 142 general-education students in grades 8–10 participated in the study. Of these 142 students, 82 were from five science classes at ISD. The other 60 students were from two science classes at BHS. During the duration of the study, I was employed as a science teacher at ISD and taught three of the five classes involved in the study. Class sizes ranged from 20 to 30 students, with boys and girls being approximately equally represented, thus reducing any possible gender biases in the data. The demographics of each of these classes were representative of the overall demographics of the school and, in the case of BHS, the overall demographics of the region. The diversity of culture, gender, and socioeconomic status present in the

selected sample was expected to provide the study with a broad view of students' perceptions of the science learning environment and the attitudes that students have toward science in grades 8–10 in Dresden and the Bronx.

3.6 Instruments Used for Data Collection

This study was multifaceted in that it involved investigating reality pedagogy, students' perceptions of their classroom learning environment, and their attitudes towards science at different geographic locations at which data were collected. Accomplishing these research objectives involved collection of quantitative and qualitative data.

3.6.1 Quantitative Data Collection

A combination of three questionnaires was used in this study. Two of these instruments measured student perceptions of the learning environment while the third was selected to measure students' attitudes toward science, thus allowing investigation of attitude–environment relationships. The remainder of this section provides a broad description of each of these instruments, as well an overview of which scales were selected from which questionnaire for inclusion in the final instrument used in this study.

3.6.1.1 Constructivist Learning Environment Survey (CLES). The Constructivist Learning Environment Survey (CLES) was developed by Taylor and Fraser (1991) to allow researchers to gauge to what extent a classroom was indicative of a constructivist epistemology. Constructivism is a pedagogical approach that views learning as a cognitive process in which students make sense of the world in relation

to the knowledge that they have already gathered (Dorman & Adams, 2004). Essentially, students are asked to link new ideas to their current understanding of a topic in an effort to construct their own understanding, while engaging in dialogue with the others to ensure a common perception. The CLES measures the degree to which students feel that constructivist approaches are present in their learning environment using five dimensions: Personal Relevance, Uncertainty, Critical Voice, Shared Control, and Student Negotiation (Fraser, 2007). The CLES contains a total of 36 items with each being answered on a five-point frequency scale with the response alternatives: Almost Never, Seldom, Sometimes, Often, and Almost Always (Nix, Fraser & Ledbetter, 2005).

The CLES has been used in research studies to measure students' perceptions of constructivist learning environments in science, mathematics, humanities, English, and classes with an emphasis on the use of technology to deliver curriculum. The CLES has also been used to evaluate the effectiveness of education reforms, innovative curricula, and teacher development programs. Additionally, the CLES has been translated into various languages and used in an array of cross-national studies designed to account for culture and language differences when comparing constructivist learning environments in different countries. Below are examples of such studies, but a more extensive review of research that used the CLES is found in Chapter 2, Section 2.3.1.

Nix, Fraser, and Ledbetter (2005) used the CLES to investigate science classrooms in the United States and, later, used a modified form of the CLES to investigate the effectiveness of a teacher development program nested in constructivism. In South Africa, the CLES was used by Aldridge, Fraser, and Sebela (2004) to investigate constructivist teaching approaches. The CLES was also used in

Texas by Dryden and Fraser (1998) to evaluate the success of an urban reform initiative aimed at promoting constructivism in the science classroom. Wilks (2000) expanded and modified the CLES in Singapore to assess how effective a college course was in having students analyze causes of social injustice and advocate political reform. In addition to these studies, the CLES has also been translated and validated into a variety of other languages, including Korean by Kim, Fisher, and Fraser (1999) and Chinese for use in Taiwan by Aldridge, Fraser, Taylor, and Chen (2000).

The CLES was selected as an instrument for this study because of its proven validity and reliability in measuring the degree to which constructivist practices occur in a classroom according to students. Descriptions of research studies that have added to the validity and reliability of the CLES as a data-collection instrument are found in Chapter 2, Section 2.3.1. While this study did not aim to measure constructivism directly, there are certain aspects of constructivism that underlie the practice of reality pedagogy, therefore making the CLES relevant and appropriate for use in my study. However, not all of the CLES scales were equally relevant for this study and therefore some scales were excluded in the final instrument. Guided by my personal experience as a science teacher, past research, and discussion with my thesis supervisor, only three of the original five scales were selected for this study. Table 3.3 provides a scale description and a sample question from the three classroom learning environment dimensions selected for this study: Personal Relevance, Critical Voice, and Shared Control.

The items associated with each of these scales were left in their original English wording with one exception. One of the items selected for the final instrument was originally negatively worded to allow for scoring in the reverse direction. However, because many of the participants in the study were not native

Table 3.3 – Scale Description and Sample Item for Each Scale Used from the CLES

Scale	Description	Sample Item
Personal Relevance	The extent to which school science connects with students' out-of-school experiences	I learn how science can be part of my out-of-school life.
Critical Voice	The extent to which students can express a critical opinion about the learning environment	It's OK for me to question the way I'm being taught.
Shared Control	The extent to which students are invited to share control of the learning environment with the teacher	I help the teacher to decide which activities are best for me.

English speakers, it was decided that all items would be positively worded. The wording of the item was changed from “What I learn has nothing to do with my out-of-school life” to “What I learn is related to my out-of-school life”. As my thesis supervisor and I reviewed the modification, it became clear that there were no fundamental differences in meaning between the modified version of the item and the original. Therefore, no major concerns arose because of the modification made to the selected CLES item. In addition, all items underwent translation into German and Spanish for use with the two distinct populations described in Section 3.5.3. The process for translation is described in Section 3.6.1.5.

3.6.1.2 *What Is Happening In this Class? (WIHIC) Questionnaire.* The What Is Happening in This Class? (WIHIC) learning environment questionnaire is a fairly new instrument developed by Fraser, Fisher and McRobbie (1996). The WIHIC was developed by combining scales from a wide range of existing questionnaires with additional scales to address contemporary dimensions of the learning environment. The WIHIC measures student perceptions of the learning environment using seven psychosocial dimensions: Student Cohesiveness, Teacher Support, Involvement,

Investigation, Task Orientation, Cooperation, and Equity. Each item makes use of a five-point frequency scale with the response alternatives of Almost Never, Seldom, Sometimes, Often, and Almost Always (Aldridge, Fraser, & Huang, 1999).

Since its creation, the WIHIC has been adapted and modified to fit the goals of a variety of studies throughout the world. The WIHIC has been used to measure students' perceptions of classes in geography, mathematics, biology, chemistry, and classes with an emphasis on the use of technology to deliver curriculum. The WIHIC has also been used to investigate relationships between the learning environment and educational issues such as academic efficacy and information technology. Researchers have also used the WIHIC to investigate gender differences in perceptions of the learning environment from within the same classroom situation. The WIHIC has also been used in an array of cross-national studies designed to account for culture and language differences when comparing learning environments in different countries. Below are examples of such studies, but a more extensive review of research studies that used the WIHIC is found in Chapter 2, Section 2.3.2.

Raaflaub and Fraser (2002) used a modified version of the WIHIC to investigate the use of laptop computers in classrooms in Canada. In Australia, a modified version of the WIHIC was used by Aldridge, Fraser, and Fisher (2003) to investigate student outcomes in an outcomes-based, technology-rich learning environment, thus giving rise to a new questionnaire, the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI). In South Africa, Aldridge, Laugksch, Seopa, and Fraser (2006) used the WIHIC as the basis for the development of the Outcomes Based Learning Environment Questionnaire (OBLEQ). In Singapore, Khoo and Fraser (2008) used the WIHIC to investigate computer courses in five private computing schools. Although the studies described above have

typically utilized an English version of the WIHIC, the WIHIC has also been translated and validated in the Korean (Kim, Fisher & Fraser, 2000), Taiwanese (Chinese) (Aldridge & Fraser, 2000; Aldridge, Fraser & Huang, 1999), Indonesian (Fraser, Aldridge, & Adolphe, 2010; Margianti, Fraser & Aldridge, 2001), and Arabic (Afari et al., in press; MacLeod & Fraser, 2010) languages.

Overall, the WIHIC was selected as an instrument for this study because of its proven validity and reliability across a variety of contexts. Descriptions of research studies that have added to the validity and reliability of the WIHIC as a data-collection instrument are found in Chapter 2, Section 2.3.2. Past studies that have investigated research questions similar to the ones that I have posed in this study have also used the WIHIC as a data-collection instrument, thus supporting its appropriateness for my study. As with the CLES, not all the scales from the WIHIC were equally relevant for this study and therefore some scales were excluded in the final instrument. Similar reasoning that guided my selection of scales from the CLES was used to select scales from the WIHIC. Table 3.4 provides a scale description and a sample question from the two WIHIC classroom learning environment dimensions selected for this study: Involvement and Cooperation. The items associated with each of these scales were left in their original English wording. However, these items did undergo translation into German and Spanish for use with the two distinct populations described in Section 3.5.3. The process for translation is described in Section 3.6.1.5.

Table 3.4 – Scale Description and Sample Item for Each Scale Used from the WIHIC

Scale	Description	Sample Item
Involvement	The extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class	I discuss ideas in class
Cooperation	The extent to which students cooperate rather than compete with one another on learning tasks	I learn from other students in this class

3.6.1.3 *Test of Science-Related Attitudes (TOSRA)*. The Test of Science-Related Attitudes (TOSRA) was developed by Fraser (1981) to allow researchers to assess science-related attitudes among secondary school students. Thurstone (1928) describes an attitude as how strongly an individual feels towards some psychological object and asserts that attitude toward an object could be learned and/or changed with exposure to certain experiences. The original TOSRA measures student attitudes towards science and science-related attitudes using seven scales: Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. Each of these seven scales is addressed through ten items for a total of 70 items. The TOSRA measures each of the 70 items on a five-point Likert scale that asks students to express their degree of agreement with each statement. The response alternatives for this five-point scale are Strongly Agree, Agree, Not Sure, Disagree, Strongly Disagree (Fraser, 1981).

Since the TOSRA was developed in 1981, it has had a rich history of use in a wide array of research studies. Examples of such studies are described below. A more extensive review of research studies that used the TOSRA, including studies that have added to the TOSRA's validity and reliability, can be found in Chapter 2,

Section 2.5. In Singapore, Wong and Fraser (1996) used three scales from the TOSRA to create the Questionnaire on Chemistry-related Attitudes (QOCRA) for investigating associations between students' perceptions of their chemistry laboratory classroom environments and their attitudes towards chemistry. Fraser, Aldridge, and Adolphe (2010) used the TOSRA and the WIHIC to evaluate the strength of associations between students' perceptions of their classroom environment and their attitudes to science in Australia and Indonesia. They further used the scores on the WIHIC and TOSRA to explore variations between sexes and between the two countries. Another study conducted in Western Australia by Aldridge, Fraser, and Fisher (2003) used only a single scale from the TOSRA to investigate how the learning environment created by teachers influences students' achievement, attitudes and self-efficacy. Modified versions of the TOSRA for use in other academic disciplines have also been created. A modified version of the TOSRA, the Test of Geography Related Attitudes (TOGRA), was used in Texas by Walker (2006) to measure students' attitudes towards geography. The TOSRA has also been modified to assess Spanish-related students' attitudes by rewording statements from the TOSRA and translating them into the Spanish language resulting in the Test of Spanish Related Attitudes (TOSRA—L₁) (Adamski, Fraser, & Peiro, in press). In addition to these studies, a single scale from the TOSRA has been translated and validated into Chinese for use in Taiwan by Aldridge, Fraser, and Huang (1999).

As is evident from the studies outlined in this section and in Chapter 2, Section 2.5.1, the TOSRA is a valid and reliable instrument for measuring students' attitudes toward science and scientific attitudes. The TOSRA was selected as an instrument for this study because not all scales need to be used to maintain the TOSRA's validity and reliability. This unique feature allows the TOSRA to yield

separate scores for each of the distinct attitudinal scales, thus enabling researchers to obtain a ‘profile’ of attitude scores for groups of students (Fraser, 1981). For this study, not all the scales from the TOSRA were relevant and therefore not included in the final instrument. After consulting with my thesis supervisor, only two of the original seven scales from the original TOSRA were retained and deemed to be most relevant for my study (for descriptions of the original scales see Chapter 2, Table 2.3). Table 3.5 provides a scale description and a sample question from the two attitudinal scales selected for this study: Attitudes to Scientific Inquiry and Enjoyment of Science Lessons.

Table 3.5 – Scale Description and Sample Item for Each Scale Used from the TOSRA

Scale	Description	Sample Item
Attitudes to Scientific Inquiry	Attitude to scientific experimentation and inquiry as ways of obtaining information about the natural world	I would prefer to do my own experiments than to find out information from a teacher.
Enjoyment of Science Lessons	Student satisfaction with their science learning experiences at school	I find science lessons to be exciting and interesting.

Certain aspects of the TOSRA needed to be modified in order to better correspond to the layout of the final instrument used in my study. The first of these modifications involved the wording of the response alternatives for each item. The TOSRA was originally designed to make use of a five-point Likert scale with response alternatives ranging from Strongly Agree to Strongly Disagree (Fraser, 1981). However, items selected from the WIHIC and CLES make use of a five-point frequency scale with response alternatives ranging from Almost Always to Almost Never. For this study, all items selected from the WIHIC, CLES, and TOSRA were presented in a single instrument described in greater detail in Section 3.6.1.4.

Therefore, to allow for continuity in responding to items and ease in administration, all items made use of the response alternatives affiliated with the WIHIC and CLES. To avoid any possible loss of validity associated with the rewording of items, items that could not be responded to using this set of frequency response alternatives were not included in the final instrument. The second modification involved the wording of certain items. The wording of one of the items from the Enjoyment of Science scale had to be modified to allow it to fit the new response alternatives. The item was changed from “Science is one of the most interesting school subjects” to “I find science to be an interesting school subject.” In addition, some of the items selected for the final instrument were originally negatively worded to allow for scoring in the reverse direction. However, because many of the participants in the study were not native English speakers, it was decided that all items should be positively worded. Table 3.6 shows the changes made to the negatively-worded items that were used in the final instrument for this study.

Table 3.6 – Modifications to Negatively-Worded Items from TOSRA

Original Item Number	Original Wording	Modified Wording
10	Doing experiments is not as good as finding out information from teachers.	I would rather do an experiment to find out an answer than be told by a teacher.
26	Science lessons bore me.	I find science lessons to be exciting and interesting.
54	The material covered in science lessons is uninteresting.	The material covered in science class is interesting.

The changes made to specific TOSRA items were only made after extensive consultation with my thesis supervisor. As we reviewed these items, it became clear that there were no fundamental differences in meaning between the modified versions

of some items and the originals. Therefore, no major concerns or problems arose because of the modifications that were made to selected TOSRA items. As with the WIHIC and CLES, all items included in the final instrument underwent translation into German and Spanish for use with the two distinct populations described in Section 3.5.3. The process for translation is described in Section 3.6.1.5

3.6.1.4 Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA). Creation of the final instrument used to quantitatively assess the learning environment and student attitudes in this study involved a combination of scales from the three instruments, CLES, WIHIC and TOSRA, described in Section 3.6.1.1, 3.6.1.2, and 3.6.1.3, respectively. While the WIHIC has a broad range of scales that could assess a variety of learning environment areas, it is not designed to assess student attitudes or constructivism in the classroom environment. Dorman and Adams (2004) tackled this issue by combining scales from the CLES with scales from the WIHIC to accomplish the aims of their research. In this study, I attempted to extend the model created by Dorman and Adams (2004) by adding scales from the TOSRA to assess student attitudes towards science to form the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA). Table 3.7 provides a summary of the QuALESA.

Table 3.7 – Summary of Items and Scales from the WIHIC, CLES and TOSRA Included in the QuALESA

Instrument	Number of Scales	Name of Scale	Number of Items
WIHIC	2	Involvement	16
		Cooperation	
CLES	3	Personal Relevance	18
		Shared Control	
		Critical Voice	
TOSRA	2	Attitudes to Scientific Inquiry	12
		Enjoyment of Science Lessons	

3.6.1.5 *Translation of the QuALESA.* Because of the diverse ethnicities of the student populations at the two schools, it was thought beneficial to offer the QuALESA not only in English, but also in Spanish and German. All of the selected items from the WIHIC, CLES, and TOSRA that were included in the English version of the QuALESA were translated by educators based in Germany. In addition, the instructions appearing on the cover of the QuALESA were also translated into Spanish and German. These documents were then back translated by independent third-party translators from German and Spanish back to English as recommended by Brislin (1970). As a final step, I compared the back translations with the original English version of the QuALESA to ensure that the items retained their original meanings. While some minor modifications were made, all items were retained. The Spanish and German back translations of the questionnaires revealed no major problems and were deemed acceptable for use in this study. This process allowed the production of two versions of the QuALESA: an English–German version and an English–Spanish version. Producing these two versions was preferred over creating

separate English, Spanish and German versions of the QuALESA in order to reduce the possibility of students being teased or ostracized because of their comfort level with one language over another. Therefore, to ensure that students truly understood what they were reading, each English item was followed by the corresponding German or Spanish item. Figures 3.1 and 3.2 show examples of how items were structured for the English–German version and the English–Spanish version of the QuALESA, respectively. The complete English–German version and English–Spanish version of the QuALESA can be found in Appendix D and E, respectively.

Statement / Behauptungen	Almost Always	Often	Sometimes	Seldom	Almost Never
1. I discuss ideas in class. <i>Ich diskutiere Ideen im Unterricht.</i>	5	4	3	2	1
2. I give my opinions during class discussions. <i>Ich äußere meine Meinungen während Diskussionen im Unterricht.</i>	5	4	3	2	1
3. The teacher asks me questions. <i>Der Lehrer bzw. die Lehrerin stellt mir Fragen.</i>	5	4	3	2	1

Figure 3.1 – Sample of Item Structure for English–German Version of the QuALESA

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
1. I discuss ideas in class. <i>Discuto ideas en clases.</i>	5	4	3	2	1
2. I give my opinions during class discussions. <i>Doy mis opiniones durante las discusiones en clases.</i>	5	4	3	2	1
3. The teacher asks me questions. <i>El profesor me hace preguntas.</i>	5	4	3	2	1

Figure 3.2 – Sample of Item Structure for English–Spanish Version of the QuALESA

3.6.1.6 Administration of the QuALESA. Teachers at the two participating schools were contacted in August 2010 regarding the research study. After providing teachers with relevant information pertaining to my study, including the goals of the research and the role of the teacher in the research, all the teachers agreed to participate. There were a total of four teachers involved in this research study: three (including myself) from the International School of Dresden (ISD) and one from Bronx High School (BHS). A complete description of the schools and the student sample can be found in Section 3.5 of this chapter.

The QuALESA was administered to student participants during the start and end of the academic year (August through June). Responding to the QuALESA occurred during class time and took approximately 15 minutes each time to complete. I consulted with the participating teachers prior to each administration of the QuALESA to remind them of the established protocol for administering the questionnaire. Teachers were instructed to read aloud the instructions to the students. Further, teachers were asked not to read the questionnaire to the students but, instead, to allow students to read and respond to the questionnaire on their own and at their own pace. In some cases, students asked what an item meant. During these instances, teachers were instructed to encourage students to respond to the questionnaire as best they could and to assure students that there were no correct or incorrect answers to questionnaire items.

3.6.2 Qualitative Data Collection

Qualitative data were collected to augment the quantitative data, as well as to provide plausible explanations and additional validity for a smaller ‘fine grain’ sample of students. Cogenerative dialogues, classroom observation, and semi-

structured interviews were the sources of qualitative data. The remainder of this section provides a broad description of each of these sources of qualitative data as they relate to their use in providing greater depth and breadth to our understanding of learning environments and student attitudes towards science.

3.6.2.1 Cogenerative Dialogues. The cogenerative dialogue is the chief component by which reality pedagogy is accomplished in the urban science classroom. As described in Chapter 2, Section 2.7.1, cogenerative dialogues provide teachers and students with opportunities to discuss their experiences within and outside the classroom, thus allowing an exchange of social capital. Cogenerative dialogues were used as a tool for investigating the practices that students enacted in the science classroom and for understanding why students engaged in such practices. A better understanding of these practices can allow teachers and students to engage in the process of questioning existing structures that do not support success in science and creating plans of action to transform them. Teachers could then use the fundamental tenets of reality pedagogy along with the plans of action created during cogenerative dialogues to teach their classes.

There were a total of five classes of students participating in the study from the International School of Dresden (ISD) and two classes from Bronx High School (BHS). In my role as teacher and researcher at ISD, I facilitated all of the cogenerative dialogues. Cogenerative dialogues occurring at BHS were facilitated by research assistants under the supervision of a colleague. However, regardless of differences in facilitator, the structure of the cogenerative dialogue remained relatively unchanged. Approximately four to six students, each representing a different group in the classroom, were selected to participate in a conversation about

the science classroom. This group met with the discussion facilitator about once per week for 30–45 minutes, usually during the students' lunch hour. During these conversations, there were established norms about equal turns at talk among participants, mutual respect, and cogenerating a plan of action that the entire group of participants, including the teacher, could improve about the science classroom.

The goals of cogenerative dialogues were guided by the research questions and intended to supplement data collected from the QuALESA. The first of these goals was to provide teachers and students with opportunities to engage in critical discussions about their experiences within and outside of the classroom. The second was to provide students and teachers with the opportunity to investigate, question, and research their own practice as learners of science. Because cogenerative dialogues are not bound by content, listing a specific set of questions or topics to be addressed would be neither fruitful nor authentic. Rather, the cogenerative dialogue was meant to be a reflective conversation involving topics that were organically generated and meant to improve the learning environment and student attitudes toward science. Such reflective conversations typically revolved around the ways in which science lessons were taught, how the classroom was structured, the types of students' external experiences that teachers could use to better teach scientific content, and how students could enact practices that would allow all their classmates to be successful in science. Essentially, students were providing the teacher with insightful critique into science instruction and the learning environment and useful recommendations for improving both (Emdin, 2011).

The individual facilitating each cogenerative dialogue, usually the teacher, did not change throughout the study. At ISD, I facilitated all of the cogenerative dialogues. At BHS, the cogenerative dialogues were facilitated by a colleague's

research assistant. However, accomplishing the goals of cogenerative dialogues required that all students participating in the study be given the opportunity to also actively participate in the cogenerative dialogue. Because a cogenerative dialogue session typically only accommodated between four and six students at a time, a metaphorical revolving door was put into place. After participating in a minimum of three and maximum of five cogenerative dialogues, one student from the group was asked to volunteer to leave. This student was typically charged with finding his/her replacement for the cogenerative dialogue and was also given a classroom task that allowed continued engagement and connection with the cogenerative dialogue group. The individual facilitating the cogenerative dialogue did no

3.6.2.2 *Classroom Observations.* Observations of science classrooms allow an interpretive, naturalistic approach to data collection (Denzin & Lincoln, 1994). The purpose of conducting classroom observations is to attempt to understand phenomena through the eyes of the participants and to compare those understandings with the existing operational framework with the intent of reconsidering and explaining the participants' perspectives (Anderson, 1998). Classroom observations can be conducted in three ways within a research field: complete observer, complete participant, and participant observer (Anderson, 1998). A complete observer remains physically detached from the activities and social interactions occurring in the classroom, whereas a complete participant is fully immersed in the activities and social interactions of the classroom. A participant observer takes the middle ground between the complete observer and the complete participant. For classrooms that were not my own, I functioned as a complete observer while, within my own class, I functioned as a complete participant.

All classrooms were observed on average about three times per week throughout the academic year. In classrooms other than my own, because of scheduling conflicts and to reduce issues related to the Hawthorne Effect (the presence of the observer altering the behavior of those being observed), I was never physically present to conduct observations. Rather, digital video cameras were set up in the science classrooms and set to record the class during instruction. Digital video cameras were also set up in science classrooms where I functioned as a complete participant. During some class sessions, the camera was focused on the teacher and his/her actions, other sessions focused on the class as a whole, and still others focused on a specific group of students in the class. After every week of observations, I collected the digital video cameras and uploaded the files to my computer. In the case of the classrooms in BHS in the Bronx, those files of classroom observations were emailed to me weekly.

3.6.2.3 *Semi-Structured Interviews.* According to Anderson (1998), there are two types of interviews: normative and key informant. A normative interview involves collecting data which are classified and statistically analyzed. A key informant interview, the type used in this study, explores the views of a small number of individuals who have particular knowledge about the matter being investigated. Generally, the key informant interview allows the participant to provide the interviewer with insight regarding specific events and personal perspectives.

Key informant interviews can be further broken down into being structured or semi-structured. A structured key informant interview contains a formalized, limited set of questions to which the participant responds. For this study, I used semi-structured key informant interviews to assess and further investigate changes in

student perceptions of the learning environment. Conducting the interview using a semi-structure format provided the flexibility of basing questions on themes that I wished to explore rather than using a set of rigid questions. While I began the interview with some questions or topics, the respondent was not bound to these and new questions were often brought up as a result of a participant's responses. This freedom allowed me to shape questions to the particular context of the interview and the individual being interviewed (Lindlof & Taylor, 2011).

Semi-structured interviews were conducted with six students from five different science classrooms (three from ISD and two from BHS) throughout the course of the study and lasted approximately 15 minutes. The same six students participated throughout the course of the study. For students from ISD, I conducted the semi-structured interviews, whereas students from BHS were interviewed by a colleague's research assistant. On average, each student was interviewed between four and six times throughout the year. The interview questions and themes were guided by the research questions whose purpose was to extract information regarding specific events that occurred in the classroom. Interviewers (myself and a colleague's research assistant) approached each interview with the following questions as possible starting points:

Have you noticed anything different about your learning environment?

Do you have any suggestions for the improvement of any future science lessons?

Has anything occurred in the classroom which prevented you from learning?

As suggested by Morgan (1997), these questions were often followed up with more questions asking students to provide specific examples and instances. As previously mentioned, not all of these questions were necessarily addressed at each interview. Rather, questions could be altered at the interviewer's discretion to accommodate the direction in which the interview was going.

While the questions asked during interviews are obviously important, there are other aspects of the interview process to also consider. Therefore, to ensure that interviews were conducted effectively and consistently, a set of interview protocols was developed as described by Anderson (1998). First, to ensure fluidity of the interview, interviewers were asked not to take notes during the interview. Rather, the interviews were audiotaped and later transcribed to ensure accuracy. Second, interviews took place in a space that allowed minimal interruptions (usually an empty classroom). Third, the physical arrangement of the classroom and position of the interviewer and respondent had to be conducive for an authentic exchange. Because respondents had varying levels of comfort with the interview process, it was agreed that the respondents would decide this arrangement. Next, interviewers were expected to be active listeners and to display openness and empathy in order to demonstrate their genuine interest in what the respondent had to say rather than making value judgements. Finally, interviewers were expected to provide respondents with an oral summary of the major points discussed at the end of each interview and to ask students whether or not the summary accurately captured the contents of the interview.

3.7 Data Analyses

Generally, the data collected throughout this study were used to explore the effect of reality pedagogy on changing student perceptions of their learning environment and student attitudes toward science in classrooms in Dresden and the Bronx. While Section 3.6 of this chapter detailed the actual instrumentation employed to accomplish this overarching aim, this section describes the methods used to analyze the data collected.

Quantitative data collected using the QuALESA underwent statistical analyses to examine the questionnaire's validity and reliability. Once the scales from the questionnaire had been shown to be valid and reliable, student responses were analyzed further to investigate changes in student perceptions of their learning environment and student attitudes, differences between science students from the Bronx and Dresden in terms of their classroom learning environment perceptions and attitudes to science, and relationships between students' perceptions of their learning environment and their attitudes towards science. During the time between pretest and posttest administrations of the QuALESA, qualitative data were collected from cogenerative dialogues, classroom observations, and semi-structured interviews. These sources of qualitative data provided students with opportunities to elaborate their thoughts regarding reality pedagogy, the learning environment, and their attitudes towards science. Without the qualitative data in place to supplement the quantitative findings, much information might have remained a mystery.

3.7.1 Validity and Reliability of the QuALESA

Research Question #1

Is the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) valid when used with samples in Dresden, Germany and the Bronx, New York?

Boslaugh and Watters (2008) describe validity and reliability as the two standards by which to evaluate measurements. According to Anderson (1998), validity refers to the extent to which what we measure reflects what we expected to measure, whereas reliability refers to consistency in measurement.

To validate the QuALESA, the responses of 142 students from seven science classrooms in Dresden and the Bronx were subjected to factor analysis to check the scale structure. The purpose of factor analysis is to reduce a large number of variables into reduced sets of variables, or factors, that explain most of the variance observed (Anderson, 1998). Factor analysis was conducted using principal axis factoring with varimax rotation and Kaiser normalization. Varimax rotation with Kaiser normalization seeks to maximize the variances of the squared loadings so that, for each factor, high loadings result for a few variables, with the other loadings being near zero (Boslaugh & Watters, 2008). Eigenvalues provided an alternate way of viewing numerically whether the factors resulting from the factor analysis are unique from each other (Boslaugh & Watters, 2008).

Factor loadings obtained from this analysis were used to identify whether each scale measured a distinct aspect of the learning environment or student attitudes towards science. Further, factor analysis enabled me to identify faulty questionnaire

items that could be removed to improve the factorial validity of the seven scales of the QuALESA. In order for a questionnaire item to be retained, two criteria had to be satisfied: a factor loading of at least 0.35 with their own scale and a factor loading of less than 0.35 with other scales. Details of the results of the factor analysis, especially the resulting factor loadings, are presented in Chapter 4, Section 4.2.

To ensure that each of the items making up a scale in the QuALESA reflect a common construct, a measure of internal consistency reliability was used. Cronbach's alpha coefficient was used to determine the internal consistency of each scale for two units of analysis: the individual student and the class mean. The Cronbach alpha coefficient has an upper bound of 1 so that, as the alpha coefficient approaches that value, the greater is the reliability of the scale (Boslaugh & Watters, 2008).

While factor analysis identifies whether factor scores on each scale measure a distinct aspect of the learning environment or student attitudes towards science, the discriminant validity indicates the extent to which raw scores on each scale are in fact unique in the dimension that they assess. Campbell and Fiske (1959) state that a successful evaluation of discriminant validity shows that a specific scale is not highly correlated with other scales designed to measure theoretically-different concepts. The discriminant validity was measured by calculating the mean magnitude of the correlation of one scale to other scales in the QuALESA for two units of analysis: the individual student and the class mean. Although there is no accepted cut-off value for discriminant validity, a smaller mean correlation coefficient generally shows that discriminant validity is likely to exist between scales. On the other hand, a larger mean correlation coefficient generally shows that the two scales overlap and are likely measuring the same aspect.

Finally, a one-way analysis of variance (ANOVA) statistic was used to check whether each of the QuALESA's scales were capable of differentiating between the perceptions of students in different classrooms. Class membership was used as the independent variable. According to Boslaugh and Watters (2008), if there is relatively little variance within a group when compared to a larger degree of variance between groups, we can conclude that the groups are different. The η^2 statistic, which is a measure of the variance in scale scores accounted for by class membership, was calculated by taking the ratio of 'between' to 'total' sums of squares from ANOVA.

Having undertaken appropriate statistical tests to refine the QuALESA and determine its validity and reliability, the next step was to use the data collected from the instrument in statistical analyses aimed at answering my study's other research questions.

3.7.2 Exploring the Effectiveness of Reality Pedagogy in Science Classrooms

Research Question #2

Is the implementation of reality pedagogy in science classrooms effective in terms of changes in (a) student perceptions of their learning environment and (b) student attitudes? Why?

To investigate how students' perceptions of their learning environment and their attitudes towards science changed over time in response to reality pedagogy, data generated by the QuALESA were statistically analyzed. Descriptive statistics including the mean, standard deviation, and standard error were calculated for each

scale. Further, pretest–posttest differences for the set of QuALESA scales underwent statistical analysis in the form of a Multivariate Analysis of Variance (MANOVA) with repeated measures. Because the multivariate test using Wilks’ lambda criterion yielded significant changes for the set of scales, the individual ANOVA was interpreted separately for each individual QuALESA scale.

Effect sizes were also calculated to indicate the magnitude of pre–post differences for each scale without having to worry about sample size (Boslaugh & Watters, 2008). Cohen (1992) defines effect size as the difference between the means divided by the pooled standard deviation. According to Cohen (1992), there are varying degrees of effect size. An effect size of 0.2 to 0.3 might be a ‘small’ effect, 0.5 a ‘medium’ effect and 0.8 and above, a ‘large’ effect. Calculating effect size is relevant because the presence of a statistically significant difference between two means does not in itself indicate whether the difference is important. Therefore, combining a calculation of effect size with traditional significance testing provides researchers with greater certainty regarding their data (Boslaugh & Watters, 2008).

3.7.3 Exploring Differences Between the Bronx and Dresden in Students’ Perceptions and Attitudes

Research Question #3

Are there differences between science students from the Bronx and Dresden in terms of (a) their classroom learning environment perceptions and (b) attitudes to science?

If so, how can these differences be explained?

To investigate how perceptions of the learning environment and attitudes toward science differ between students in Dresden and the Bronx in response to

reality pedagogy, data generated by the QuALESA were statistically analyzed using the individual student scores as the unit of analysis. As for the previous research question, descriptive statistics including the mean, standard deviation, and standard error were calculated for each scale.

Differences between how students in two geographic locations perceived the learning environment and their attitudes towards science were explored by conducting a Multivariate Analysis of Variance (MANOVA) separately for pretest data and for posttest data. Because the multivariate test using Wilks' lambda criterion revealed significant between-country differences for the set of dependent variables as a whole, the corresponding ANOVA was then interpreted for each scale of the QuALESA. Finally, as with the previous research question, effect sizes were calculated to indicate the magnitudes of differences between the populations of the two geographic locations for the various QuALESA scales.

3.7.4 Determining Associations Between Environment and Attitude Scales

Research Question #4

Is there a relationship between students' perceptions of their learning environment and their attitudes toward science? If so, how can this relationship be explained?

This research question focused on the relatedness between scores on learning environment scales and attitudinal scales. Determining these associations involved simple correlation and multiple regression analyses. Care must be taken here because the finding of a correlation between two variables does not imply that a change in one variable causes a change in the other (Boslaugh & Watters, 2008). However,

performing these analyses can still provide insight to the degree of association between students' perceptions of the learning environment and their attitudes towards science.

Simple correlation analyses were carried out using Pearson's product-moment correlation coefficient (r). This correlation coefficient measures the tendency of two variables to change in value together. In the context of this study, the correlation coefficient was used to determine bivariate associations (strength and direction of the relationship) between each of the learning environment scales and each attitude scale (Boslaugh & Watters, 2008). The correlation coefficient can range in value from -1 to 1, with values that approach zero indicating a weak relationship between the two variables. Correlation coefficient values approaching -1 or 1 indicate either strongly negative or strongly positive relationships, respectively.

Simple correlation analyses could involve a single independent variable accounting for a large amount of variance in a dependent variable, when in actuality there might be multiple independent variables that account for some portion of variance in the dependent variable. Theoretically, this analysis could be accomplished by calculating numerous simple correlations, but this would give rise to a greater probability of Type I errors. Therefore, multiple regression analysis was used to determine the joint influence of the set of correlated learning environment scales on each scale assessing students' attitude towards science. Additionally, in this study, multiple regression analysis was used to determine which learning environment scales made a significant contribution to the variance in students' attitudes when the other learning environment scales were mutually controlled.

3.7.5 Qualitative Data Analyses Used to Support Findings from the QuALESA

In addition to the collection of quantitative data, this research also involved qualitative data from three sources: cogenerative dialogues, classroom observations, and semi-structured interviews. The data obtained from these sources were used to further confirm or refute the results obtained from quantitative analyses of the responses to the QuALESA, as they relate to Research Questions 2–4. Specific content and themes extracted from each of the qualitative sources of data are presented in greater detail in Chapter 5.

With regards to qualitative data analysis, cogenerative dialogues and semi-structured interviews were treated fairly similarly. The content of each cogenerative dialogue was audiotaped and then subsequently transcribed. Knowing that classrooms are dynamic entities, it is understandable that the specific topics discussed during cogenerative dialogues would vary from dialogue to dialogue and from group to group. As the content of the cogenerative dialogues were reviewed, a tally of the frequency of specific topics and issues was taken. This analysis allowed the identification and extraction of common themes. The contents of the cogenerative dialogues were then organized in the form of vignettes to reflect the common themes extracted. To make the data related to cogenerative dialogues more meaningful, samples of plans of actions that capture the differences between the Bronx and Dresden with regard to the extracted themes are presented in Chapter 5, Section 5.3. Analysis of semi-structured interviews were treated similarly to cogenerative dialogues, with each of the interviews being audiotaped and then transcribed for the purpose of elaborating on differences between the Bronx and Dresden in terms of students' perceptions of their learning environment and their attitudes toward science. The transcribed interviews were then reviewed and, as with the cogenerative

dialogues, a tally was taken to identify some of the most frequently occurring topics and issues. To facilitate analysis, at the conclusion of each semi-structured interview, the content was organized in the form of vignettes to reflect the identified common themes, individual perspectives, and the components of reality pedagogy. Rather than provide student responses to each interview question for the reader to interpret, I opted to use specific quotes from students to provide evidence for each theme. This method of analysis permitted access to the various views and realities of the participants and allowed an understanding of how students make sense of their classroom (Exley, 2008). Analysis of semi-structured interviews along with the extracted common themes can be found in Chapter 5, Section 5.3.

In the design of the study, it was determined that observations of classrooms would be made through video recordings. While watching videotapes of classroom observations, certain sections deemed irrelevant were removed through the use of video editing software. Pieces thought to be most relevant were spliced together. As videos of classroom observations were watched, thick, descriptive notes on aspects of the classroom deemed interesting and worthwhile were made. Field notes extracted from the video of classroom observations were organized to describe the classroom learning environment and student attitudes toward science before and after the implementation of reality pedagogy. Unlike the semi-structured interviews, the intent of the classroom observations was to draw attention to the topics and issues relevant to each scale, rather than to individual participants (Yin, 2011). In Chapter 5, Section 5.2, each set of classroom observations is presented in a timeline format to best illustrate the transformation of the learning environment and student attitudes, beginning with a time when reality pedagogy was either not yet being implemented or just starting to be implemented.

3.8 Limitations and Biases of the Study

Research involving human subjects is always subject to limitations and biases, and this study was no different. While every effort was taken to remove as many of the limitations and as much of the bias, it would be foolish not to acknowledge their existence and possible implications for the research. This section addresses my study's limitations and biases in three distinct areas: sample size and sample selection, instrument construction and administration, and data collection and analyses.

3.8.1 Concerns Related to Sample Size and Representativeness

Issues of sample size are ever-present and can always contribute to potential biases in a study and/or invalidity of data. While there were approximately 800 students spread throughout the two schools involved in the study, access was only granted to certain classrooms, resulting in a relatively small sample size ($N=142$). This sample size posed some constraints when used with correlational and multiple regression analyses. While the sample is large enough to carry out certain data analyses, it must be noted that the statistical power of and confidence in significance tests are not as strong as if a larger sample size had been used.

While not related directly to the sample size, the method of sample selection must also be mentioned. The two schools that participated in this study were purposely selected because I was able to easily gain access to them. Selecting the International School of Dresden as a participant school was out of convenience because I was a teacher there during the time of the study. Bronx High School was selected for two reasons. First, my colleague had previously conducted research there and had thus already built a rapport with students, faculty, and administration.

Second, the population of students attending Bronx High School was typical of the type of students with whom I wished to conduct a comparison.

However, it must be acknowledged that the selected samples represent a small proportion of the entire school population. Further, the selected schools represent only a small sample of the total number of international schools in Germany and public high schools in New York City. With regard to representativeness, the sample of students selected from Bronx High School was reasonably representative of the overall school population as well as the populations of other schools in the Bronx. Further, the sample of students selected from the International School of Dresden was also reasonably representative of the overall school population. However, this sample was not representative of other schools in Dresden but, rather of other international schools throughout Germany. Because perfect representativeness cannot be assumed, caution is needed in generalizing results for my sample to broader groups of students at other schools.

3.8.2 Concerns Related to Questionnaire Construction and Administration

Another limitation of the study was the pioneering approach of combining scales from two learning environment questionnaires and a science-related attitudes questionnaire into a single instrument. While the three questionnaires have been in existence for some time, combining scales created a ‘new’ questionnaire whose validity and reliability was not fully known at the time of my collecting data.

Further limitations existed in the construction of the QuALESA. While items associated with scales from the WIHIC remained unchanged, this is not true for items of scales from the CLES (see Section 3.6.1.1) and the TOSRA (see Section 3.6.1.3). Some items were reworded from negative to positive, in an effort to avoid confusion

among students whose native language might not have necessarily been English. In addition, the agreement response alternatives associated with the original TOSRA were changed to make them identical to the frequency response alternatives associated with the WIHIC and the CLES. Rather than having to reword TOSRA items to fit the new response alternatives, the items that did not fit were just not included. This adds to issues of item validity and reliability which, again, were not known at the time of data collection. Further, the total number of items selected for inclusion in the QuALESA was limited because of the sample's perceived concentration span.

Limitations and biases were further encountered during administration of the QuALESA. As it was decided that the teachers would be the ones to administer the QuALESA to their respective classes, with guidance and suggestions shared by me, there existed the possibility of variation in the method of distribution. However, after consulting with the teachers following completion of the questionnaires, it was deemed that no important discrepancies occurred that would compromise the integrity of students' responses. Finally, the times of year when the questionnaires were administered must be taken into consideration. The pretest questionnaire was administered at the start of the academic year, a time when students are generally excited to be back in school with friends and to tackle another year of academic challenges. This is in contrast to the attitudes that many students displayed when the questionnaire was administered near the conclusion of the academic year. Many students seemed apathetic, disinterested, and simply burnt out.

Finally, although all items on the QuALESA were simplified to allow easier reading for students, the possibility that students misunderstood certain items or had problems reading them because of poor reading skills or language barriers still

existed. In anticipation of these issues, English–German and English–Spanish versions of the QuALESA were produced. Producing these two versions of the QuALESA instead of separate English, Spanish and German versions reduced the possibility of students being teased or ostracized because of their comfort level with one language over another. While this practice naturally seemed ethical, it limited my ability to validate the translated items in the QuALESA, because students did not have to select a language, nor did they have to indicate which language they were actually reading when responding to the questionnaire.

3.8.3 Concerns Related to Data Collection and Analyses

Limitations and biases specific to collecting data through questionnaires first are addressed, and these are followed by issues pertaining to qualitative data collection. Ensuring that those individuals selected to administer and complete the questionnaires are given appropriate resources and blocks of time to do so is of utmost importance. Because these areas were addressed during the design phase of my study, I firmly believe that limitations related to these areas were miniscule. Further, one of the limitations of using questionnaires to collect data is the possibility that students are not honest in their responses. Students could feel pressured to answer more positively than they normally would in an attempt to please the teacher or to avoid the possibility of being reprimanded. To avoid such occurrences, students were assured that their responses to the questionnaire would have no impact on their course grade and that any identifying information would not be shared with the teacher. Further, because of the ages of the students (13–16 years), I am fairly confident that they comprehended the purpose of the research and the assurances they were given.

Qualitative data, just like quantitative data, also carry their own set of limitations and biases. First, it should be noted that a major criticism of qualitative research is that it lacks objectivity and is at the mercy of the researcher's subjective reality (Anderson, 1998). While I am certain that my roles as researcher and science teacher influenced my thinking in some ways, I made every effort to avoid personalizing the research, over-interpreting data, and placing my own expectations on the outcomes of the research. In addition to the biases of the researcher, limitations involved with collecting data from cogenerative dialogues and interviews had to be addressed. During cogenerative dialogues and interviews, every effort was made to ensure the participants' physical and mental comfort. This was accomplished by providing the participants with a stress-free and comfortable physical space, as well as a gentle reminder that they could respond to the extent to which they felt comfortable. In terms of classroom observations, the possibility of the presence of the video camera altering the behavior of those being observed was of concern. Informal conversations with teachers indicated that this was an issue during the first few weeks of the research, but that the students became accustomed to the presence of the camera and barely noticed it as the study progressed. Further, because I relied on video cameras to record observations of classrooms rather than being physically present, I risked the chance of getting an incomplete observation. For example, certain events might have been occurring outside the frame of the camera or sufficiently far away that they could not be clearly seen. However, I believe that the use of multiple qualitative data-collection methods offset these limitations.

There are also certain issues pertaining to the analyses of data with regards to quantitative and qualitative data sources. Overcoming these potential limitations and biases involved putting into place certain quality standards. The analysis and

interpretation of classroom observations and interviews must undergo the same scrutiny as the quantitative data collected and, thus, must be performed in a manner that minimizes threats to rigor and focuses on the validity and reliability of the data. A quality standard for the qualitative sources of data involved member checking (Lincoln & Guba, 1985), a procedure in which the participants were given the opportunity to interpret their own actions. The participants were then either able to accept their actions as being correctly interpreted or were given the opportunity to explain the events, thus leading to a reinterpretation. This gives a more accurate representation of the interpretation of qualitative data as researchers have the tendency to include their biases or to over-interpret events (Creswell, 2008).

3.9 Summary of Research Methods

This chapter described the quantitative and qualitative research methods used to investigate the effect of reality pedagogy on student perceptions of the learning environment and attitudes toward science across contexts. Understanding my selection of methods first required an appreciation of the paradigm in which I was functioning, as well as my ontological and epistemological views of educational research. As an extension to my views on educational research, I provided an overview of the ethical practices that guided my research, as well as an amalgamation of my thoughts on what ethical research practices in education should be like. Guba and Lincoln (1989) describe these research practices as those that provide students with the opportunity to inform the research and provide input at multiple stages of the research.

The remainder of the chapter discussed the research design and the methods used to address the research questions delineated in Chapter 1. One of the aims of the

study was to investigate the validity and reliability of the newly formed QuALESA. The second aim was to investigate the effect of reality pedagogy in science classrooms in terms of changes in student perceptions of their learning environment and student attitudes. The third aim was to explore differences between science students from the Bronx and Dresden in terms of their classroom learning environment perceptions and attitudes to science. The final aim was investigate associations between students' perceptions of their learning environment and their attitudes toward science.

Accomplishing these research objectives required combining quantitative and qualitative data sources as recommended by Tobin and Fraser (1998). Quantitative data were gathered via administration of the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA), which combines scales from three existing questionnaires: WIHIC, CLES, and TOSRA. The What Is Happening In this Class? (WIHIC) learning environment questionnaire was developed by Fraser, Fisher and McRobbie (1996) by combining scales from a wide range of existing questionnaires with additional scales to address contemporary dimensions of the learning environment. The QuALESA made use of two classroom learning environment dimensions from the WIHIC: Involvement and Cooperation. The Constructivist Learning Environment Survey (CLES) was developed by Taylor and Fraser (1991) to allow researchers to gauge to what extent a classroom was indicative of a constructivist epistemology. The QuALESA made use of three classroom learning environment dimensions from the CLES: Personal Relevance, Critical Voice, and Shared Control. The Test of Science-Related Attitudes (TOSRA) was developed by Fraser (1981) to allow researchers to assess science related attitudes among secondary school students. The QuALESA made use of two attitude scales from the

TOSRA: Attitudes to Scientific Inquiry and Enjoyment of Science Lessons. Slight modifications for their use in the QuALESA included a change to the response alternatives of items associated with the TOSRA, rewording of items to reflect a positive perspective, and a reduction in the number of items adapted from each of the TOSRA scales. Additionally, the items included in the QuALESA were translated and back translated into Spanish and German.

A variety of data analyses in line with the research questions were performed in my study. The validity and reliability of the QuALESA were investigated using factor analyses, internal consistency reliability analyses, discriminant validity analyses, and one-way analyses of variance (ANOVAs) for class membership differences in learning environment scores. Investigating changes in students' perceptions of their learning environment and their attitudes towards science in response to reality pedagogy involved a MANOVA for repeated measures and effect sizes. Investigating differences in perceptions towards the learning environment and the attitudes towards science between students in Dresden and the Bronx in response to reality pedagogy also involved conducting a MANOVA separately for pretest and posttest data using the individual as the unit of analysis. Effect sizes were also calculated to indicate the magnitude of differences between the samples in the two geographic locations. Associations between learning environment scales and attitudinal scales were analyzed through simple correlation and multiple regression analyses.

Cogenerative dialogues, semi-structured key informant interviews, and classroom observations were used as qualitative data sources. Cogenerative dialogues and semi-structured interviews were audiotaped with the content being later transcribed. Watching videotapes of classroom observations allowed the taking of

field notes which were organized based on the scales from the QuALESA in an effort to unearth the reasoning behind students' responses to items on the questionnaire. The content of cogenerative dialogues and semi-structured interviews was organized in the form of vignettes to reflect common themes extracted.

Many of the potential biases and limitations of the study, related to sample size, sample representativeness, questionnaire construction, questionnaire administration, data collection, and data analyses were also addressed in this chapter. Many of these limitations are based on the issue of sample size. However, while the sample used to accomplish these research objectives was small for the type of data analyses used, it was representative of the socioeconomic and racial structure of the populations that were compared, and it was not so small as to invalidate the findings of this study.

While this chapter detailed the methods chosen for the design and carrying out of this study, the next chapter describes in greater detail the analyses of the data and the associated findings of the study.

Chapter 4

QUANTITATIVE DATA ANALYSES AND FINDINGS

4.1 Introduction to the Chapter

This chapter consists of a detailed description and summary of the findings that became apparent from analyses of the data which emerged from administration of the QuALESA, a questionnaire created from combining specific learning environment scales from the CLES and the WIHIC, and attitude scales from the TOSRA. In this thesis, the quantitative data are reported in this chapter, but the qualitative data are reported separately in Chapter 5. The decision to do so was made because of the great amount of qualitative data available and my not wanting the qualitative data to get lost among all the quantitative data.

Analyses of the quantitative data helped to answer the following research questions:

Research Question #1

Is the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) valid for use with samples in Dresden, Germany and the Bronx, New York?

Research Question #2

Is the implementation of reality pedagogy in science classrooms effective in terms of changes in (a) student perceptions of their learning environment and (b) student attitudes? Why?

Research Question #3

Are there differences between science students from the Bronx and Dresden in terms of (a) their classroom learning environment perceptions and (b) attitudes to science? If so, how can these differences be explained?

Research Question #4

Is there a relationship between students' perceptions of their learning environment and their attitudes toward science? If so, how can this relationship be explained?

This chapter reports the analyses of the data undertaken to answer each of the research questions for this study. First, validity and reliability analyses for each learning environment and attitude scale are reported (Section 4.2). Second, whole-sample differences between the pretest and posttest for each of the scales are discussed (Section 4.3), and this is followed by a report of differences between the Bronx and Dresden for each of the scales (Section 4.4). Next, associations are reported between the learning environment scales and attitude factors using simple correlation and multiple regression analyses (Section 4.5).

4.2 Validity and Reliability of the QuALESA

The QuALESA was the primary instrument used in this study to collect quantitative data about students' perceptions of the learning environment and attitudes toward science. The QuALESA was administered to a total of 142 students. Sixty of these students were divided between two classes in a single school in the Bronx, and the other 82 students were divided between five classes in a single school in Dresden.

The QuALESA consists of a combination of learning environment scales from the CLES and WIHIC and attitude scales from the TOSRA. The scales of Personal Relevance, Shared Control, and Critical Voice were adapted from the CLES, while the scales of Involvement and Cooperation were adapted from the WIHIC. From the TOSRA, the scales of Attitudes to Scientific Inquiry and Enjoyment of Science Lessons were modified and subsequently used. Certain items underwent slight modifications in wording and all items included in the QuALESA were translated into Spanish and German in an attempt to aid understanding for populations whose first language was not necessarily English. Greater details regarding modifications to items and the translation of the QuALESA can be found in Chapter 3, Sections 3.6.1.3 and 3.6.1.5, respectively.

To determine the suitability of the QuALESA for use with students in the International School of Dresden (ISD) and Bronx High School (BHS), the collected data were analyzed to investigate the instrument's validity and reliability. These analyses were carried out in order to add credibility to the results and conclusions made based on data obtained using this instrument. Thus, analyses of the QuALESA included factor analyses (Section 4.2.1), internal consistency reliability and discriminant validity (Section 4.2.2), and ability to differentiate between classes (Section 4.2.3).

4.2.1 Factor Analyses

In the field of learning environments, factor analysis is a commonly-used method for checking the internal structure of an instrument and to compress a large number of variables (i.e. items) into a smaller and more manageable data set by identifying the factors of an instrument that consist of common themes and which are

answered in a similar fashion by respondents. Essentially, factor analysis seeks the least number of factors accounting for the common variance of a set of variables. In doing so, factor analysis can identify faulty questionnaire items that could be removed to improve the factorial validity of the questionnaire. With regard to the credibility of an instrument, an inference associated with factor analysis is that, if the factor analysis results for a particular instrument with one sample are consistent with previous analysis of data from a different sample, this adds to the credibility of the instrument.

For this study, factor analysis was carried out using principal axis factoring with varimax rotation and Kaiser normalization to check the structure of the 46-item, seven-scale questionnaire. The varimax rotation with Kaiser normalization is a statistical method used to examine how groupings of questionnaire items measure the same concept. Further, this method seeks to maximize the variances of the squared loadings so that, for each factor, high loadings result for a few variables, with the others being near zero (Boslaugh & Watters, 2008). Eigenvalues, which indicate the extent to which the factors resulting from the factor analysis are unique from each other, were also used to determine factor strength (Boslaugh & Watters, 2008). A separate analysis was conducted for the pretest data and the posttest data for the QuALESA. Each of these analyses was carried out using combined data collected from both the Dresden and Bronx samples. Ideally, validity analyses for these two samples should have been conducted separately. However, because of the small sample size for each population, accomplishing such analyses required combining the participants into a single sample. Even then, the minimal sample size required for factor analysis is at least five times the number of questionnaire items. In my study, a sample size of at least 230 students was required, whereas my achieved sample size

was only 142 students. Still, preliminary separate analyses of data for each sample displayed patterns similar to the combined sample, adding confidence to the results of the validity analyses.

Table 4.1 shows the factor loadings for the QuALESA for the pretest and posttest for the entire sample. Additionally, the percentage of variance and eigenvalue for each scale can be found at the bottom of Table 4.1. Items are referred to by scale name and corresponding number. The complete wording for each item affiliated with a specific scale can be found in Appendix D (English–German version) and Appendix E (English–Spanish version).

In order for an item to be retained, it had to meet certain criteria. For this study, these criteria were that, for the QuALESA pretest and posttest, all of the items must have a loading of at least 0.35 on their *a priori* scale and less than 0.35 on all other scales. The percentage of variance for the pretest ranged between 4.58% to 22.73% and the eigenvalue ranged between 2.06 and 10.23 for different scales. The total proportion of variance accounted for by these 46 items in seven scales was 59.9%. The percentage of variance for the posttest ranged between 3.95% to 21.77% and the eigenvalue ranged between 1.81 and 10.01. The total proportion of variance accounted for by these 46 posttest items in seven scales was 59.8%.

For both the pretest and the posttest, results of the factor analyses indicate that the QuALESA's factor structure was sound. First, all 46 items had factor loadings of less than 0.35 with all other scales except their own scale. Additionally, the seven scales collectively accounted for about 60% of the variance. Further, the eigenvalue associated with each of the seven scales was greater than 1. When these three pieces of evidence are collectively taken into consideration, one can see that the QuALESA

Table 4.1 – Factor Loadings, Percentages of Variance, and Eigenvalues for the Pretest and Posttest for the QuALESA

Item	Factor Loadings													
	Involvement		Cooperation		Personal Relevance		Critical Voice		Shared Control		Attitude to Scientific Inquiry		Enjoyment of Science Lessons	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Invo1	0.70	0.70												
Invo2	0.75	0.75												
Invo3	0.42	0.58												
Invo4	0.65	0.47												
Invo5	0.57	0.73												
Invo7	0.39	0.41												
Invo8	0.35	0.35												
Coop 1			0.70	0.67										
Coop 2			0.60	0.72										
Coop 3			0.71	0.73										
Coop 4			0.67	0.71										
Coop 5			0.61	0.32										
Coop 6			0.69	0.79										
Coop 7			0.61	0.72										
Coop 8			0.38	0.43										
PRel1					0.71	0.74								
PRel2					0.72	0.65								
PRel3					0.72	0.69								
PRel4					0.78	0.75								
PRel5					0.67	0.53								
PRel6					0.74	0.73								
CriVo1							0.80	0.70						
CriVo2							0.76	0.79						
CriVo3							0.74	0.79						
CriVo4							0.66	0.80						
CriVo5							0.61	0.71						
CriVo6							0.61	0.74						
SCon1									0.71	0.65				
SCon2									0.77	0.74				
SCon3									0.78	0.81				
SCon4									0.77	0.76				
SCon5									0.71	0.74				
SCon6									0.72	0.70				
ATSI1											0.78	0.74		
ATSI2											0.78	0.76		
ATSI3											0.69	0.75		
ATSI4											0.73	0.82		
ATSI5											0.78	0.74		
ATSI6											0.80	0.77		
EOSL1													0.80	0.77
EOSL2													0.81	0.84
EOSL3													0.77	0.73
EOSL4													0.80	0.87
EOSL5													0.78	0.75
EOSL6													0.84	0.79
% Variance	4.58	3.95	6.55	9.05	5.37	4.72	4.73	7.84	7.06	5.65	8.88	6.84	22.73	21.77
Eigenvalue	2.06	1.81	2.94	4.16	2.42	2.17	2.13	3.61	3.18	2.60	3.99	3.15	10.23	10.01

N=142 (N=82 students in 5 classes in Dresden) (N=60 students in 2 classes in the Bronx)

Factor loadings less than 0.35 have been omitted from the table.

Principal axis factoring with varimax rotation and Kaiser normalization.

demonstrated sound factorial validity for my sample of students in Dresden and the Bronx.

4.2.2 *Internal Consistency Reliability and Discriminant Validity of QuALESA*

All 46 items of the QuALESA were used to generate further indices of scale reliability and validity. The Cronbach alpha reliability was used as an index of internal consistency reliability to ensure that each of the items making up a scale in the QuALESA reflected a common construct. Calculation of the mean magnitude of the correlation of one scale to other scales was used as an index of discriminant validity to ensure that raw scores on each scale were in fact unique in the dimension that they assess. The individual student was used as the unit of analysis for both the reliability and discriminant validity analyses.

Table 4.2 shows that the Cronbach alpha reliability coefficient was high for all scales for both the pretest and posttest for the QuALESA. Previous research indicates that values over 0.70 are typically desirable (Cortina, 1993). Using the class mean as the unit of analysis, Cronbach alpha coefficients for the learning environment scales for the pretest ranged from 0.72 for Involvement to 0.86 for Personal Relevance and for the posttest from 0.76 for Involvement to 0.87 for Critical Voice. Cronbach alpha coefficients for the attitude scales for the pretest were 0.88 for Attitude to Scientific Inquiry and 0.94 for Enjoyment of Science Lessons and for the posttest were 0.87 for Attitude to Scientific Inquiry and 0.92 for Enjoyment of Science Lessons. These results attest to the QuALESA's strong internal consistency reliability.

Discriminant validity involves how well separate scales are able to measure theoretically-different concepts. Scales that show good discriminant validity should not be highly correlated with other scales (Campbell & Fiske, 1959). Although there

is no accepted cut-off value for discriminant validity, a smaller mean correlation coefficient generally shows that discriminant validity is likely to exist between scales. On the other hand, a large mean correlation coefficient generally shows that the two scales overlap and probably are partly measuring the same aspect of the learning environment.

Table 4.2 – Scale Mean, Standard Deviation, Internal Consistency Reliability (Cronbach Alpha Coefficient), and Discriminant Validity (Mean Correlation With other Scales) for the QuALESA

Scale	No of Items	Mean		Standard Deviation		Alpha Reliability		Mean Correlation	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
<i>Learning Environment</i>									
Involvement	8	3.31	3.46	0.58	0.59	0.72	0.76	0.29	0.31
Cooperation	8	3.46	3.82	0.64	0.59	0.82	0.83	0.29	0.26
Personal Relevance	6	3.38	3.64	0.75	0.69	0.86	0.85	0.29	0.32
Critical Voice	6	3.30	3.74	0.88	0.86	0.84	0.87	0.26	0.24
Shared Control	6	2.28	2.59	0.75	0.79	0.86	0.85	0.22	0.19
<i>Attitudes</i>									
Attitude to Scientific Inquiry	6	3.86	4.01	0.91	0.78	0.88	0.87	0.23	0.15
Enjoyment of Science Lessons	6	3.50	3.66	0.88	0.81	0.94	0.92	0.34	0.30

N=142 (N=82 students in 5 classes in Dresden) (N=60 students in 2 classes in the Bronx)

Table 4.2 shows that the mean correlation coefficient, using the individual student as the unit of analysis, for learning environment scales ranged from 0.22 for Shared Control to 0.29 for Involvement on the pretest. On the posttest, the mean correlation coefficient for the learning environment scales ranged from 0.19 for Shared Control to 0.32 for Personal Relevance. For the attitude scales, the mean

correlation coefficient on the pretest was 0.23 for Attitude to Scientific Inquiry and 0.34 for Enjoyment of Science Lessons and on the posttest were 0.15 for Attitude to Scientific Inquiry and 0.30 for Enjoyment of Science Lessons. Thus, it can be concluded that raw scores on each of the five learning environment scales and two attitude scales are largely measuring a different construct. Moreover, the factor analysis results attest to the independence of factor scores on the QuALESA.

The internal consistency reliability and discriminant validity results above are comparable with other studies that utilized scales from the CLES, WIHIC, and TOSRA. For example, internal consistency reliability data reported for 1079 students in north Texas by Nix, Fraser, and Ledbetter (2005) for the CLES at the individual unit of analysis were 0.75 for Personal Relevance, 0.77 for Critical Voice and 0.84 for Shared Control. That study also reported mean correlation coefficients of 0.29, 0.28, and 0.28 for Personal Relevance, Critical Voice, and Shared Control, respectively, with the individual unit of analysis. A study conducted in Australia by Dorman (2008) used scales from the WIHIC with 978 secondary school students and reported an alpha reliability of 0.84 for Involvement and 0.83 for Cooperation, using the individual as the unit of analysis. Raaflaub and Fraser (2002) used the WIHIC to collect data from 1,173 students in 73 mathematics and science classrooms in four different schools in Ontario, Canada. Using the individual as the unit of analysis, Raaflaub and Fraser (2002) reported an alpha reliability of 0.84 and 0.77 for the scales of Involvement and Cooperation, respectively, and a mean correlation coefficient of 0.38 for Involvement and 0.28 for Cooperation with the individual as the unit of analysis. Using the QOCRA, a slightly modified form of the TOSRA, Wong and Fraser (1996) reported a reliability value for a sample in Singapore of 0.86 for the scale of Attitudes to Scientific Inquiry and 0.97 for Enjoyment of Chemistry Lessons.

4.2.3 *Ability of the QuALESA to Differentiate Between Classrooms*

Ideally, students who are in the same classroom should hold relatively similar perceptions of their learning environment and thus respond to each of the items in a scale fairly consistently. The ability of an instrument to differentiate between classes can be determined by examining the amount of variance within a group as compared to the amount of variance across groups. According to Boslaugh and Watters (2008), if there is relatively little variance within a class when compared to a larger degree of variance between classes, we can conclude that the instrument is able to differentiate between classrooms. In order to investigate this characteristic, a one-way analysis of variance (ANOVA) was used for each of the QuALESA's learning environment scales with class membership as the independent variable. The resulting η^2 statistic is a measure of the variance in scale scores accounted for by class membership. It is calculated by taking the ratio of 'between' to 'total' sums of squares from ANOVA. The presence of a statistically significant difference between classes was taken to indicate that each QuALESA scale could differentiate between the perceptions of students in different classrooms. Analyses were conducted separately for pretest and posttest data. Table 4.3 presents the results of the ANOVAs.

The amount of variance in pretest scores accounted for by classroom membership ranged from 0.05 to 0.27 for different scales. For the pretest, three learning environment scales (Cooperation, Personal Relevance, and Critical Voice) were able to differentiate significantly between classrooms, while the scales of Involvement and Shared Control were not. For the posttest, each of the learning environment scales was able to differentiate significantly between classrooms, with the η^2 statistic ranging from 0.11 to 0.22 for different scales.

Table 4.3 – Ability to Differentiate Between Classrooms (ANOVA Results) for the Learning Environment Scales of the QuALESA

Scale	Number of Items	ANOVA (Eta ²)	
		Pre	Post
Involvement	8	0.06	0.15**
Cooperation	8	0.14**	0.11*
Personal Relevance	6	0.22***	0.22***
Critical Voice	6	0.27***	0.12*
Shared Control	6	0.05	0.14**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$N = 142$ ($N = 82$ students in 5 classes in Dresden) ($N = 60$ students in 2 classes in the Bronx)

It should also be noted here that the ability to differentiate between classrooms was not a relevant validity criterion for the two scales relating to students' attitudes towards science.

4.3 Differences in Learning Environment Perceptions and Attitudes to Science Before and After Reality Pedagogy

This section describes the data analyses used to respond to my second research question: *Is the implementation of reality pedagogy in science classrooms effective in terms of changes in (a) student perceptions of their learning environment and (b) student attitudes?*

Descriptive statistics comparing students' perceptions of the learning environment and attitudes towards science before and after the implementation of reality pedagogy in the science class are provided in Table 4.4 for the combined sample of students from Dresden and the Bronx. Figure 4.1 graphically compares the average item mean (scale mean divided by the number of items associated with that scale) for the QuALESA administered before (pretest) and after (posttest) the

implementation of reality pedagogy. Calculating the average item mean permitted a comparison between scales that might have a differing number of constituent items.

Table 4.4 – Average Item Mean, Average Item Standard Deviation, and Difference Between Pretest and Posttest (ANOVA Results and Effect Size) for Entire Sample for QuALESA

Scale	Average Item Mean		Average Item Standard Deviation		Difference	
	Pre	Post	Pre	Post	<i>F</i>	Effect Size
<i>Learning Environment</i>						
Involvement	3.31	3.46	0.58	0.58	1.73**	0.25
Cooperation	3.46	3.81	0.64	0.59	2.34***	0.56
Personal Relevance	3.38	3.64	0.75	0.69	1.90***	0.36
Critical Voice	3.30	3.74	0.88	0.86	2.41***	0.51
Shared Control	2.28	2.59	0.75	0.79	1.98***	0.40
<i>Attitudes</i>						
Attitude to Scientific Inquiry	3.86	4.01	0.91	0.78	1.29	0.17
Enjoyment of Science Lessons	3.50	3.66	0.88	0.81	1.44*	0.19

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ $N = 142$ students

One’s ability to make sense of Table 4.4 requires an understanding of how to interpret the values for the average item mean. As described in Chapter 3, Sections 3.6.1.1, 3.6.1.2, and 3.6.1.3, all items were responded to using a five-point frequency scale. Thus, for learning environment scales, average item mean scores of between ‘3’ and ‘4’ indicate that students perceived practices pertaining to that specific aspect of the learning environment as occurring more frequently than Sometimes and moving towards Often. For the two attitude scales, average item mean scores greater than ‘3’ indicate that students had certain feelings towards science more frequently than Sometimes and moving towards Often or Almost Always. In contrast, an

average item mean score less than '3' indicates that students perceived practices pertaining to that specific aspect of the learning environment as occurring less frequently than Sometimes and moving towards Seldom or Almost Never. For the two attitude scales, average item mean scores less than '3' indicate that students had certain feelings towards science less frequently than Sometimes and moving towards Seldom or Almost Never.

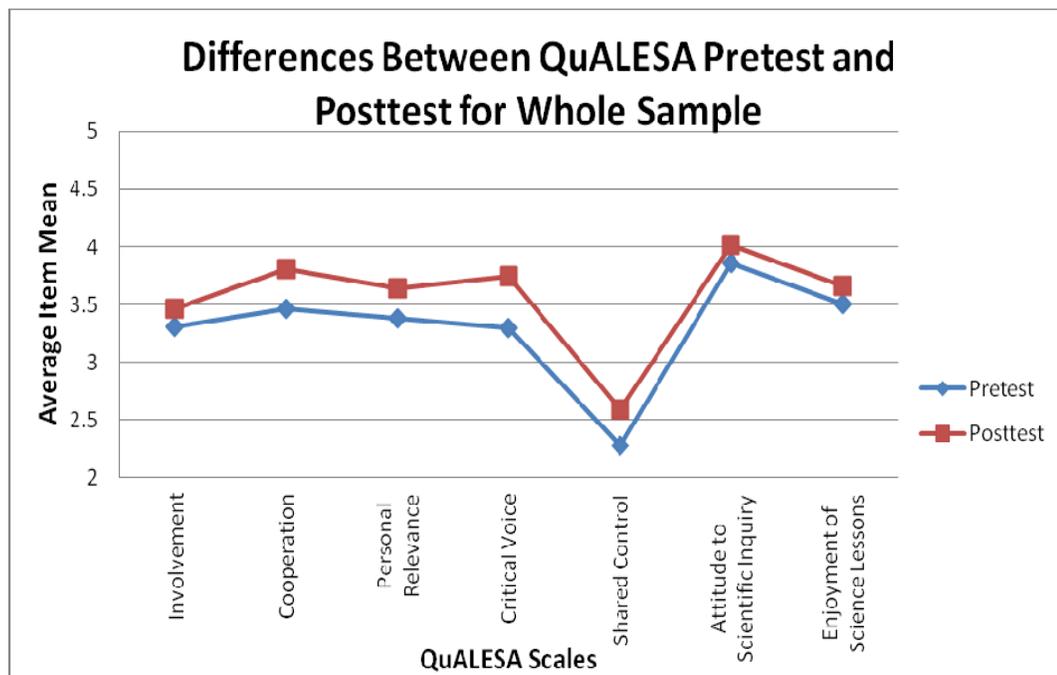


Figure 4.1 – Pretest and Posttest Differences on QuALESA Scales

Table 4.4 indicates that the average item mean for all seven scales of the QuALESA increased between the pretest and posttest. Differences between the average item means for the pretest and posttest ranged from 0.15 for Involvement to 0.44 for Critical Voice. The scales of Cooperation, Personal Relevance, Shared Control, Attitude to Scientific Inquiry, and Enjoyment of Science Lessons had average item mean differences of 0.35, 0.26, 0.31, 0.15, and 0.16, respectively. Despite increases in average item mean scores between the pretest and posttest

administration of the QuALESA across all scales, examination of these differences alone is not enough to indicate the effectiveness of reality pedagogy.

To investigate the statistical significance of changes over time in students' perceptions of their learning environment and in their attitudes towards science in response to reality pedagogy, scores for each scale of the QuALESA underwent statistical analysis in the form of a MANOVA with repeated measures. Because the multivariate test using Wilks' lambda criterion revealed a statistically significant change in the set of seven learning environment and attitude scales as a whole, the individual univariate ANOVA was interpreted separately for each dependent variable. The ANOVA results shown in Table 4.4 indicate that there were significant differences ($p < 0.05$) between the pretest and posttest for all scales assessing the learning environment and student attitudes, except for Attitude to Scientific Inquiry.

Because the presence of a statistically significant difference between two means does not in itself indicate that the difference is important, a calculation of effect sizes in conjunction with traditional significance testing provides researchers with deeper understanding of their data (Boslaugh & Watters, 2008). An effect size for a scale is calculated by dividing the difference between the means by the pooled standard deviation. Further, effect size values indicate the magnitude of pre-post differences in standard deviation units for each scale without having to worry about sample size (Boslaugh & Watters, 2008). According to Cohen (1992), there are varying degrees of effect size. An effect size of 0.2 to 0.3 might be a 'small' effect or 0.5 a 'medium' effect or 0.8 and above a 'large' effect.

Table 4.4 indicates that most effect sizes were 'small' to 'medium' as defined by Cohen (1992). Pre-post differences for the five learning environment scales showed 'medium' effects, with effect sizes ranging from 0.25 standard deviations for

Involvement to 0.56 standard deviations for Cooperation. The two attitude scales showed ‘small’ effects, with effect sizes of 0.17 and 0.19 standard deviations for the scales Attitude to Scientific Inquiry and Enjoyment of Science Lessons, respectively, for pre–post differences.

In summary, according to the quantitative data gathered from the pretest and posttest administrations of the QuALESA, it can be argued that implementation of reality pedagogy in science classrooms was somewhat effective in terms of changes in student perceptions of their learning environment. Further, reality pedagogy did have an effect on students’ enjoyment of their science lessons. However, when the responses of the entire sample were taken into consideration, there did not appear to be any significant difference and only a ‘small’ effect in terms of changes in students’ attitude towards scientific inquiry.

4.4 Differences in Learning Environment Perceptions and Attitudes to Science Between the Bronx and Dresden

This section describes the data analyses used to respond to the research question: *Are there differences between science students from the Bronx and Dresden in terms of (a) their classroom learning environment perceptions and (b) attitudes to science?*

To investigate the statistical significance of differences between the Bronx and Dresden in terms of students’ perceptions of the learning environment and attitudes toward science, scores for each scale of the QuALESA underwent statistical analysis in the form of MANOVA. Analyses were conducted separately for pretest and posttest data. Because the multivariate test using Wilks’ lambda criterion revealed a statistically significant change in the set of seven learning environment and attitude scales as a whole, the individual univariate ANOVA was interpreted separately for

each dependent variable. Consistent with previous analyses, effect sizes were also calculated in conjunction with traditional significance testing.

Table 4.5 shows descriptive statistics, including means and standard deviations, as well as ANOVA results and effect sizes for between-country differences. Figure 4.2 graphically compares the average item mean (scale mean divided by the number of items associated with that scale) for both samples for the QuALESA administered before (pretest) and after (posttest) the implementation of reality pedagogy, respectively.

Table 4.5 – Between-Country Differences for QuALESA Scales for Pretest and Posttest

Scale	Occasion	Average Item Mean		Average Item Standard Deviation		Difference	
		Dresden	Bronx	Dresden	Bronx	F	Effect Size
<i>Learning Environment</i>							
Involvement	Pretest	3.31	3.67	0.59	0.51	1.99***	0.65
	Posttest	3.28	3.36	0.58	0.59	0.92	0.13
Cooperation	Pretest	3.61	3.24	0.54	0.71	1.87**	0.58
	Posttest	3.83	3.79	0.52	0.69	0.66	0.06
Personal Relevance	Pretest	3.63	3.04	0.77	0.58	2.22***	0.86
	Posttest	3.72	3.52	0.74	0.61	1.30	0.29
Critical Voice	Pretest	3.64	2.82	0.74	0.76	2.48***	1.09
	Posttest	3.77	3.70	0.92	0.77	0.70	0.08
Shared Control	Pretest	2.34	2.20	0.74	0.76	1.06	0.18
	Posttest	2.58	2.61	0.83	0.74	0.45	0.03
<i>Attitudes</i>							
Attitude to Scientific Inquiry	Pretest	4.08	3.58	0.82	0.95	1.83**	0.56
	Posttest	4.09	3.89	0.83	0.70	1.25	0.16
Enjoyment of Science Lessons	Pretest	3.81	3.07	0.88	0.67	2.32***	0.94
	Posttest	3.74	3.55	0.88	0.69	1.17	0.24

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
 $N = 82$ (Dresden), 60 (Bronx)

Differences in QuALESA scores between Dresden and the Bronx for the pretest ranged from 0.18 standard deviations for Shared Control to 1.09 standard

deviations for Critical Voice. The scales of Involvement, Cooperation, Personal Relevance, Critical Voice, Attitude to Scientific Inquiry, and Enjoyment of Science Lessons had between-country differences at pretesting of 0.65, 0.58, 0.86, 1.09, 0.56, and 0.94 standard deviations, respectively, which represent large effect sizes (Cohen, 1992).

In contrast, for the posttest, differences between Dresden and the Bronx were nonsignificant and were associated with small effect sizes ranging from only 0.03 standard deviations for Shared Control to 0.29 standard deviations for Personal Relevance. A graphical comparison of QuALESA average item mean scores for Dresden and the Bronx for the pretest and posttest can be viewed in Figure 4.2.

Figure 4.2 highlights certain patterns. Whereas there were large and statistically significant differences for all learning environment and attitudes scales (except Shared Control) between Dresden and the Bronx for the pretest, these differences became much smaller and were nonsignificant for the posttest. That is, by the time of the posttest, all of the significant differences between Dresden and the Bronx that had been present for the pretest had disappeared.

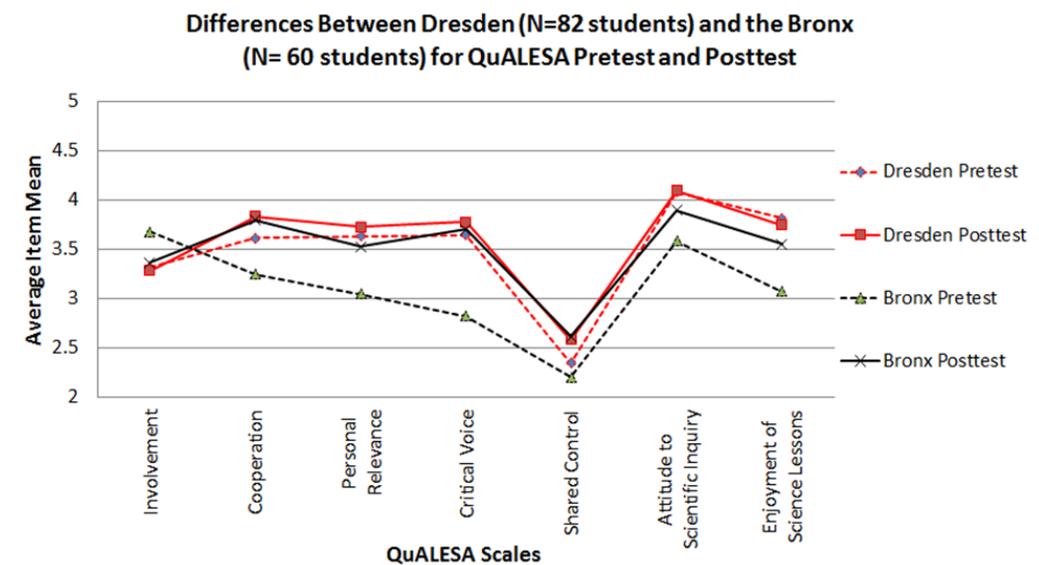


Figure 4.2 – Differences on QuALESA Scales Between Dresden and the Bronx

As shown in Table 4.5, for nearly all the pretest QuALESA scales, students in Dresden had significantly higher scores than students from the Bronx. However, upon closer examination, one can see that the learning environment perceptions and attitudes towards science changed little between the pretest and posttest for the Dresden sample. In contrast, the Bronx sample exhibited sizeable pre–post changes in average item means for all scales. By the time of the posttest, the average item mean scores for the Bronx population had become more closely aligned with the average item mean scores for students in Dresden. One interpretation of this could be that reality pedagogy had a greater impact on the Bronx population than the Dresden population.

4.5 Associations Between Learning Environment Perceptions and Attitudes to Science

This section describes the data analyses used to respond to the research question: *Is there a relationship between students' perceptions of their learning environment and their attitudes toward science? If so, how can this relationship be explained?*

Associations between students' perceptions of their learning environment (as assessed by the QuALESA's five learning environment scales) and their attitudes toward science (as assessed by the QuALESA's two attitudinal scales) are reported in this section. These associations were investigated using the sample of 142 students (80 from Dresden and 62 from the Bronx) and undertaking simple correlation and multiple regression analyses. The simple correlation analysis provided information about the tendency of two variables to change in value together and was used to determine bivariate associations (strength and direction of the relationship) between each of the learning environment scales and each attitude scale (Boslaugh & Watters,

2008). The multiple regression analysis was used to determine the joint influence of the set of correlated learning environment scales on each scale assessing students' attitude towards science. Additionally, multiple regression analysis was used to determine which learning environment scales made a significant contribution to the variance in students' attitudes when the other learning environment scales were mutually controlled. The results of the simple correlation and multiple regression analyses are reported in Table 4.6 separately for the pretest and posttest data.

Table 4.6 – Simple Correlation and Multiple Regression Analyses for Associations Between Classroom Environment Perceptions and Student Attitudes Toward Science

Scale		Attitude to Scientific Inquiry		Enjoyment of Science Lessons	
		<i>r</i>	β	<i>r</i>	β
Involvement	Pretest	0.24**	0.11	0.37**	0.15
	Posttest	0.13	0.04	0.39**	0.22**
Cooperation	Pretest	0.24**	0.11	0.43**	0.25**
	Posttest	0.15	0.00	0.26**	0.02
Personal Relevance	Pretest	0.32**	0.24**	0.45**	0.28***
	Posttest	0.33	0.33***	0.47**	0.36***
Critical Voice	Pretest	0.20*	0.09	0.36**	0.21**
	Posttest	0.17*	0.10	0.22**	0.01
Shared Control	Pretest	0.07	0.04	0.14	0.05
	Posttest	0.04	0.15	0.31	0.15*
Multiple Correlation (<i>R</i>)	Pretest		0.38***		0.60***
	Posttest		0.37**		0.56***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

N = 142 students

4.5.1 Simple Correlation Analyses

The results of the simple correlation analyses presented in Table 4.6 indicate that, for the QuALESA pretest, four of the learning environment scales (Involvement, Cooperation, Personal Relevance, and Critical Voice) were statistically significantly correlated with Attitude to Scientific Inquiry ($p < 0.05$). For the QuALESA posttest,

only the scale of Critical Voice was positively and significantly correlated with Attitude to Scientific Inquiry. For both the pretest and posttest, the simple correlation between Personal Relevance and Attitude to Scientific Inquiry was the highest of all five learning environment scales. However, even though the simple correlation between Personal Relevance and Attitude to Scientific Inquiry was the highest, only the pretest result was significant.

Table 4.6 also displays the results of the simple correlation analysis between the learning environment scales of the QuALESA and the attitude scale, Enjoyment of Science Lessons. Results indicate that, for the QuALESA pretest and posttest, four of the learning environment scales (Involvement, Cooperation, Personal Relevance, and Critical Voice) were statistically significantly correlated with Enjoyment of Science Lessons. As with the pretest, the simple correlation between Personal Relevance and Enjoyment of Science Lessons was the highest of all five learning environment scales for the posttest. Further, a closer look at the mathematical signs associated with each of the significant correlations for Attitude to Scientific and Enjoyment of Science Lessons indicated the presence of positive correlations.

4.5.2 *Multiple Regression Analyses*

The maximum value for a multiple correlation coefficient (R) is 1.00 and indicates perfect correlation. Thus, calculation of the multiple correlation coefficient allowed me to determine the strength of the relationship between the set of five independent learning environment variables and each of the attitude scales. Table 4.6 indicates a statistically significant multiple correlation between the learning environment and the attitude scale Attitude to Scientific Inquiry for the QuALESA for the pretest and posttest ($p < 0.01$). The results of $R = 0.38$ for the pretest and $R = 0.37$ for

the posttest suggest a moderate multiple correlation between the learning environment scales and Attitude to Scientific Inquiry. Similarly, there was a statistically significant ($p < 0.001$) multiple correlation between the learning environment and the attitude scale Enjoyment of Science Lessons for the QuALESA for the pretest and posttest. The results of $R = 0.60$ for the pretest and $R = 0.56$ for the posttest suggest a moderate to high multiple correlation between the learning environment scales and Enjoyment of Science Lessons.

To interpret the multiple regression results, standardized regression coefficients (β) were examined to determine which of the specific learning environment scales explained most of the variance in each attitude scale when all other learning environment scales were controlled. Table 4.6 shows that, for Attitude to Scientific Inquiry, there was only a single positive significant standardized regression coefficient for the pretest and posttest. Personal Relevance was a statistically significant independent predictor of Attitude to Scientific Inquiry for the pretest ($\beta = 0.24$) and for the posttest ($\beta = 0.33$).

Standardized regression coefficients also were examined to determine which of the specific learning environment scales explained most of the variance in Enjoyment of Science Lessons. Table 4.6 shows that, for the pretest, the three learning environment scales of Cooperation ($\beta = 0.25$; $p < 0.01$), Personal Relevance ($\beta = 0.28$; $p < 0.001$) and Critical Voice ($\beta = 0.21$; $p < 0.01$) were significant independent predictors of Enjoyment of Science Lessons. Table 4.6 also shows that, for the posttest, the three learning environment scales of Involvement ($\beta = 0.22$; $p < 0.01$), Personal Relevance ($\beta = 0.36$; $p < 0.001$) and Shared Control ($\beta = 0.15$; $p < 0.05$) were significant independent predictors of Enjoyment of Science Lessons. The scale of Personal Relevance had the largest independent association with Enjoyment of

Science Lessons, although Involvement and Shared Control were also statistically significant independent predictors of Enjoyment of Science Lessons Attitude during the posttest.

It should also be noted that, for each of these associations, the standardized regression coefficient was positive, thus confirming positive links between the learning environment and student attitudes. These findings replicate those from past research into associations between learning environment scales and attitudinal scales (Adamski, Fraser, & Peiro, in press; Chionh & Fraser, 2009; Wong & Fraser, 1996).

4.6 Summary of Quantitative Data Analyses

This chapter presented analyses and results for the quantitative data that were gathered from administration of the QuALESA, a questionnaire created from combining specific learning environment scales from the CLES and the WIHIC with attitude scales from the TOSRA. The quantitative data were used to determine the validity and reliability of the QuALESA. Further, data collected from the QuALESA were also used to investigate whole-sample pre–post differences for each of the scales of the questionnaire as well as differences between students from the Bronx and Dresden for each of the scales. Finally the quantitative data were used to investigate associations between the learning environment scales and attitudes toward science. The data were collected from a total of 142 students in a total of seven coeducational classes. Five of the classes were from Dresden and had 82 students. The other two classes were located in the Bronx and had 60 students.

To check the validity and reliability of the QuALESA, factor analyses, internal consistency reliability and discriminant validity analyses, and one-way ANOVA were used. Factor analysis led to acceptance of the structure of the QuALESA comprising

46 items in seven scales. The total amount of variance accounted for by these factors was nearly 60% for the pretest or the posttest. Internal consistency reliability was measured using the Cronbach alpha coefficient. Using the class mean as the unit of analysis, Cronbach alpha coefficients for the learning environment scales for the pretest ranged from 0.72 for Involvement to 0.86 for Personal Relevance and for the posttest from 0.76 for Involvement to 0.87 for Critical Voice. Cronbach alpha coefficients for the attitude scales for the pretest were 0.88 for Attitude to Scientific Inquiry and 0.94 for Enjoyment of Science Lessons and for the posttest were 0.87 for Attitude to Scientific Inquiry and 0.92 for Enjoyment of Science Lessons. The discriminant validity results (mean correlation of a scale with other scales) obtained for the QuALESA's learning environment scales for the pretest ranged from 0.22 for Shared Control to 0.29 for Involvement and for the posttest ranged from 0.19 for Shared Control to 0.32 for Personal Relevance. For the attitude scales, the mean correlation coefficient for the pretest was 0.23 for Attitude to Scientific Inquiry and 0.34 for Enjoyment of Science Lessons and for the posttest was 0.15 for Attitude to Scientific Inquiry and 0.30 for Enjoyment of Science Lessons. The results of a one-way ANOVA for each learning environment scale for the pretest indicated that three scales (Cooperation, Personal Relevance, and Critical Voice) were able to differentiate significantly ($p < 0.05$) between classrooms. For the posttest, each of the learning environment scales was able to differentiate significantly between classrooms. Overall, these results suggest that the QuALESA is a valid and reliable instrument that can be used with confidence to assess students' perceptions of the learning environment and their attitudes toward science in Dresden, Germany and the Bronx, New York.

Differences in learning environment perceptions and attitudes toward science between pretest and posttest for the whole sample were investigated using a MANOVA with repeated measures. As the MANOVA yielded a statistically significant change in the set of seven learning environment and attitude scales as a whole, the individual univariate ANOVA was interpreted separately for each dependent variable. The ANOVA results indicated significant differences between the pretest and posttest for all scales assessing the learning environment and student attitudes, except for Attitude to Scientific Inquiry. The effect sizes for the scales for which pretest and posttest differences were statistically different ranged from 0.19 standard deviations for Enjoyment of Science Lessons and 0.56 standard deviations for Cooperation.

MANOVA was performed to investigate the statistical significance of differences in scores for each scale between students from Dresden and the Bronx separately for the pretest and posttest. Data analyses revealed significant differences between Dresden and the Bronx on the pretest for Involvement, Cooperation, Personal Relevance, Critical Voice, Enjoyment of Science Lessons, and Attitude to Scientific Inquiry. For the pretest, effect sizes ranging from 0.56 to 1.09 standard deviations for scales exhibiting significant differences suggest a fairly substantial difference between the two countries. However, by the time of the posttest, all of the significant differences that had been present for the pretest had disappeared.

Associations between students' perceptions of their learning environment and their attitudes toward science were investigated using simple correlation and multiple regression analyses. The results of the simple correlation analyses indicated that, for the QuALESA for the pretest, four of the learning environment scales (Involvement, Cooperation, Personal Relevance, and Critical Voice) were positively and statistically

significantly correlated with Attitude to Scientific Inquiry. For the posttest, only the scale of Critical Voice was positively and statistically significantly correlated with Attitude to Scientific Inquiry. Further, the simple correlation analyses between the learning environment scales and the attitude scale, Enjoyment of Science Lessons, indicated that, for both the pretest and posttest, four of the learning environment scales (Involvement, Cooperation, Personal Relevance, and Critical Voice) were positively and statistically significantly correlated with Enjoyment of Science Lessons.

The multiple regression analysis indicated a statistically significant ($p < 0.01$) multiple correlation between the set of learning environment scales and Attitude to Scientific Inquiry for both pretest and posttest. Similarly, there was a statistically significant ($p < 0.001$) multiple correlation between the learning environment scales and Enjoyment of Science Lessons for both the pretest and posttest. Standardized regression coefficients (β) were calculated to determine which of the specific learning environment scales explain most of the variance for each of the attitude scales of the QuALESA when all other learning environment scales are controlled. Data analyses suggested that the learning environment scale of Personal Relevance was a statistically significant independent predictor of Attitude to Scientific Inquiry for the pretest ($\beta = 0.24$) and the posttest ($\beta = 0.33$). Further, data analyses suggested that three learning environment scales, Cooperation ($\beta = 0.25$; $p < 0.01$), Personal Relevance ($\beta = 0.28$; $p < 0.001$), and Critical Voice ($\beta = 0.21$; $p < 0.01$), had about equal independent influences and were statistically significant independent predictors of Enjoyment of Science Lessons for the pretest. For the posttest, the learning environment scale of Personal Relevance had the largest independent influence on Enjoyment of Science

Lessons, although Involvement and Shared Control were also statistically significant independent predictors of Enjoyment of Science Lessons Attitude for the posttest.

Overall, using the analyses of the quantitative data as evidence I can argue that implementation of reality pedagogy in science classrooms was effective in terms of changes in student perceptions of their learning environment. Further, when comparing the effectiveness of reality pedagogy between Dresden and the Bronx, it appeared that reality pedagogy was helpful in shifting the learning environment perceptions and attitudes of students from the Bronx to be more positive and comparable to the perceptions and attitudes initially held by students in Dresden. Additionally, an investigation of associations between learning environment perceptions and attitudes indicated that Personal Relevance is a good predictor of Enjoyment of Science Lessons. This alludes to one of the goals of reality pedagogy which is to use student experiences to enhance science instruction.

Chapter 5

QUALITATIVE DATA ANALYSES AND FINDINGS

5.1 Introduction to the Chapter

Investigating learning environments and student attitudes using a combination of quantitative and qualitative methods has advantages. First, the combination of methods allows researchers to gain a more complete understanding of the research questions than by either method alone. Second, the complexities of learning environments and student attitudes require multiple methods and sources of data to elaborate and complement each other. (Aldridge & Fraser, 2000; Creswell, 2008; Fraser & Tobin, 1991). Tobin and Fraser (1998, p. 639) assert the importance of using multiple research methods when exploring learning environments and student attitudes and “advocate the use of both in an effort to obtain credible and authentic outcomes.”

Morgan (1997) describes four general ways of combining the quantitative and qualitative data, based upon which one is primary and which is secondary and upon which one is used first and which is used second. For this exploratory study, I first collected quantitative data using the QuALESA as the primary method and used the qualitative data presented in this chapter to better interpret and evaluate the results obtained through the QuALESA (see Chapter 4). The specific methods used to collect the quantitative and qualitative data are described in detail in Chapter 3, Sections 3.6.1 and 3.6.2, respectively. This combination of methods also provided me with the opportunity of investigating the differing ‘grain sizes’ associated with

learning environment research (Fraser, 1999). Moving between ‘fine grain’ and ‘coarse grain’ data allowed triangulation (Fraser & Tobin, 1991) by combining information from several types of data in an attempt to gain a better sense of the social behaviors of individuals while minimizing the amount of error posed by either type of data standing alone (Boslaugh & Watters, 2008; Fraser & Tobin, 1991). Creswell (2008) further explains triangulation as the process by which the researcher attempts to more fully understand the complexity of human behavior by viewing it through a variety of lenses, in this case, quantitative and qualitative data-collection methods.

While the previous chapter presented analyses and results based on the quantitative data collected through administration of the QuALESA, this chapter is dedicated to presenting analyses and findings based on the qualitative data collected from classroom observations, cogenerative dialogues, and student interviews. These data were obtained in an effort to validate and provide further insight into Research Questions #2 and #3 as described in Chapter 4, Section 4.1.

Hence, this chapter is organized using the following subheadings:

- 5.2 Classroom Observations: Differences in Learning Environment Perceptions and Attitudes to Science Before and After Reality Pedagogy
- 5.3 Interview Responses and Plans of Action: Common Themes and Differences Between the Bronx and Dresden
- 5.4 Summary of the Qualitative Data Analyses.

5.2 Classroom Observations: Differences in Learning Environment Perceptions and Attitudes to Science Before and After Reality Pedagogy

According to the statistical analyses undertaken in Chapter 4, Section 4.3, for all five of QuALESA learning environment scales, there was a statistically significant

difference between pretest and posttest. Effect sizes of these statistically significant differences ranged from 0.25 standard deviations for Involvement to 0.56 standard deviations for Cooperation. For the attitude scales, there was a statistically significant difference between pretest and posttest for Enjoyment of Science Lessons with an effect size of 0.19 standard deviations. Each of the subsections below presents a specific scale from the QuALESA, and within each of these subsections, I present qualitative data from classroom observations that describe the classroom learning environment and student attitudes toward science before and after the implementation of reality pedagogy. The classroom observations are presented in a cross-person manner with the intent of drawing attention to the topics and issues relevant to each scale rather than to individual participants (Yin, 2011).

Each set of classroom observations is presented in a timeline format to best illustrate the transformation of the learning environment and student attitudes, beginning with a time when reality pedagogy was either not yet implemented or just starting to be implemented. To maintain confidentiality of a student's identity, all names of students given in the following vignettes are fictional. The classroom observations are derived from a total of seven science classrooms, two in the Bronx and five in Dresden. The two classes in the Bronx were taught by the same teacher, whereas the five classes in Dresden were divided among three teachers. As mentioned in Section 3.6.2.2, each class was observed on average about three times per week. Thus, throughout the study there were approximately 700 total classroom observations or about 100 observations per class.

5.2.1 Personal Relevance Scale (Pretest Mean = 3.38, Posttest Mean = 3.64, Effect Size = 0.36 Standard Deviations)

Quantitative data analyses reported in Table 4.4 revealed that a statistically significant change of 0.36 standard deviations occurred for Personal Relevance between pretest and posttest. The following set of classroom observations are presented in an order that illustrate changes in classroom practices with regard to how students perceived Personal Relevance in their learning environment. Personal Relevance describes the extent to which students were learning about science within a context that made it relevant to and connected with their out-of-school experiences.

Through the gathering of the qualitative data, two important points emerged regarding students' perceptions of personal relevance in the learning environment. First, as noted by the comment expressed by the student in the first classroom observation, students are unlikely to engage with the learning task if the learning task is disconnected from their out-of-school experiences. Secondly, as captured in the second classroom observation, any attempt at making the science content relevant needs to be made from the perspective of the student and not the teacher. Thus, the reference to an older James Bond film fell short of its intended audience as students had little connection to the film and thus unable to relate to it. However, the third and fourth classroom observations provided good examples of the teacher's ability to consider the realities of the students and use those as entry points into the lesson. Evident in these classroom observations was an increase in student engagement as indicated by time spent on task and participation in classroom discussions. The fifth classroom observation described a situation in which the teacher made a connection between the scientific content, in this case electricity usage, and a real-world application. Throughout the lesson, students eagerly discussed their experiences with being wasteful of electricity, how they were reprimanded for it, and what they could

do differently to help conserve electricity. These five classroom observations are summarized below.

During the previous lesson, the teacher had assigned a homework task asking students to graph and analyze a small data set. The next day, while reviewing the homework assignment with students, the teacher noticed that very few students had fully completed the assignment and that many of the students' answers were either incorrect or insufficient. The teacher expressed his discontent with the students' performance on the assignment. In response, students expressed that they were unfamiliar with many of the items that were being mentioned in the data set as well as in the accompanying analytical questions and thus found it difficult to complete the task. It was observed that in the homework assignment, the teacher had used examples that students were unfamiliar with and did not have any personal connection to, such as statistics involving the organization 'Mothers Against Drunk Driving' (MADD), as well as the travel patterns of basking sharks. The teacher then reprimanded students for not taking the initiative to research what they did not know. One student then raised her hand and said, "It's not that I couldn't have figured out what these things are but I just didn't find any of these things interesting." Other students in the class quickly chimed in with similar remarks. The teacher responded by continuing to reprimand the students and discussing his own personal experiences with the MADD organization, basking sharks, as well as other references he had made in the homework assignment.

[Classroom A from Dresden, Germany]

The teacher presented a lesson on how hydroelectric power was produced and mentioned the Hoover Dam. Many of the students stated that they had never heard of the Hoover Dam. The teacher continued to describe the Hoover Dam as one of the sites used for stunts in an older James Bond film. Some students expressed that they were not familiar with the film. As the teacher tried to continue on with the lesson, one student raised his hand. The student described a nearby dam that his family visited during a recent trip. A few other students also had visited this dam and shared their experiences. The teacher listened and many of the other students asked questions such as, "How big was the dam?", "Was it loud?", and "Could you actually see the generators?". The teacher allowed the discussion to continue while the students engaged in a dialogue with each other regarding their experiences.

[Classroom B from Bronx, New York]

An assignment had students work individually or in pairs to research one of Earth's biomes and construct a model of that biome using any materials they felt appropriate. Students were prompted to do some preliminary research on each of the biomes before choosing one biome to focus on. Over the next few lessons, students used a variety of resources to write up their reports and construct their models. Two students, Joan and Errol, appeared engaged throughout the entire assignment. Joan opted to do research on the tundra and Errol selected to collect more information on the shallow seas. Joan and Errol were very meticulous in how they built their biome models and took great care to ensure they had done a good job. While the students were completing their biome models, the teacher asked both of these students what prompted their high level of engagement with the assignment. Joan expressed that model building was a hobby of hers and that she was excited to be able to use one of her hobbies in the classroom, thus allowing her to perform well on the assignment. Errol explained that he grew up in California and spent nearly his entire life next to the ocean. Further, Errol explained that he felt he could be successful on this assignment because it allowed him to work on something he was familiar with and had a personal connection to.

[Classroom B from Dresden, Germany]

During a lesson on the organization of life, the teacher asked students to break up into groups of four. The teacher provided each group with a digital camera and asked them to take the next 10 minutes and walk around the school to take photographs of anything they found interesting. The only stipulation was that each photograph had to focus on one thing. After about 10 minutes, the students returned to the classroom and uploaded their photographs to the computer. The teacher projected each photograph on a large screen and instructed students to examine each photograph closely and to decide if the item being shown was living or non-living. Students had taken a variety of photographs including pictures of the tree in the school yard, a window, other students, a squirrel, the school principal, sand from the playground, a basketball, seeds on the ground, books in the library, and the light fixtures in the hallway. Once each group of students decided whether the object depicted in the photograph was living or non-living, they used the characteristics of life that had been previously discussed in class to develop arguments for how and why something that was supposedly non-living could be considered living and vice-versa.

[Classroom C from Dresden, Germany]

During a unit on electricity and electrical circuits, the teacher planned a lesson titled "How do electric companies charge their customers?". During the lesson, the teacher asked students to write about how often they used various electrical appliances or other gadgets at home. Next, the teacher asked students to share their experiences regarding the frequency of use which led to a discussion about wastefulness. Almost immediately, many of the students started to discuss with each other and the teacher on the numerous times they had been reprimanded by their parents at home for being wasteful with electricity. Riya described a situation where she was watching television in one room of her house and then moved to another room to use the computer, while keeping the television on. Jeremy described a situation where his parents followed him around the house to shut the lights off after he left a room as he had a habit of turning the lights on in a room and then forgetting to turn them off as he left. The teacher then displayed a picture of his most recent electrical bill and helped orient the students to the various parts of the bill and how electrical companies charged their customers. Near the end of the lesson, the teacher requested that each student bring in an electrical bill from home as they would be using that as the basis for the next lesson. During the next class, it was observed that each student was examining the electrical bill they had brought in and using it as the basis to perform a variety of calculations to figure out the usage, cost, and other values of relevance. Students appeared engaged and through conversations with other students and the teacher were able to thoroughly explain their calculations.

[Classroom B from Bronx, New York]

Regarding the Personal Relevance scale, context studies and content understanding appeared to be the most prevalent aspects of reality pedagogy present. However, it should be noted that these pieces of reality pedagogy did not organically appear in the teachers' practices simply as the academic year progressed. Rather, the teachers' abilities to enact the context and content portions of reality pedagogy resulted from consistent feedback from students engaged in cogenerative dialogues. Thus, as the study progressed and teachers rethought and shifted their instructional practices, there was an increase in learning opportunities that reflected the realities of students. As revealed in the last three classroom observations, teachers made greater

use of student-based cultural artifacts as anchors for classroom instruction. For example, in the fourth classroom observation, the teacher provided the space for students, through the taking of photographs of various sections of the school, to focus the discussion on whether an object was living or non-living. Using this approach, the teacher revealed to the students experientially the connection between the artifacts that they selected to photograph and science, and thus provided the opportunity for the artifact to be viewed through a scientific lens. The fifth classroom observation described the teacher's effort to make science relevant for students by asking them to bring to class an electricity bill from home for analysis. Crafting such an activity required not only an understanding of students' realities but also a level of comfort with the scientific content and being able to relay the content in a manner that was both accurate and interesting. The teacher could have opted to have students work through problems in the textbook involving the calculation of energy usage. However, in selecting to teach about energy consumption through electricity bills, the teacher provided students with the opportunity to appreciate science within a real-world context.

In this section, the classroom observation vignettes depict shifts in instructional practices related to personal relevance. The vignettes are followed by an explanation of how the aspects of reality pedagogy fit with personal relevance in the classroom. The importance of emphasizing personal relevance in the classroom is described by Keat and Urry (1982) who explain that, all too often, science is taught as a collection of facts and patterns, devoid of any connectedness or relevance to students. Additionally, the following idea put forth by Grennon-Brooks and Brooks (1999) helps to further support the importance of utilizing personal relevance in the science classroom. Grennon-Brooks and Brooks (1999) explain that true learning

occurs when the classroom defies the linear percepts of measurement and accountability by providing students with the opportunity to use what they already have a familiarity with to internally construct an understanding of how the world functions.

5.2.2 *The Shared Control Scale (Pretest Mean = 2.28, Posttest Mean = 2.59, Effect Size = 0.40 Standard Deviations)*

As described in Chapter 4, Section 4.3, the pre–post change in the quantitative score for students’ perceptions of Shared Control was 0.40 standard deviations and was statistically significant. This change in Shared Control is elaborated using the set of five classroom observations described in this section. Shared control describes the extent to which students were invited to make mutual decisions with the teacher with regards to teaching and learning in the classroom.

Initially, most teachers participating in this study did not openly encourage the sharing of control with students. Rather, as described in Chapter 2, Section 2.6, these classrooms functioned in a corporate manner that aided in the reproduction of hegemonic structures as dictated by the teacher. This corporate scheme is clear in the first classroom observation where the teacher decided to turn off the sound effects associated with the lesson contrary to the students asking him to keep them on. The teacher’s corporate allegiance shone through with his statement, “Well this is my class after all and what I say goes.” In the second classroom observation, a corporate structure was also in place as the teacher was the one who decided about the music played during independent student work. While this teacher conceded some control to the students, it came at the cost of openly admitting that he did not trust the students’ musical choices. The last three classroom observations showed different ways in which control was shared amongst all the participants in the classroom. For

example, the third classroom observation focused on sharing the teaching responsibility in the classroom while the fourth classroom observation demonstrated shared control by including students in the creation of assessments. Finally, the last classroom observation was selected as it painted a picture of shared control from the point of view of two students in the classroom. Emily and her classmate felt at ease moving about the classroom as shown by her comfort in occupying the space at the head of the classroom, a place typically reserved for the teacher. My classroom observations are briefly outlined below.

Near the beginning of the school year, one teacher was using a Microsoft PowerPoint slideshow created by a fellow colleague to teach the internal structure of cells. Within each of the PowerPoint slides were embedded various sound and graphic effects. Initially, the teacher joked about the sound effects. The students did not seem to find the jokes funny as indicated by their lack of interaction with the teacher. Within minutes, the teacher expressed his annoyance with the sound effects and indicated that he was going to turn the sound off. The students, however, enjoying the sound effects, as they found them entertaining and kept them engaged in the lesson, responded with an overwhelming groan of “Nooooo”. The teacher proceeded to turn the volume off and Lyla was said “You’re going against the whole class”. The teacher replied “Well this is my class after all and what I say goes”.

[Classroom D from Dresden, Germany]

As students independently worked on their class work, the teacher played some background music at a low volume. The teacher had engaged in this practice since the beginning of the academic year with much of the music coming from the classical and country music genres. Students often suggested changing the type of music but the teacher generally responded that he did not believe their music would be appropriate for the classroom. During one lesson, Kevin pleaded with the teacher to give his playlist a try. The teacher finally agreed, taking Kevin’s digital music player and connecting it to the classroom speakers. The teacher looked surprised when he heard some jazz, mixed in with hip-hop music, and some light rock music. During the next lesson, another student brought in his digital musical player and said that he had created a music play list that he thought would be appropriate for the class.

Soon, this became a practice where students were encouraged to bring in their own music to share while doing independent class work.

[Classroom A from Bronx, New York]

At the beginning of a lesson, John and Luis approached the teacher. In an effort to be more involved in class, the two students asked if they could teach a lesson the same way some of their classmates had in the past. John and Luis were not particularly active during class so this request surprised the teacher a bit. The teacher asked the students to meet with him during the lunch break. Later that week, the teacher explained to the class that John and Luis were going to lead the lesson on the states of matter. The teacher explained to the class that John and Luis were provided with the original lesson plan and asked to completely revise it, keeping only the content the same. John and Luis began the lesson with a PowerPoint slideshow presentation they created. Next, there was a whole class reading exercise followed by a cooperative learning activity similar to one the teacher had carried out previously in the year. John and Luis successfully carried out the lesson, but student engagement initially appeared to be low. Near the end of the lesson, the teacher saved a few minutes to allow students to provide critical feedback to their peers. John and Luis listened and expressed that they would be willing to use the feedback to lead another lesson in the future.

[Classroom A from Bronx, New York]

As was customary for this teacher, he generally brought a unit to a close by assigning an essay asking students to tie together the major themes from the unit and to describe how they have grown as learners. However, near the end of one lesson, a small group of students asked the teacher if they could forego the traditional essay writing and rather demonstrate their understanding of the unit through a digital project. The teacher agreed as long as the students helped to co-create the assignment. A few days later, the teacher presented to the class the assignment that he and the cogenerative dialogue group created. The assignment allowed students to flex their creative muscle while ensuring that all of the information which would traditionally be found in an essay was still present. Further, the teacher decided to have students create a digital product in the form of an informative commercial whose goal was to describe how a specific electronic product has transformed the world and how this transformation has positively and negatively affected the world. The class seemed pleased with the change in assignment because the new assignment was co-created

using input from students and it addressed many of the students' concerns.

[Classroom E from Dresden, Germany]

During a lesson on the Earth and seasons, students were working independently to complete a problem that the teacher had posed. The teacher was working with one student near the front of the classroom and had his back turned to the rest of the class. One student sitting in the middle of the classroom waved his hand around in an attempt to get the teacher's attention. Another student walked over to the student who was looking for assistance. The two students spoke briefly and the student who came to help invited the other student up to the front of the classroom. She used a dry-erase board to draw a diagram explaining why the Earth has seasons. The teacher saw the two students at the front of the classroom and acknowledged them with a nod of his head and a smile, showing his comfort in sharing the physical classroom space with the students. As the lesson ended, the teacher acknowledged the two students for helping each other and stated, "I want you guys to know that the board up here isn't only for me. Feel free whenever you need to, to just come up and use it if you need to explain a concept to someone else. Well done Emily!"

[Classroom A from Dresden, Germany]

With regard to the Shared Control scale and the classroom observations described in this section, two strands of reality pedagogy emerged: cosmopolitanism and coteaching. By their very nature, cosmopolitanism and coteaching require the involvement of everyone in the classroom and this can only be achieved when the teacher relinquishes and shares some of the control in the classroom. Cosmopolitanism aims to create an inclusive classroom atmosphere where the individual differences of students are valued and students share a responsibility for each other's learning (Appiah, 2006). A cosmopolitan attitude began to appear in the second classroom observation as the teacher acknowledged students' abilities to make respectful musical choices for inclusion during the science lesson. In doing so, the teacher created a classroom culture that valued the musical choices of all the students. The next three classroom observations also depicted an ethos of cosmopolitanism as

students were either given or adopted specific roles and responsibilities to enact in the classroom, such as presenter of content, creator of assessments, and peer tutor, respectively. In each of these classroom observations, the actions of the students created a communal atmosphere where their strengths were clearly valued. The act of coteaching is not mutually exclusive from cosmopolitanism, as coteaching can be used as a vehicle by which to achieve and maintain a cosmopolitan ethos in the classroom. The third classroom observation described the willingness of the students and the teacher's comfort with having the students function as coteachers. Of significance was the teacher's expectation that the students be given all the responsibilities of the teacher, including lesson planning, selection of materials, and lesson execution. In sharing this power with the students, the teacher provided himself with an opportunity to observe the lesson, take notes on pedagogical strategies used by the students to teach content to individuals sharing the same cultural background, and learn more about how students interact with their peers. As the academic year progressed and the teacher gave students greater responsibility for the functioning of the classroom, coteaching in the more informal style of one-on-one help emerged, as indicated in the fifth classroom observation. In this classroom observation, one student felt comfortable with the content and noticed another student who was struggling and not receiving assistance. Because a culture of power sharing was created, Emily felt responsible to share her knowledge with her peer by bringing her to the white board and teaching the parts of the lesson that her peer had not grasped. Hence, in this example, coteaching is married to cosmopolitanism as Emily's desire to ensure her classmate was learning was achieved by providing her with the space to teach her classmate.

In classrooms where control is not shared among all the actors, teachers are typically the ones disseminating content knowledge with students expected to identify and replicate the knowledge disseminated. If such a classroom were depicted in a diagram, it would have the teacher in the center, with arrows originating from the teacher and pointing toward the students. Arrows pointing back toward the teacher or between students would be rare as student initiated questions and student-student interactions are atypical. However, when control of the classroom is shared, all stakeholders are given the opportunity to best judge what circumstances will and will not allow for success. As shown in the classroom observation vignettes, shared control can be enacted multiple ways, thus the observations in this section were meant to be descriptive, not prescriptive. The importance of sharing control of the classroom is well described by Calabrese-Barton (2003) and Chomsky (2000), who essentially argue that, when control is not shared among all members of the classroom, opportunities for students to be actively engaged and to display their knowledge are reduced. The reason behind this is that authentic learning activities, such as critical questioning, co-teaching, inquiry, debate, and inquisition, require the sharing of control to be enacted successfully.

5.2.3 *Critical Voice Scale (Pretest Mean = 3.30, Posttest Mean = 3.74, Effect Size = 0.51 Standard Deviations)*

The following classroom observations are arranged in a manner which illustrate changes in classroom practices related to students' perceptions of their being able to express their critical voice in their learning environment. As shown in Table 4.4, the pre-post change of 0.51 standard deviations was statistically significant for this scale. The Critical Voice scale describes the extent to which students are able to

express a critical opinion about the learning environment, typically by questioning the actions of the teacher.

Toward the beginning of the study, few students felt that it was appropriate to express critical opinions about their learning environment. Rather than voicing such an opinion, students often expressed a feeling of apathy toward anything the teacher did. In the first classroom observation, Alice was one of the few students who tried to express her opinion to the teacher but the statement “You already know it doesn’t matter how much you complain about something. He is going to do what he wants.” spoken by a fellow classmate indicated this apathy. The first classroom observation was indicative of how many students perceived Critical Voice in their learning environment. However, as reality pedagogy was implemented throughout this study, there was an increase in the number of students who felt comfortable expressing a critical opinion, as indicated by the second classroom observation. This classroom observation was significant because it was one of the first instances where the teacher listened to the opinions expressed by his students and used those opinions to make a change, in this case, the due date of an assignment. This action showed the teacher’s willingness to listen to students and to take their well-being into account. A significant transformation in how critical opinions were expressed is described in the third and fourth classroom observations. In these observations, the teacher was the one who was somewhat prodding students to express critical opinions, essentially asking students for assistance in improving something believed to be ineffective. For example, in the third classroom observation, the teacher asked, “What’s going on?” and then listened to the various viewpoints of students, using those to make changes to the classroom. In the fourth classroom observation, the teacher acknowledged Karen’s question, “What’s the point of this?” and relayed the question back to the

students. When the teacher asked, “So, what is the point of this?”, this showed that the teacher valued Karen’s opinion and hoped that she receive a genuine answer. In the final classroom observation, the primary action involved changing the video being watched from ‘Bill Nye’ to ‘Galileo’. This action illustrated the teacher’s willingness to listen to the needs of the students and adapt instruction in order to meet those needs. Below is a summary of these classroom observations.

During a laboratory exercise, students worked in groups of two due to a lack of materials. Alice asked the teacher if all the students could just work together as one large group and share the data. The teacher replied, “No.” Alice asked if the teacher could explain his reasoning and continued to plead that she did not understand what the difference was if students were going to work in pairs anyhow. Alice was known to be one of the more outspoken students in the class and often times tried to understand the teacher’s reasoning behind his classroom decisions. Other students then called to Alice to just get to work. One student said, “You already know it doesn’t matter how much you complain about something. He is going to do what he wants.” Alice smiled back at the class and then walked over to her assigned partner. The teacher reiterated his initial instructions to the class and reaffirmed that the students were not allowed to share data.

[Classroom A from Bronx, New York]

The teacher passed out an assignment sheet to each student as they filed into the classroom. Once students were seated, the teacher began to review the expectations of the assignment. A few students near the middle of the class complained that the teacher had not told them that they were going to receive an assignment. The teacher said, “It’s almost the end of the marking period and I need more grades for you for your report card.” The teacher continued explaining the assignment and then gave the due date: end of the week on Friday. Students unleashed a frenzy of complaints while the teacher adhered to the original due date he set. As students frantically looked through their planners, Eric walked up to the teacher and showed him all the other assignments that had been given to the class and were due that week. As students continued to protest the due date, the teacher asked students to discuss with each other an expected timeline of completing the work and to propose a reasonable due date. Students thought this was a good option and spent a few minutes discussing how long they thought it would take to complete the assignment and then came up

with a due date that was three school days after the one proposed by the teacher. The teacher agreed and the students relaxed, allowing them to focus their attention back to the lesson.

[Classroom E from Dresden, Germany]

The seating arrangement in the science class was set up in a traditional layout of rows of desks across the classroom starting from the front and ending in the back of the classroom. The teacher tried to engage students in discussions throughout the course, but did not have much success. During one class period, the teacher raised the question, “I tried to make this class more than just note-taking and learning facts, but you guys just don’t seem to want to talk to each other. What’s going on?” Students in the class expressed a variety of viewpoints but one of the themes that seemed to be common was their discontent with the seating arrangement in the class. Students described the current seating arrangement as not being conducive for discussions and that this prevented them from engaging in class discussions. Luis said, “I can’t even hear what Chris is saying half the time.” The teacher immediately fielded suggestions as to how to change the seating arrangement. Within minutes, the students had collectively decided a new seating arrangement and began to rearrange the desks in a U-shape, where student could now directly see each other. The teacher expressed his concern about students potentially getting distracted during the lesson, but decided to let the new seating arrangement stand until there was a problem.

[Classroom A from Bronx, New York]

During a unit on theoretical genetics, the teacher developed a lesson that used artifacts from outside the school, in this case, cars parked in the school’s parking lot to teach the class about genes and alleles. The teacher prompted students to select five traits or characteristics of cars (i.e. car color, number of doors, type of interior). Then, for each of the characteristics, students identified the variations (alleles) they found from 30 different cars. For example, if the trait selected was car color, the variations or alleles were blue, red, green, black, etc. Before the activity began, Karen asked, “What’s the point of this?” Rather than providing a straight forward answer, the teacher responded, “That is a great question!” and relayed the question back to the students. The teacher asked, “So, what is the point of this?” and urged students to discuss the purpose of the activity with each other. Essentially, the teacher was asking students to think about and explain what the connection was between the activity and genetics.

[Classroom E from Dresden, Germany]

On several occasions, the teacher used the science-based American television show 'Bill Nye: The Science Guy' to teach scientific concepts. During one such lesson, the students complained and voiced their discontent with the Bill Nye series. Students stated that they found Bill Nye's jokes to be more distracting than comedic. Further, they found it difficult to understand what Bill Nye was saying as he often spoke quickly. Additionally, for many of the students English was not their first language. The class suggested that the teacher look into showing video clips from the television show, Galileo, a German version of the popular, and more contemporary, American television show, 'Myth Busters'.

[Classroom D from Dresden, Germany]

With regard to the classroom observations described above, two aspects of reality pedagogy were prevalent. Cosmopolitanism is directly related to the Critical Voice scale while context is relevant because the teachers' actions were based on the critical opinions of students. One of the fundamental ideas behind cosmopolitanism is that all of the stakeholders in a community feel responsible for each other. Thus, a student's comfort with expressing a critical opinion of the learning environment and the teacher's willingness to listen to such an opinion as described in the classroom observations above, demonstrate a shared responsibility for the betterment of the classroom and present approaches by which cosmopolitanism could be achieved in the classroom. For example, when the teacher changed the due date of the assignment or when the students rearranged the seats in the class, these actions were taken to improve the learning environment and to ensure that everyone involved had the opportunity to be successful. While the final classroom observation depicted a cosmopolitan classroom where students cared for their peers, I selected to present it to further assert the importance of the context piece of reality pedagogy. The teacher's use of the 'Bill Nye' video series demonstrated a lack of understanding of the cultural artifacts possessed by his students. Fortunately, through the sharing of critical opinions, students expressed their comfort with the 'Galileo' video series over the

'Bill Nye' video series. Thus, by swapping the videos used for science instruction, changes in many other learning environment scales were also evident. For example, the change made by the teacher was also a good indicator of sharing control. Additionally, the fifth classroom observation showed that students whose primary language was German organically flocked to their classmates whose German language skills were not very strong to ensure understanding of the video. Thus, cosmopolitanism was enacted through the level of cooperation between classmates, as students became aware of and more sensitive to the needs of the other non-dominant cultures in the classroom.

Nix, Fraser, and Ledbetter (2005) assert that students' comfort with expressing their critical voices could be a consequence of the overall school-level environment. Thus, if the school-level environment does not value students' critical voices, it is unlikely that a student will express a critical voice in the classroom. While there might be some merit to this statement in the context of the Nix, Fraser, and Ledbetter study, according to the classroom observations in this section, students from the Bronx and Dresden both faced barriers created primarily by the teacher to expressing their critical voices. However, through engagement with reality pedagogy, teachers increased their awareness of practices that caused students to shy away from being critical of the learning environment. Particularly in the Bronx, not only classroom structures, but school-level structures prevented students from expressing their critical voice. However, shifts in teacher practices, as described in the classroom observations in both the Bronx and Dresden, allowed students to feel more comfortable in speaking about and against structures they thought were detrimental to their learning of and success in science.

5.2.4 *Involvement Scale (Pretest Mean = 3.31, Posttest Mean = 3.46, Effect Size = 0.25 Standard Deviations)*

In this section, classroom observations are presented in an order that describes changes in classroom practices with regards to how students perceived Involvement in their learning environment. According to Table 4.4, the improvement of 0.25 standard deviations in Involvement between pretest and posttest was statistically significant. Involvement describes the extent to which students have attentive interest, participate in discussions, do additional work, and enjoy the class. For my study, I went beyond the definition of the questionnaire scale of Involvement and extended it to include any action which involved students taking on a new role in the classroom. Such student actions might include finding new ways to connect cultural experiences to science content, being able to express challenges to learning and conquering them, and using their strengths to help the teacher and fellow classmates overcome classroom challenges.

The first two classroom observations describe teacher-centered classrooms that did not involve students in the teaching and learning process. Further, when students tried to participate and were not acknowledged by the teacher, the students typically disengaged from the lesson. The second and third classroom observations are similar in that they both describe students using personal experiences to make sense of and extend the significance of the scientific content. The major difference between these two classroom observations was in how the teacher acknowledged the student. The student in the second classroom observation made a relevant comment about something he had seen on television. The teacher disregarded the student's comment as insignificant and quickly moved on to the next portion of the lesson. In return, in an act of frustration and defiance, the student made a decision to withdraw from the lesson and not complete any of his class work. The third classroom

observation begins in a very similar fashion, however, the teacher's reaction to the student's involvement is starkly different. In this case, the teacher welcomed the student's comment and asked follow-up questions. The student seemed pleased and continued to be involved for the remainder of the lesson. Further, the level of involvement welcomed by the teacher in the third classroom observation enhanced the personal relevance of the science content for the student. The fourth and fifth classroom observations describe students being deeply involved in the classroom. For example, in the fourth classroom observation the teacher asked students to reflect on their own experimental designs and to provide insight into the designs of their classmates. These actions went beyond answering a few questions after reading a passage. Similarly, in the fifth classroom observation, the teacher involved students in classroom practices which extended beyond a traditional view of student involvement. Students in this class were working on higher-order thinking questions, responding to their classmates, and using their own realities to make sense of a topic that initially appeared to be difficult to understand. My classroom observations are briefly outlined below.

As part of a unit on the Earth, Moon, and Sun System, students watched a series of video clips that illustrated and reinforced many of the concepts learned throughout the unit. While students watched the video clips, students were observed with their faces in their hands, their heads laid on the desk, and looking up at the ceiling or through the windows. Intermittently throughout the video, a student raised his/her hand to ask a question about the video but was not acknowledged by the teacher. Philip kept raising his hand to ask a question and after a few minutes of not getting called on, he blurted out a question about the video. The teacher told him that he needed to be quiet, put his hand down, watch the video and save his question for the end. As the end of the lesson approached, the teacher did not leave any time for students to ask questions. However, the teacher asked to speak to Philip before he left for his next class. During this meeting, the teacher inquired as to why Philip was not performing very well in class. Philip looked confused and attempted to

articulate his frustration with not being given time to ask questions during class to which the teacher said, “You need to stop being distracted and distracting others.”

[Classroom A from Dresden, Germany]

As the teacher presented a lesson on the cycle of energy, he attempted to make an analogy using hamburgers being sold at the local fast food chain. The analogy was poorly constructed and fell short of its intended goal as evident when students asked each other, “Where is he [the teacher] going with this?” and “Does that make sense to you?” One student who generally had not been very active during the lesson raised his hand and was called on by the teacher. The student described something he had recently seen on television regarding polar bears in Alaska and their hunting behaviors. He explained that when polar bears hunt, they do not consume their entire prey in one sitting in an attempt to conserve energy. The student further explained that polar bears will first eat the internal organs of their prey rather than the meat because the organs are more nutritious. The teacher looked at the student grimacing, made a joke about eating a bear, and then moved the lesson along according to the agenda without any acknowledgement of the student's comment. The student retreated into his seat and did not participate in any way for the remainder of the lesson nor did he complete his required class work.

[Classroom B from Dresden, Germany]

As an introduction to the cell theory, the teacher projected a picture of cork as seen under a microscope. The teacher asked students to make observations to predict what was being shown in the picture. Students made several attempts to guess the unknown picture but were unsuccessful in correctly identifying it as cork. The teacher identified the object in the picture as cork and asked, “Can anyone tell me what cork is?” Leonard raised his hand and stated, “It’s used to keep wine bottles closed...it’s put on top.” Before the teacher could speak, Leonard continued, “Cork comes from cork trees which are mostly found in Portugal, but they are cutting all of them [trees] down so cork is getting rarer and more expensive.” The teacher asked Leonard how he knew this information. Leonard explained that he had visited a field of cork trees during a recent trip to Portugal with his family and how some of the local people in Portugal had explained to him that the number of cork trees was in decline and real cork was reserved for use in more expensive bottles of wine. The

teacher smiled at Leonard and thanked him for his contribution to the class discussion.

[Classroom C from Dresden, Germany]

During one lesson, the teacher asked students to do some research on the internet to gather information about the circulatory system and respiratory system of humans. Students were instructed to use the information they gathered to design a laboratory activity that could be used to investigate the relationship between the two systems of the body. Once these directions were given, the teacher took on the role of facilitator, circling through the classroom to ensure students were on task and offering guidance where appropriate. Any guidance offered by the teacher was generally in the form of asking students questions to help clarify their reasoning behind selecting to perform the task a certain way. When groups of students asked similar questions, the teacher made the different groups communicate with each other. This caused students to direct their questions to other students and at times critique the design protocols of the other groups and explain why they thought it was a good or poor design. Students appeared to be greatly involved in the learning process as they actively found and gathered information either from their own group or other students in the class.

[Classroom A from Bronx, New York]

The teacher began a lesson on DNA, aware that it was a topic which excited students. The teacher explained that DNA was a popular topic and that contrary to what the students thought, they [students] probably knew quite a bit about DNA, mostly due to being constantly exposed to the term in the media and on television. Students laughed and quickly began to discuss the popular crime television show, CSI (Crime Scene Investigation). As students talked to each other about the television show, the teacher asked students to write down anything they knew, or thought they knew about DNA, regardless of where they learned it. All the students were observed writing as this provided them with the opportunity to enter into and engage with the lesson. After a few minutes, the teacher asked student to share what they had written and referred back to the initial conversation involving the television show. The writing activity and class discussion allowed the teacher to segue into identifying many of the commonly held student misconceptions about DNA. The teacher functioned to ensure that misconceptions were not being perpetuated and asked clarifying questions that allowed students to refocus their statements about DNA. During this exercise, all students actively participated in the class discussion, offered their personal experiences, supported and questioned each other's responses and took over as

facilitators of the discussion. Every student in the class spoke at least once in an extended manner. The teacher was able to take a topic like DNA that many students initially appeared apprehensive about and gave students the confidence to know that they actually had quite a bit of exposure to and knowledge of DNA.

[Classroom A from Bronx, New York]

The Involvement scale is related to all aspects of reality pedagogy: cogenerative dialogues, cosmopolitanism, co-teaching, context learning, and content understanding. After all, one of the overarching goals of reality pedagogy is to get students to be more deeply involved in the classroom and in their own learning. In terms of reality pedagogy, the five classroom observations described in this section show the development of practices aimed at increasing student involvement. The first classroom observation appears to lack pieces of reality pedagogy. However, by the second classroom observation, even though student involvement is not explicitly welcomed by the teacher, one can see the importance of context. The student tries to make sense of the scientific concept being taught by attaching it to a familiar context, in this case, a story about a polar bear he heard on television. In the third classroom observation, the aspect of content, along with context, seems to take hold. Here, Leonard used his current knowledge of cork along with his experience in Portugal to involve himself in the lesson. Further, this classroom observation showed that content knowledge does not always have to originate from the teacher. Students also possess a wealth of knowledge, which when tapped, are ways to more greatly engage students. Coteaching and cosmopolitanism were highly prevalent in the last two classroom observations. Coteaching was used to promote student involvement and in the process of coteaching, students shared their knowledge and behaved in ways that allowed their classmates to also be successful. For example, in the last classroom observations, students informally co-taught by offering personal experiences with

DNA and tying these in with the main theme of the lesson. As all students engaged in a form of coteaching, a discussion where students supported and questioned each other's responses is the signal of cosmopolitanism. Students asked questions and clarified responses to ensure that the entire class was able to come to a mutual understanding of the topic of DNA.

Providing opportunities for students to construct their own understanding of the scientific content, as well creating opportunities for students to discuss their experiences with a particular topic, are critical ways to involve students in the classroom. Educators often say that they want students to be engaged in and involved with the classroom but, more often, do not support or implement practices that facilitate genuine student involvement (Emdin, 2009). Rather, Emdin (2009) asserts that many educators support practices that foster superficial student involvement, such as, silent reading, asking of lower-order thinking questions, and raising of the hand. The classroom observations in this section begin with a description of superficial student involvement and teachers not willing to involve students and move toward a description of students who are actively involved in the classroom learning environment by showing excitement through increased volume, talking about experiences which at first glance may appear unrelated to the content, and students talking to each other. Thus, as classrooms utilized practices associated with reality pedagogy, there was an increase in student involvement which moved beyond superficial interactions.

5.2.5 Cooperation Scale (Pretest Mean = 3.46, Posttest Mean = 3.81, Effect Size = 0.56 Standard Deviations)

The set of five classroom observations presented in this section supports the statistically significant change of 0.56 standard deviations between pretest and

posttest in how students perceived Cooperation in their learning environment (see Table 4.4). Cooperation describes the extent to which students cooperate rather than compete with one another on learning tasks.

Through the classroom observations, two important points emerged regarding students' perceptions of cooperation in the learning environment: the willingness of the teacher to welcome cooperation in the classroom and the effect of cooperation on the relationships between students in the classroom. The first classroom observation describes an attitude held by many of the teachers at the beginning of the school year when cooperation was only welcome when explicitly stated by the teacher. Typically, when students tried to cooperate with each other, the teacher chastised them for their behavior, as Gable was in the first classroom observation. The second classroom observation describes a similar attitude as the first, where the teacher did not welcome cooperation during traditional science lessons, but rather only during laboratory activities. However, this classroom observation is relevant because it illustrates the inability of students to decipher when they should be cooperating and when they should not. Using the teacher's previous actions toward cooperation as a baseline, students in the class usually did not cooperate unless prompted to do so by the teacher. As the school year progressed and instructional practices shifted to increase shared control between teacher and students, there was also an increase in the frequency and scope of cooperation amongst students. The third classroom observation illustrates the increase in shared control and cooperation through the teacher's providing students with the opportunity to work with another classmate. Further, Felix's statement, "It's like we are looking out for each other and what I can't do then my partner can and what he can't do, I can" serves as evidence that cooperation was moving beyond the simple act of splitting up a task in an attempt to

save time, but rather students were cooperating in a manner that utilized each other's strengths, thus building their classroom relationship while concurrently maximizing the amount of learning. In the fourth and fifth classroom observations cooperation between students extended beyond traditional versions of cooperation where students worked together because they were assigned to complete a project or some other assignment. Rather, when students required assistance, other students took on the role of teacher and, without being prompted to do so by anyone, decided to offer help to their classmates. These five classroom observations are summarized below.

After about ten minutes of direct instruction to the students, the teacher gave each student a hand-out with a few word problem questions based on the frequencies and wavelengths of different types of electromagnetic waves. The teacher had not explicitly mentioned that the task was to be completed independently. While the students worked on the task, Gable, who sat in the first row, turned to Jules and asked if she could explain how to do the second problem. All the other students in the class were working on their own with little to no evidence of cooperation. When the teacher looked up from his desk and noticed Gable talking to Jules, he said, "Mr. Gable, are you unaware of where your desk is? Turn around, be quiet, and get back to work." The teacher seemed to have made the comment without any consideration of why Gable had turned around to speak to Jules in the first place.

[Classroom B from Bronx, New York]

In this class, laboratory activities typically prompted greater levels of cooperation amongst students. During non-laboratory lessons, the teacher did not welcome cooperation and hence the students did not cooperate with each other. Rather, during such lessons, students sat at their desks and wrote down notes from the board without any communication between them. However, when students engaged in a laboratory exercise, the teacher seemed to welcome cooperation and allowed students to move about the classroom and seek help from classmates. It appeared difficult for students to get used to the change in the amount of expected cooperation between the two types of lessons. During laboratory exercises at the beginning of the school year, the extent of cooperation was splitting up the task so that one student did part of the activity and another student did the other part. Students did not help each other in any way such as talking through a problem. However, the teacher expressed his

expectation of cooperation during laboratory exercises and explicitly stated that just splitting an activity between two students was not cooperation. When the teacher made this statement, Alice was heard saying, “Ohhh, I didn’t know you wanted us to actually help each other”. In the weeks that followed, Alice took on more of a helping role, particularly when she felt she understood the content. In one instance, when the class was working on completing a digital essay project, Alice worked on collecting information for the essay while also helping her partner design the digital aspect of the project.

[Classroom B from Bronx, New York]

When given the option to work alone or in groups of two, students preferred to work in groups, whether it was for class work or a long term assignment. One lesson, before the teacher gave students a task, the teacher stated, “I’ve noticed that you prefer working in groups of two and that you’re always working with the same person. How come?” Felix raised his hand and responded, “It’s like we are looking out for each other and what I can’t do then my partner can and what he can’t do, I can.”

[Classroom B from Dresden, Germany]

A Buddy System arrangement took effect during a lesson on the balancing of chemical equations. Higher-performing students in the class paired up with students who they anticipated might have difficulties understanding this concept. Max and Anna struggled to correctly balance the chemical equations provided by the teacher. Nathan joined their group and asked Max and Anna what they had difficulty understanding. Nathan worked with the group for about 15 minutes, doing examples with them and having Max and Anna explain their thought process as they worked out some of the problems. As the lesson came to a close, Max and Anna, two of the weaker students in the class, were able to solve most of the teacher-provided problems on their own. Further, Max and Anna were able to articulate the process they undertook to solve each of the problems to the teacher, showing that they had a better understanding of how to go about balancing chemical equations. During this same class, David and Francine, were working in two separate groups. Francine noticed that David had asked for help several times from his group. David’s group tried to better explain how to balance chemical equations but did not do so in a way that allowed David to grasp the concept. Francine walked over to David, pulled him aside, and helped him with a few problems until he was able to do a few on his own.

Interestingly enough, David did not ask Francine for assistance, but rather Francine noticed David struggling and felt it her responsibility to offer David help.

[Classroom E from Dresden, Germany]

During a lesson on using ball-and-stick pieces to build models of hydrocarbons, students worked in groups of their choice with either one or two partners. Often times throughout the activity, a student would leave his/her group and briefly join another group to offer assistance. Simone asked John for help who went ahead and helped out. In another instance, Charles was confused about how to build a model of a cyclohexane. Charles initially asked the teacher for help but before the teacher could get to that group, Katerina was heard saying “I got it!”. Katerina walked over to Charles’ group and guided him through the steps of how to build the cyclohexane. On the other side of the classroom, Alexis was also struggling with the model building and in this case, his own partner led him step by step to understand the process. Throughout this lesson, many students struggled with certain parts of the task. However, rather than relying solely on the teacher as a source of assistance, many of the students felt comfortable asking a classmate for help. Of great significance was that when the students were helping each other, the question “What is the answer?” was not prevalent. Rather, the student offering assistance asked questions such as, “What would happen if you did this?” and “Why did you do it that way?”

[Classroom A from Bronx, New York]

The items that make up the Cooperation scale, along with the five classroom observations selected to illustrate changes in cooperation between students, align closely with co-teaching and cosmopolitanism. The type of coteaching as seen in the fourth and fifth classroom observations is different from the coteaching described in Sections 5.2.2 and 5.2.4 for which students taught nearly an entire lesson to the class. Rather, in this section, coteaching was attained through the Buddy System for which higher-performing students, while seeing themselves as the experts in the classroom and feeling comfortable with the idea of cooperation as established by the teacher, worked with lower-performing students. In doing so, students were able to cooperate

and support each other with the learning of scientific content. With regard to cosmopolitanism, the first two classroom observations show some cooperation, albeit to the dismay of the teacher. However, the actions of the students in the first two classroom observations are not aligned with a cosmopolitan attitude as the cooperation which occurred was more for selfish purposes than for the mutual benefit of each person involved. However, the final three classroom observations showed a shift in the reasoning behind the cooperation amongst students. During these instances, students consistently took on a non-traditional role as coteacher to support the smooth functioning of the classroom. Further, while enacting the responsibilities associated with these this non-traditional role, there was not an expectation of receiving some sort of dividend from the teacher.

The classroom observations in this section describe the learning environment created by the teacher with regard to the Cooperation scale. Through reality pedagogy, one of the teachers' goals was to establish a classroom that functioned more like a community. As evident in the classroom observations, teachers wanted their students to take on greater responsibility in the classroom and to understand that the good of the classroom as a whole is more important than the individual parts that make up the classroom. Thus, in terms of cooperation, the latter classroom observations described students who genuinely cared for each other and ensured that their peers were able to learn and understand the science content.

5.2.6 *Attitude to Scientific Inquiry Scale (Pretest Mean = 3.86, Posttest Mean = 4.01, Effect Size = 0.17 Standard Deviations)*

The following set of classroom observations is presented in an order that illustrates changes over time in how teachers enacted scientific inquiry in the classroom. The Attitude to Scientific Inquiry scale describes a student's preference

for or attitude to using scientific experimentation and inquiry as methods to obtain information about the natural world. According to the quantitative data, the change between the pretest and posttest for the Attitude to Scientific Inquiry scale was not statistically significant, and only had an effect size of 0.17 standard deviations (see Table 4.4). This is probably because, from the beginning of my study, most students said that they would rather learn science through the inquiry process than being provided with all the information directly from the teacher. Throughout the duration of the study, students maintained this attitude to scientific inquiry thus answering associated items in a similar manner between the pretest and posttest. While the attitudes to scientific inquiry expressed by students did not change, the number of opportunities for students to engage in the inquiry process along with their level of engagement with each opportunity did change. Thus, the set of five classroom observations described below do not show changes in students' attitudes to scientific inquiry but rather changes in scientific inquiry opportunities provided by the teacher.

In my experience as an educator, many of the laboratory investigations performed by students at the secondary school level are not genuine investigations. Rather, students often engage in a cycle that confirms the results of an experiment performed thousands of times by students in other science classrooms. However, the process that a student undertakes to reach the final result might be different. For example, in the first two classroom observations, the teacher provided very regimented and scripted activities, that read like a recipe in a cookbook. If students followed the procedure exactly then they would get good results, however, not adhering to the procedure meant a failed laboratory investigation. On the QuALESA, students articulated their desire to more greatly engage with the process of scientific inquiry, however, a good portion of the beginning of the academic year relegated

students to performing such trivial laboratory investigations as described in the first two classroom observations. Through cogenerative dialogues, students expressed their discontent with such lower-order thinking activities. This prompted teachers to provide their students with greater opportunities for genuine investigations as described in the third classroom observation. Further, as the school year progressed, teachers promoted scientific inquiry by engaging students in investigations that tied the science content to the personal interest of students, as described in the fourth classroom observation. Finally, teachers engaged in a questioning cycle with students which valued questions posed by students but were not intent on providing students with answers to their questions. Hence, as described in the fifth classroom observation, students were given the opportunity to investigate questions that were relevant to them, and as one student eloquently explained to his classmate, “I’m the one who asked the question and I really wanted to find out the answer”. Below is a summary of these classroom observations.

Much of the class work assigned by the teacher thus far consisted of students reading passages from the text book or listening to the teacher lecture on a topic and then answering a series of accompanying questions. There appeared to be little to no evidence of any genuine investigation occurring in this classroom. During a laboratory activity involving electrical circuits, the teacher provided students with the answer to any question they posed rather than trying to help the students figure out the answer using their own background knowledge. The laboratory activity itself was very formulaic in that students were expected to go through a procedure simply to re-confirm an idea that had been confirmed so many times in the past, thus making the actual process of scientific inquiry non-existent. Further, when a student did not get the results expected by the teacher, the teacher said that the experiment failed and asked the student to get the correct answers from a classmate who carried out a more successful experiment.

[Classroom B from Bronx, New York]

During a unit on cells and cell processes, the teacher introduced a laboratory activity where students compared human skin cells to onion skin cells. The teacher explained that students are to collect human skin cells from their wrists. Before allowing students to proceed with the investigation, the teacher revealed to students everything that they should expect to observe along with warnings regarding everything that could go wrong and why. In doing so, the teacher removed all inherently investigatory aspects of the activity. Students seemed unexcited by the activity and when prompted to begin working, they moved slowly and without any urgency. Essentially, students were asked to go through the motions of following the procedure on the activity sheet rather than conducting any form of pure investigation.

[Classroom C from Dresden, Germany]

Students were organized into groups of four and without any prior instruction, advised to use the provided materials to determine the shape of an unknown object. The class brainstormed on how to approach the problem and decided that a good method would be to roll marbles at the covered object while recording the incoming and outgoing trajectories of the marble. When the students began to work, each group independently delegated a responsibility to each member. In one group, one student rolled the marble, one student tracked the incoming trajectory, one student tracked the outgoing trajectory and another marked the trajectories on the paper. Once the group deemed that an appropriate number of trajectories had been plotted, the unknown shape was removed. The group of students used the plotted trajectories and engaged in a discussion about the possibilities of the unknown shape. Students provided their insight equally and listened to the different possibilities put forth by each group member until they decided on a single shape as the unknown object. During the discussion phase, the teacher stressed that the purpose of the activity was not necessarily the correct identification of the unknown object but rather an appreciation of the process that each group undertook to complete the activity.

[Classroom E from Dresden, Germany]

The teacher passed out several vials of red litmus paper so that students could appreciate the pH detection range provided by red litmus paper. Jose asked if it was safe to put the red litmus paper in his mouth. The teacher asked, "Why would you want to do that?" Jose responded, "I'm curious about the pH of my spit." Gabriella chimed in saying, "I just had a lemonade drink during lunch. Do you think that will change the pH of my saliva?" The teacher had not intended for his class to take this direction. However, he noticed that the students were genuinely interested after

listening to the comments made by Jose and Gabriella. The teacher decided to have students make a list of everything they had eaten for lunch and to predict whether they thought their saliva would be acidic or basic. Once this preliminary exercise was completed, students were given the opportunity to test their saliva using the pH paper and according to the teacher's instructions to ensure their safety. Students excitedly reported the pH of their saliva along with a description of their lunch. Jose was overheard saying, "That's so cool that you let us do this."

[Classroom A from Bronx, New York]

The teacher had his class learn about the various properties of metals by having each student generate his/her own questions regarding metals based upon his/her own interests and curiosities. The teacher called on a variety of students and charted the questions on the board. As the teacher wrote down one question, he asked for other related questions. Many of the questions appeared unrelated to the scope of the lesson and when one student asked about this, the teacher replied, "Yes, but it's a question you have, so it is relevant". Many of the students smiled as they understood that the teacher valued their questions. Jacob then asked, "Could diamonds be melted?" Fallon asked, "Are diamonds even a metal?" Several other questions emerged and as the lesson ended, the teacher advised Jacob to do some research on his question and that he would be given the opportunity to present his findings to the class. The next day, Jacob reminded the teacher of his task, walked to the front of the class and presented his findings to his peers. At the end of the presentation, Lucas said, "Wow, I can't believe you actually did the extra work." Jacob responded, "I'm the one that asked the question and I really wanted to find out the answer."

[Classroom D from Dresden, Germany]

The five classroom observations described above are reflective of the content understanding aspect of reality pedagogy. It was observed that, when teachers created activities which did not include the inquiry process, it was because the teachers were unfamiliar with the content. For example, one of the teachers had a background in biology but was being asked to create investigations in physics. This lack of physics content knowledge probably prevented the teacher from creating investigations that went beyond generic laboratory exercises which asked students to simply reconfirm a

result. Conversely, when teachers designed laboratory activities in the content area they were familiar with, these activities contained greater opportunities for students to wrestle with the process of scientific inquiry and reach an agreed upon understanding of the content. This relationship between the teacher's content knowledge and the teacher's ability to provide students with high-quality inquiry opportunities points to the importance of ensuring the teacher's comfort with finding multiple ways to deliver the content.

Having a positive attitude toward inquiry is a very important student attribute. Newmann, Marks, and Gamoran (1995, p. 1) explain that, all too often, "students spend too much of their time simply absorbing—and then reproducing—information transmitted to them." They continue to explain that "students can earn credits, good grades and high test scores, they say, demonstrating a kind of mastery that frequently seems trivial, contrived or meaningless outside of school" (1995, p.1). However, the quantitative data for the Attitude to Scientific Inquiry scale along with the classroom observations suggest that students want to engage in the inquiry process rather than in inconsequential learning activities. The classroom observations in this section support the assertion made by Wong and Fraser (1997), that when students are exposed to learning activities nested in the inquiry process, they show greater enthusiasm for and engagement with the science content. The first two observations of classrooms which lacked authentic learning activities describe student behavior associated with lack of interest and engagement in science class, whereas the final three observations of classrooms describe students engaging in activities that allowed them to produce new meanings for them, share an understanding of new ideas, and explore connections between their content knowledge and personal experiences. While it is clearly advantageous to hold positive attitudes toward scientific inquiry,

Emdin (2011) explains, reality pedagogy calls for the teacher to expose his/her limitations with regard to content knowledge and to invite students to jointly explore these knowledge gaps. While this process occurred during some of the time during each of the observations, this practice was not very prevalent when it came to using content to create inquiry opportunities for students.

5.2.7 Enjoyment of Science Lessons Scale (Pretest Mean = 3.50, Posttest Mean = 3.66, Effect Size = 0.19 Standard Deviations)

One of the overarching goals of reality pedagogy is to transform teaching practices so that students experience an increase in their enjoyment of science lessons. An underlying assumption here is that, if students enjoy their science lessons more, then they are more apt to perform well on assessments, including standardized achievement examinations. According to the quantitative data for the Enjoyment of Science Lessons scale, there was a statistically significant difference of 0.19 standard deviations between students' responses on the pretest and posttest (see Table 4.4). The classroom observations described are not specifically meant to show how students began to enjoy their science lessons more as the school year went on. Rather, as reality pedagogy positively influenced students' perceptions of their learning environment, students began to express a more positive attitude with regard to their enjoyment of science lessons. For example, in the first classroom observation, there was a clear absence of shared control, personal relevance, cooperation, involvement, and critical voice. Students showed their discontent with their science class by dropping their pencils, shutting their notebooks, and disengaging from anything that the teacher was saying. The more and more that students' perceptions of their learning environment shifted, the more students seemed to enjoy their science lessons. For example, in the third classroom observation, students appeared to be

more involved in the classroom, functioning as volunteers and being asked to make predictions about the science demonstration. In turn, students excitedly talked about what they observed and even felt compelled to capture the moment using their cellular phones as recording devices. Finally, students in the fifth classroom observation appeared to enjoy their science lesson as the lesson incorporated involvement, personal relevance, shared control, and cooperation. The following set of classroom observations are arranged in a manner to illustrate changes in students' attitudes toward science with regard to the Enjoyment of Science Lessons scale. This scale describes the extent to which students express satisfaction with their science learning experiences at school. The five observations of classrooms are summarized below.

At the completion of an activity where students constructed various electrical circuits, the teacher said, "This is the only summary you are going to get from me on electrical circuits, so you need to be paying attention. If you don't like numbers, be sure to have your calculator out or you will be doing a lot of number crunching in your head." Over the next two minutes, the teacher read a series of statements regarding what students should have learned from the lesson. Students were expected to write these statements down as the teacher dictated them. Some students tried to keep up with the teacher and wrote at least some of the statements down. As the teacher continued reading the statements, more and more students were observed giving up: dropping their pencils down on the desks or simply shutting their notebooks.

[Classroom E from Dresden, New York]

Students did not seem to be enjoying their science lessons. Most of the classroom activities consisted of copying terms and definitions written on the board by the teacher without any further explanation of how these terms tie into what was discussed during class. At the beginning of every lesson, the teachers asked, "Who can tell me what we learned last lesson?" Generally, few students are able to accurately respond to this question prompt. Most students either refuse to respond to the teacher or do not know the answer. These students just sit back quietly, put their heads in their hands, or their heads on the table. During one lesson, the teacher began by spending about the first six minutes of class lecturing students about how poorly they did on their most recent assignment, how they do not listen to directions and

providing them with a plethora of other overarching reasons as to why their scores were so low. While the teacher continued on with his lecture, students engaged in numerous activities showing their discontent with this science class: some students made groaning noises, some slung their head back, and others began talking. Malcolm shouted out, “Can you please stop repeating yourself!” The teacher gave Malcolm a stern look and continued on with his speech.

[Classroom B from Bronx, New York]

To illustrate the concept of static electricity, the teacher used a van der Graff generator to conduct a variety of demonstrations. As sparks were emitted from the van der Graff generator and negatively charged objects floated above the generator, students were clearly excited and enjoyed the science lesson. Nearly every student took out a cellular phone and began to record video, take pictures, or text their friends in the other class about what they were experiencing. The teacher made a request for volunteers and asked the rest of the class to use what they had learned to make predictions about a specific scenario and to also prepare an explanation that could be used to defend their predictions.

[Classroom D from Dresden, Germany]

On several occasions, when students engaged in cooperative activities such as classroom games or review sessions, students were observed giving each other a high-five. The teacher asked students about this frequent practice and the students explained that the act of giving another individual a high-five is viewed as a sign of enjoyment or agreement. The students extended the practice of high-fiving to include the teacher and showed their enjoyment of the science lesson by giving or not-giving the teacher a high-five as they exited the classroom at the conclusion of a lesson.

[Classroom B from Dresden, Germany]

While working to build models of various hydrocarbons, Charles and Simone pretended that each model they built was an imaginary animal and gave it an imaginary name. After the two students built a molecule of hexane, Charles described the molecule as a dog with three pairs of legs and a tail that had the capabilities of acting both as a helicopter for flying and a propeller for moving through water. Charles and Simone engaged in this practice after each model they built. The teacher noticed what the group was doing and went over to them. The teacher asked why they were giving the molecules these names and Charles said, “Its

fun plus I think it will help us remember what each of the molecules looks like.”
[Classroom A from Bronx, New York]

With regard to reality pedagogy, an assertion that is made is that changes in students' perceptions of their learning environment were, at least in part, attributable to the effects of reality pedagogy on the science classroom. Further, students appeared to more greatly enjoy their science lessons when they held more positive perceptions of their learning environment and when the instruction was in line with these perceptions. This association is described in greater detail in Chapter 4, Section 4.5. Hence, I argue that reality pedagogy was useful in promoting a student's enjoyment of his or her science lessons.

5.2.8 *Summary of Findings from the Classroom Observations*

The collection of classroom observations allowed me to explore the impact of reality pedagogy on each of the specific learning environment and attitudinal scales of the QuALESA. Classroom observations were selected that could serve as evidence for the transformative nature of reality pedagogy. While not necessarily evident from the quantitative data analyses, the classroom observations showed positive changes, albeit to varying degrees, in terms of students' perceptions of the learning environment and their attitudes toward science. The classroom observations supported this conclusion because of the increase in frequency of teacher and student practices which aligned with the five components (cogenerative dialogues, cosmopolitanism, coteaching, context studies, and content understanding) of reality pedagogy. For example, when it came to sharing control in the classroom, many of the observations of classrooms, particularly at Bronx High School, suggested that they functioned using a corporate model in which the teacher maintained all the power and

control in the classroom. However, as reality pedagogy became a part of the classroom, practices associated with cosmopolitanism and co-teaching became more prevalent (e.g. allowing students to collaborate on their work and to use spaces in the classroom traditionally reserved for the teacher). With regard to the different geographic areas, reality pedagogy had a large positive effect on perceptions of the learning environment and attitudes toward science for students from the Bronx, and a smaller yet still positive effect on the students from Dresden. This assertion is based on an exploration of the classroom observations which revealed that many of the classrooms in the International School of Dresden initially exhibited many of the outcomes expected from reality pedagogy. In this case, reality pedagogy functioned to make many of these practices explicit during instruction and to refine them by incorporating student voice. Further, the classroom observations revealed that many practices associated with reality pedagogy were non-existent in classrooms at Bronx High School. Yet, as the study progressed, many of the practices stemming from reality pedagogy were popping up in these classrooms, to the point that teaching practices occurring in the Bronx were occurring with nearly the same frequency and rigor as they were in Dresden.

5.3 Interview Responses and Plans of Action: Common Themes and Differences Between the Bronx and Dresden

According to the statistical analyses undertaken in Chapter 4, Section 4.4, for the pretest, there was a significant difference between Dresden and the Bronx for the five scales of Cooperation, Personal Relevance, Critical Voice, Attitude to Scientific Inquiry, and Enjoyment of Science Lessons. However, the differences that had appeared on the pretest were no longer present when students responded to the posttest (see Figure 4.2). For nearly all the QuALESA scales, the Dresden sample

had a higher average item mean for the pretest than students from the Bronx. Despite the Dresden sample still having a higher average item mean for each scale for the posttest, the overall change in average item mean between pretest and posttest was not as great as it was for the Bronx sample. Thus, by the conclusion of the study, responses of the Bronx sample to the QuALESA posttest were more closely aligned with the average item mean scores for students in Dresden, thus eliminating the previously identified differences. Each of the sections below presents themes extracted from the qualitative data obtained from student interviews and cogenerative dialogues.

The interview data elaborate differences between the Bronx and Dresden in terms of students' perceptions of their learning environment and their attitudes toward science. These data were obtained from semi-structured key informant interviews conducted with six students: three from classrooms in Dresden and three from classrooms in the Bronx. The interview questions were guided by the research questions and aimed to extract information regarding specific events that occurred in the classroom. A more detailed explanation of the methods used to collect the semi-structured interview data can be found in Chapter 3, Section 3.6.2.3. Cogenerative dialogues were also conducted to investigate the impact of reality pedagogy by exploring differences between the plans of action created by students from the Bronx and students from Dresden. Section 3.6.2.1 of Chapter 3 provides greater detail regarding how cogenerative dialogues were conducted and how they were used to collect data.

As I analyzed the student interviews and cogenerative dialogues, I identified how often certain issues arose. Thus, I was able to extract four common themes which were then compared back to the differences between the pretest and posttest on

QuALESA scales reported in Chapter 4. Rather than provide student responses to each interview question for the reader to interpret, I opted to use specific quotes from students to provide evidence for each theme. Similarly, to make the data related to cogenerative dialogues more meaningful, I present samples of plans of actions that capture the differences between the Bronx and Dresden and which exemplify the specific theme.

Data and findings related to each of the common themes are provided under the following three sections.

Section 5.3.1 – What Prevents Me From Learning?

Section 5.3.2 – How Can We Improve Science Lessons?

Section 5.3.3 – How Has My Science Class Changed?

5.3.1 What Prevents Me From Learning?

All students who participated in the interview phase of this research were asked, “Has anything occurred in the classroom which prevented you from learning?”. While every student interviewed had something to offer, certain issues arose more frequently than others. When I examined the interview responses between students from Dresden and from the Bronx, students from both geographic areas declared that a teacher’s actions were the primary reason for their being prevented from learning. While this similarity exists, the type of teacher actions reported by students from Dresden were different from students in the Bronx.

Grace, a student from Dresden, had the following to say:

With the new seating arrangement meant to increase cooperation, I don’t have the teacher in direct sight. I have someone directly on my left and on my right and three people looking at me directly across the room and I find that distracting.

Kim, another student from Dresden, shared a similar sentiment. Kim explained:

Sometimes I just rather work alone. The teacher is trying to create a classroom where we all look out for each other, but just because it looks like I'm doing a good job with the work, it doesn't mean I always have the energy to help everyone else in the class. It feels good when I'm able to help my friends but sometimes the teacher should call on other people in the class to help out. I don't mind being involved in the class, but just not all the time. Like I said, sometimes I just want to work on my own.

Grace's response was the result of a new seating arrangement initiated by the teacher to increase cooperation in the classroom. In a similar manner, Kim's response arose from the teacher's desire to have students work more closely together and to initiate aspects of co-teaching in the classroom. Unlike the responses from Dresden, which describe teachers trying to do too much, students' responses from the Bronx describe a teacher who the students felt was not doing enough. Jasmine, a student from the Bronx, described her frustration with her teacher, while asking questions regarding an assignment and receiving little guidance:

So a few of us raised our hands and asked what the point of the lesson was and the teacher had no answer, but just moved on to the next topic. So I asked him if we were supposed to guess what the expectations of the assignment were and of course, no answer. I felt that I wasn't being heard and not being taken seriously. I didn't want to get into a 'teacher versus student' argument, so I just stopped talking but I was very annoyed.

Simone, one of Jasmine's classmates described a similar issue:

If a student asks for an explanation on something that was just said, the teacher will explain it the same exact way. The other thing that probably prevents me from learning better in science is the way the class is structured. For example, instead of mostly lecture, giving us the chance to figure things out on our own.

In addition to being present in student interview responses, identifying issues that prevented students from learning in the classroom was a common theme during cogenerative dialogues as well. Many of the plans of action created by students during the cogenerative dialogues were geared toward rectifying many of these issues.

Beyond what students expressed during the interview, students from both geographic areas, albeit to different extents, expressed that instruction should be more closely aligned to the interests of students and that their opinions and thoughts should be valued more by the teacher, and that the lack of these actions was also preventing them from learning. Not coincidentally, these are issues that reality pedagogy attempts to address in science classrooms by providing students with the opportunity to inform instruction.

Students' participation in cogenerative dialogues is the backbone of reality pedagogy as it is during these discussions where students are able to express their feelings about effective science instruction. It is through the cogenerative dialogues that the other four aspects of reality pedagogy emerge. Below is a description of a plan of action forged during a cogenerative dialogue with students from Dresden:

The cogenerative dialogue group decided that it might be useful to begin implementing short, weekly quizzes that would not be marked for a grade. Being concerned with the amount of content in their science lessons, the group emphasized that these quizzes could be a useful tool for learning and identifying potential strengths and weaknesses in content understanding. The student in the group demonstrated that they intrinsically wished to be successful in science and that not everything was about grades.

During the cogenerative dialogue, students expressed concern that there were long lapses of time between when they were assessed on science content and found this as a potential detriment to their learning. However, the plan of action was not completely driven by a self-centered desire to succeed. The students expressed that the weekly quizzes might also be helpful in allowing some of the weaker students pinpoint areas where the content is still unclear to them. This was identified as an indirect form of coteaching and cosmopolitanism, as the students who thought up the

plan of action displayed empathy for their classmates in wanting everyone to achieve and do well in science.

During another cogenerative dialogue, students in Dresden were introduced to the concept of genetic variation. The teacher shared his plan for the unit and students found this plan to lack luster. The students expressed that their plan lacked authentic learning opportunities and that being taught about pea plants and Gregor Mendel, while probably important, did not appear exciting. The following is a description of what occurred during the rest of the cogenerative dialogue:

As the teacher reluctantly looked on, the students embarked on a brainstorm session of how to best present the topic of genetic variation to the class. Students mentioned taking a field trip to a nearby car dealership or even the Volkswagon car factory located in the city center. The purpose of these trips was to observe and explore differences between vehicles in order to explain the concept of genetic variation. The teacher added that the different characteristics and models of the vehicles could be used to explain terms such as traits, alleles, and adaptations. The students then outlined activities for the teacher to develop further. These activities would hopefully engage students by making these trips more meaningful and worthwhile.

Cogenerative dialogues in the Bronx seemed to extend students' interview responses and called for a change in instructional methods. Students in the cogenerative dialogue group felt that their input had allowed the teacher to shift his methods of instruction from mostly consisting of working with a text book to allowing for more student exploration and discussion of ideas that involved analysis. Described below is one of the plans of action created by students in the Bronx:

Every science lesson should provide a five minute time block where students could discuss their experiences with the science content of that lesson. When a natural extension from the science content to the experiences of the students is not possible, it should be the teacher's responsibility to help draw the parallels ideas.

During a different cogenerative dialogue, yet along a similar vein, the group expressed that they felt the teacher always appeared to be talking most during class. There seemed to not be much time provided for student input. In response to this, the following plan of action was discussed and proposed to the teacher:

Each lesson should provide a period of time that moves beyond writing notes from the board or listening to the teacher lecture. Rather, each lesson should be infused with at least one extended activity asking students to engage in an independent or cooperative activity where they are given the opportunity to construct their own knowledge of the content.

Described in this section are only a few examples of plans of action created by the various groups of students participating in the study from Dresden and the Bronx. These examples serve as a good representation of the typical plans of action created by each of the cogenerative dialogue groups throughout the duration of the study, in terms of identifying an issue in the classroom that was preventing students from learning and cogenerating a plan to address that specific issue. In the next section, I present interviews responses and plans of action which address specific improvements suggested by students in Dresden and in the Bronx.

5.3.2 How Can We Improve Future Science Lessons?

The students who participated in the interview phase of this research were asked a second question, “Do you have any suggestions for the improvement of any future science lessons?” This question brought with it a range of responses. However, as student responses were analyzed, two themes began to emerge. The first theme dealt with a greater need for cooperation, while the second involved being able to express a critical voice. While analysis of interview responses uncovered these two themes, there was much variation in how students from each geographic area

responded. In this section, the interview responses, along with the follow-up plans of action, are presented for each of the two themes extracted.

5.3.2.1 Opportunities for Cooperation. According to Lipman-Blumen (2000), effective cooperation is a complex process because it involves actions, such as effective listening, empathy, and sharing of power, that would not normally need to be present when working alone. In my research, I found that engagement in reality pedagogy prompted teachers to provide students with more opportunities to cooperate. In turn, increased exposure to activities requiring cooperation allowed students to practice and refine those skills among others described by Lipman-Blumen (2000). While the theme of cooperation was common among both populations of students, there were slight differences in how cooperation was enacted. Hence, the interview responses and plans of action are divided between those from students in the Bronx and those from Dresden, in order to make those differences explicit.

The interview responses of students from the Bronx described a preference for implementation of activities that foster cooperation through the scientific inquiry process, particularly through the acts of questioning, collaboration, and self-exploration as paths toward understanding science content.

Simone, a student from the Bronx, had the following to say:

Personally, I know if we had more group work where we had to figure out some sort of challenge, then I would probably engage in the work more.

Jasmine, another student from the Bronx, shared a specific example of cooperation:

During the cogenerative dialogues we let the teacher know how we feel, so it feels good to actually be able to speak up about what you don't like in the classroom. Instead, of the teacher talking most of the time, make some sort of activity where we could work together. Last week, the teacher started to do something like this and it

was one of the first times I was listening in class. Students were split up into four groups which we chose. Each group was given an article dealing with science and that was related to our everyday life. This was different because usually the teacher would never really focus on why things were relevant for us to learn. He would just say 'you need to know this for later on' without explaining specifically for what. With the article we were given, our group had to summarize and present the information to the rest of the class, without drowning everyone with the specific data. Everyone in our group worked and even though the data wasn't from New York, it was from California, I could imagine that life there isn't very different. Also, the presentations allowed us to hear from our classmates, rather than just from the teacher. This is a good idea, but I think the real important information should still be taught by the teacher to make sure that all students fully understand it. Giving us the chance to do work and learn this way, in my opinion, was a good thing.

In addition to these student interview responses, students from the Bronx created various plans of action during the cogenerative dialogue which dealt with providing increased opportunities for cooperation amongst students. During one cogenerative dialogue, students said that the teacher consistently prevented friends from working with each other during cooperative class activities as well as during project-based assessments. As students discussed the pros and cons of the teacher's actions, the following plan of action was put forth:

As long as students are completing the work, the work load is being distributed evenly between members of the group, and no student is being singled out, students should be given the opportunity to select the people they work with rather than being assigned to a group. The students pleaded that they should be able to work with who they wish and select individuals that complement their own strengths as students.

In response to this plan of action, the teacher began to allow students the opportunity to cooperate and work alongside classmates of their choosing. This increased cooperation between students was described in greater detail in the fifth classroom observation in Section 5.2.5 of this chapter. However, not every plan of action geared toward increasing cooperation amongst students was a simple matter of allowing students the opportunity at picking who they work with. Below is a plan of action which was used as the initiation point in a series of discussions between teacher

and students. Eventually, the plan of action and subsequent discussions led to some specific changes in the teacher's practice, such as the inclusion of more group work to allow discussion and the creation of more open-ended questioning, thus allowing students to work together toward a common understanding of the science content:

Students mentioned that they felt their science class could be more creative and interesting. The group decided that they would focus a few of the cogenerative dialogues on reviewing and engaging in critical discussions with the teacher about upcoming lesson plans and teacher practices.

At first glance, with regard to increasing opportunities for cooperation, the interview responses and plans of actions put forth by students from the Bronx seem trivial. However, as trivial as something like allowing students to select who they work with may sound, students saw this newfound privilege as a victory. However, according to students in Dresden, even prior to this research study, teachers had been targeting their instruction to increase cooperation in the science classroom. Thus, the interview responses and plans of action created by students in Dresden might appear superior or more thoughtful, but this was only because some of the more basic approaches to increase cooperation were already being implemented. Thus, the interview responses of students from Dresden described a preference for implementation of activities that fostered cooperation through the scientific inquiry process, particularly through the acts of questioning, collaboration, and self-exploration as paths toward understanding science content.

Lance, a student from Dresden said:

I noticed that my friend wasn't really paying attention to the class and what was being discussed. So, I thought it was my job to talk to my friend and figure out what his problem was. I guess this is what the teacher meant by 'true cooperation'. Like, now I feel responsible for working with my friend to get him to focus and help him if he needs help. Also, I feel that this type of cooperation will help us have a longer lasting influence on the science class. It's more than just about making an interesting activity or cool lesson, but that as students we really need to be active

and always figure out ways to improve the class. Luckily, our teacher is ok with us taking on that role.

Later on in the interview, Lance continued:

Since we're always having discussions in class, it would be interesting to use those discussions to have a debate. So, like when we had the discussion about stem cells, we could have divided the class up into two sides depending on what they feel. Then give each group a few minutes to prepare their arguments and the teacher could be the person making sure the debate is focused and doesn't get out of control. Everyone would have to listen to each other and then work together to come up with the best possible arguments. We do debates in English class all the time and they are a lot of fun.

As part of being engaged in reality pedagogy, students from Dresden also participated in cogenerative dialogues and thus cogenerated plans of action aimed at increasing opportunities for cooperation amongst students. In Dresden, many of the plans of action that were created by students had to do with designing classroom activities that focused on the scientific inquiry process and required students to cooperate. For example, in one case, before introducing an assessment on biomes to the entire class, the teacher first brought the assessment task to the cogenerative dialogue group. The group looked over the task and suggested the plan of action below:

The group noticed that all the biomes listed on the assessment sheet were terrestrial and suggested that aquatic biomes, such as, coral reefs and deep seas also be included. The group also suggested ways in which students could best communicate what they learned about each biome and came up with guidelines to be incorporated in the grading rubric.

As it appears, the plan of action does not suggest any increase in cooperation between students. However, the aspects of cooperation were embedded in the grading rubric which was revised by the students as part of the plan of action. The cogenerative dialogue group suggested that two dimensions be added to the rubric. The first dimension allowed the teacher to assess how well students cooperated with each other throughout the entire assessment. The second dimension provided students

with the opportunity to reflect on how well their group mates cooperated and assess them accordingly. While this type of reflection required in the second dimension of the rubric was difficult to achieve and never appeared to serve its purpose, the fact that students intended to use the rubric to increase cooperation between students was well-intentioned. In addition to the plan of action described above, sporadically, students created a plan of action explicitly focused on the idea of cosmopolitanism. This typically involved focusing attention on a few students in the class and creating opportunities to sustain the academic success in science of those students:

While watching video of the previous week's science lessons, the cogenerative dialogue group pointed out three students that appeared unengaged. The group then promptly began to discuss strategies that they could enact to engage those students more.

As students discussed various strategies aimed at increasing student engagement, one strategy emerged as the most feasible and viable for the remainder of the school year. This plan of action ultimately gave rise to a Buddy System, similar to the one described in the co-teaching section of reality pedagogy in Chapter 2, Section 2.7.1. One result of this Buddy System arrangement was described in the fourth classroom observation in Section 5.2.5 of this chapter.

5.3.2.2 Expressing a Critical Voice in the Classroom. The ability for students to express a critical voice is rooted in critical theory which attempts to understand, critique, and ultimately change existing hegemonic social structures (Bohman, 2012). Not coincidentally, one of the objectives of reality pedagogy is to establish a learning environment that encourages students to question and critique the teaching and learning activities occurring in the classroom. In the context of this study, the sample of students from the Bronx had significantly more favourable

pretest perceptions of Critical Voice compared with the sample of students from Dresden. By the time of the QuALESA posttest, students from the Bronx had made large gains on the Critical Voice scale, eventually aligning their perceptions on this scale with students from Dresden. In this section, I examine students' expression of critical voice in the classroom in order to better understand differences between classrooms in Dresden and the Bronx. Additionally, I expand on the Critical Voice scale as it was a common theme amongst students when it came to students describing improvements of future science lessons.

When students from the Bronx were interviewed, their responses revealed concerns almost exclusively dealing with how the teacher teaches. Many of these students felt comfortable sharing their critiques of the classroom instruction with the interviewer but expressed their lack of comfort with sharing their thoughts directly with the teacher.

Jasmine, a student from the Bronx, conveyed the following sentiment explaining how many students felt toward criticizing the teacher:

Usually, nobody really wants to admit if they don't understand something and no one is going to tell the teacher anything about him not doing a good job. I mean, the teacher is supposed to be the expert, not us. He should realize if his explanations make sense and should always make sure that he is explaining things in a way that not only make sense to him. I also think the teacher should be asking us more questions to make sure we understand something and to come around more often to check.

However, because reality pedagogy is meant to be an organic process for which students determine what effective instruction looks like within their specific context, it is imperative that students build the confidence to express their critical voice to the teacher. As students noticed that the teacher was making an honest and concerted effort to improve the learning environment, they began to share their critiques of the classroom instruction more frequently and with greater detail.

Simone, another student from the Bronx, said:

Thinking back to some of our classes lately, we have been able to talk to the teacher more about what he is doing and he has definitely started to use a lot more of our suggestions when he teaches. Like last week, Nathalie made up a game called 'Mafia' and taught it to the class so we could review for our test. Also, about tests, we suggested that the teacher ask questions based on what we directly learned in class but also give us the chance to use our knowledge to answer unfamiliar questions. Like, can we take what we know about something and use that to answer a questions that isn't directly related. That sounded like a cool challenge.

The interviewer urged Simone, who remained a bit hesitant, to share her thoughts regarding tests with the teacher. With Simone's permission, the teacher, who was in a nearby classroom, was invited into the interview. Simone said the following to the teacher:

We have been complaining about having to take test after test and just answering question after question. So, the next time, instead of giving us a normal test, maybe let us write our own short-answer questions and then we can give a detailed answer.

The teacher mentioned that this would probably get the students to think more critically than a traditional test.

Simone continued:

Its not as easy as it sounds but it will challenge me and make me think outside the box.

Shawn, also a student in the Bronx, had a similar response. He said:

I think students might learn better if they knew there was more than one possible answer and might do research on their own. We could be given a weekly challenge to work on in class to investigate some sort of problem dealing with what we are learning.

Conversely, when students from Dresden were interviewed, many of their responses revealed a concern with being able be a part of the creation of assessments at every point in the process, from the initial brainstorming to the grading criteria. The primary criticism of the teacher appeared to be his lack of communication with students regarding assessment of student learning and understanding. Additionally,

unlike students from the Bronx, the students from Dresden took no issue with expressing their critical voice to the teacher, both during and after the science lesson.

Grace, a student from Dresden, critiqued the teacher for not making use of cultural artifacts to enhance instruction:

I think he could arrange to do things more out of the classroom where we can visit a place to see how something actually works. We have a bunch of museums and parks in the city but we haven't had any field trips. When we're talking about animals and their adaptations, the teacher made sure to use animals we were familiar with, but we could have gone to the park or the zoo to look at some of the animals and have our discussions there.

Kim, another student from Dresden, shared her thoughts on how she would have changed an assessment. This was interesting because, generally, after the completion of an assessment, typically, students would not offer any criticism because they believe their feedback to be irrelevant since the assessment has already passed. However, Kim's response indicated her belief that the teacher might use her critique of the assessment to improve future assessments. The response below was in reference to an assessment that asked students to build a model of DNA and write an accompanying essay:

If I could change it, I would have had the essay be a separate grade, as one part of the assignment had little to do with the other except for the topic. It was okay to review the history, but the structure of DNA and how it communicates information could have been excluded, as we had done this already in class. The word limit of 1000 words was very short if all of these things had to be included, so that there was barely space for explaining the use of DNA knowledge and the evaluation of sources. Therefore, either the word limit should be increased or the structure and how DNA communicates information should be excluded from the essay, as one could focus more on the unknown situations relating to DNA.

Most of the interview responses described above in some way or another sought to improve the classroom learning environment in the Bronx and Dresden. Not coincidentally, these interview responses also align well with the various aspects of reality pedagogy. For example, in order for the teacher to successfully provide students with inquiry-based challenges and opportunities to construct their own

knowledge as described by Shawn, the teacher must first be comfortable with and have a deep understanding of the science content that he or she is teaching. Additionally, when the students from Dresden requested a bigger role in the creation of classroom assessments, this was viewed as a form of co-teaching where students took on the roles and responsibilities of the classroom teacher.

In addition to the responses of students who were interviewed, nearly all students in this study were given the opportunity to express their critical voice through participation in cogenerative dialogues. Cogenerative dialogues provided students with an opportunity to provide critical feedback regarding their experiences in their learning environment. Hence, the sole act of participating in the cogenerative dialogues probably affected students' perceptions of the learning environment, with regard to their ability to display their critical voice.

The majority of plans of action created during the cogenerative dialogues followed a similar pattern to students' interview responses. Students from Dresden critiqued their involvement in the creation of assessments and associated activities, whereas students from the Bronx continued to focus their criticisms on the overall instructional strategies used to teach them science. During one of the cogenerative dialogues, students from Dresden asked about the upcoming unit, which happened to be acid and bases. The dialogue facilitator provided the group with a bit of background information about acids and bases. The students requested that the cogenerative dialogue be dedicated to brainstorming ideas that the teacher could use for formative and summative assessments for the upcoming unit. In the plan of action that follows, students expressed their critical voice and used the opportunity to enhance the unit with assessments that are more interesting and personally relevant:

The assessments the teacher makes for this unit need to be more interesting. This unit should focus on acids and bases that students are familiar with. The teacher should

create an inquiry activity where students guess the pH of a variety of beverages and then conduct a series of tests and collect data to confirm or refute the initial hypothesis. Since food contains different acids and bases, the teacher could also create another activity where students change the amount of an acidic or basic substance in a recipe, and make qualitative observations on the taste, texture, and appearance of the food. Once the teacher writes these assessments up, the group should look them over first and then work together to pinpoint how everyone will be graded.

Students from the Bronx also expressed their critical voice, but for a different purpose: to change how the teacher teaches science. During one of the cogenerative dialogues, students stated that one of the reasons they were not usually engaged during their science lessons was because of the teacher's consistent reliance on and overuse of PowerPoint to teach lessons. In consultation with the teacher, the cogenerative dialogue group offered the following two plans of action as alternatives to the teacher's usual instructional practice:

The first plan of action asked that the teacher think of different ways of presenting science content other than through text slides in PowerPoint presentations. For example, students suggested using relevant video clips, news articles, and inquiry-based activities as tools to teach content. An alternative plan of action suggested that if the teacher was insistent on using PowerPoint, that he provide students with a note-taking template so that students could listen to the teacher talking and not be fixated on writing notes.

While students from the two areas differed in which aspects of the classroom they were critiquing, their call for more personal relevance in the classroom was common. During one such cogenerative dialogue, students from Dresden, while learning about sources and the effects of radiation, expressed that the teacher needed to integrate more culturally relevant activities. The following plan of action was a result of the above criticism toward the type of activities offered to the students:

The teacher should incorporate articles on the effects of the earthquake and tsunami in Japan in 2011 on the nuclear power plants. Students were interested in learning about how the media was relaying information as compared to scientific organizations. Further, students were interested in learning about how radioactivity affects the human body as well as what levels of radiation are acceptable in Japan. Students suggested that they find the articles and co-plan associated lessons with the teacher.

Meanwhile, students from the Bronx decide to work directly with the teacher to aid in the incorporation of cultural artifacts relevant to the students' lives during science class. This was an ongoing plan of action in which the teacher provided students with an overview of upcoming topics and asked students to suggest artifacts that could be used to present the science content. Below is a description of one such specific plan of action:

The teacher mentioned that over the next few weeks, students would be learning about the laws of motion. As students discussed how topics dealing with motion align with their personal lives, the theme of hip-hop culture kept reoccurring. As such, students decided that it was not necessary for the teacher to make parallels between the science content and hip-hop, but rather that the science content be taught through the culture of hip-hop. For example, students suggested a graffiti wall where student questions could be posted using graffiti stylings. Further, students suggested rapping as a means by which to display content understanding.

In this section, the expression of a critical voice was a prominent theme in both the interview responses and the plans of action. By enacting reality pedagogy in the science classroom, students were provided with opportunities to express their critical voice. These opportunities were a key component that led to the many improvements in the learning environment described in this section. The next section describes the final theme extracted from the students' interview responses and cogenerated plans of action.

5.3.3 *How Has My Science Class Changed?*

As part of this research, students were asked one final question, “Have you noticed anything different about your learning environment?” As student responses were analyzed, the sharing of control with students emerged as the most common response of how the science class changed over the year. As a consequence of the teacher sharing control with the students, there was an increase in personal relevance during instruction and in assessments. Further, consistent with the previous sections in this chapter, the manner in which students described changes in shared control differed with geographic area. In this section, the interview responses along with the follow-up plans of action from Dresden and the Bronx are presented for the theme of sharing control.

Both of the responses below reveal the teacher’s willingness to share control with the students in the class. Kim described the sharing of control as including students in the creation of assessments and classroom learning activities. Kim, a student from Dresden, said:

The teacher asks about how we might change assignments to make them more interesting. I really enjoy that the teacher involves us in planning the assignments.

By assisting the teacher in such a capacity, Kim pointed out that students were able to ensure that the assessments and learning activities were indicative of students’ realities and not the teacher’s perception of them. Thus, Kim described two assessments which were a result of the shared control between the teacher and students:

Our cogenerative dialogue group and the teacher had planned a celebrity genetics poster assignment. The assessment made students create a large number of Punnett squares, allowing even the slowest-learning student the opportunity to practice and understand them. It linked to the out-of-school life of students, so that there might have been extra motivation to score high on this assignment. We also helped the teacher plan a lesson on food. We compared foods to see how much of

something is in a product in relation to another product. We also compared diet products with normal products and found that to be interesting. The differences between the two were minimal and this is important to know, as some people might grab the diet product thinking their doing better for their body. I just feel like that lesson was related very much to our everyday life, making it a good example of reality pedagogy!

With regard to reality pedagogy, the sharing of control as described by Kim is parallel to the coteaching portion of reality pedagogy. Coteaching allowed Kim and her cogenerative dialogue peers to function as the professionals in the science class by taking on the responsibility of creating relevant assessments and activities. In consultation with the teacher, this process of co-teaching ensured that decisions that would positively effect students' learning were being made and that all of the students in the class benefited. Associated with this coteaching practice is the idea of cosmopolitanism. The process of sharing control provided students with the opportunity to better understand the culture of teaching whereas the teacher was given the opportunity to dive deeper into the culture of international school youth. Additionally, Kim alluded to the fact that the decisions that were being made during the cogenerative dialogue were being made so that all students could get the most from their classroom experience. Hence, in line with reality pedagogy, such effective use of coteaching was possible because of the development and mutual understanding of the culture and personal experiences being brought into the classroom by each student.

Grace, another student from Dresden stated:

My science teacher always says, 'there is no such thing as a stupid question' and is always asking us to ask questions about the topic we are learning. And because it's my own question and requires me to do some research, I usually remember all the information better. I know I'm not the smartest student in the class but I feel comfortable asking a lot of questions, because I know otherwise, I'm not going to be simply told an answer. The teacher typically tries to relate what he is teaching to our lives and that makes it more interesting.

Grace's response painted a slightly different picture of shared control in the classroom. Traditionally, the asking of questions is a privilege reserved for the teacher. The teacher generates the questions and students, hopefully, respond. In Grace's description of the classroom, the teacher partially gave up this responsibility and transferred it to the students. Essentially, this action empowered students to ask questions during the lesson, another form of co-teaching.

Students from the Bronx also indicated that they noticed quite a few differences in their science class as the year progressed. However, unlike the differences described by students in Dresden, many of the differences described by students in the Bronx were closely related to the content understanding and context portions of reality pedagogy.

During the interview, Simone, a Bronx student, said:

I definitely enjoy going to science class more now than I did at the beginning of the year. It's a lot more fun now and I feel like I've learned more in the last few weeks than when the year first started. We are doing things in class that we didn't do before and science is a bit more interesting to me now. I would just continue to make sure that the teacher stays involved with us rather than sitting in the front of the class and talking, like he did in the beginning of the year.

Shawn, expressed similar feelings to Simone, but elaborated a bit on what the teacher was doing differently since the beginning of the year. Shawn's description points to the importance of content understanding. For the teacher to be able to provide students with learning opportunities which extend past basic knowledge, the teacher must have a deep understanding of the scientific content. The teacher must attach this scientific knowledge to pedagogical knowledge to allow students to successfully master the content. In Shawn's response, he described teacher actions indicative of a teacher who is trying to more closely align scientific knowledge with good pedagogical practices, resulting in Shawn's increased satisfaction with his science class. Further, Shawn completed his response with a statement that alluded to

increased shared control between the teacher and students (e.g. being given a variety of options for showing mastery of scientific content):

Science used to be really straight forward. The teacher just sort of talked to us and didn't really give us any chances to do experiments or to investigate something to show that we can learn it. This science class has gotten better as the year went on though in some ways. More activities and experiments, oh and stories that have to do with us. Also, the teacher is giving us more options for how to show what we learned and letting us choose how to show our work.

Jasmine, following along the same lines as her peers, continued to elaborate on shared control in the classroom in the form of coteaching, ultimately leading to increased personal relevance:

The teachers asks us what we are interested in, what we might have questions about, to see if and how it fits in with what he needs to teach us. He has tried to make things more relevant using things we know about like basketball, dance, and music.

In her response, Jasmine made explicit three key cultural artifacts that united many of the Bronx students. Interestingly, while the teacher tried to incorporate these artifacts in science instruction, an aspect of reality pedagogy referred to as context studies, it should be again noted that the teacher's identification of these artifacts resulted from interactions with students, primarily during cogenerative dialogues. This once again speaks to the interwovenness of the five aspects of reality pedagogy.

Along a different path, Shawn discussed during the interview another way that he observed his science class change. I opted to save Shawn's response for last in this section as at first glance it appears simple enough but in actuality is quite powerful when looked at closely:

I generally don't like when I can't figure out an answer to something. But when I asked the teacher a question and he said, he didn't know, that made me real curious. Not many teachers will admit to not knowing something, especially in science. I wanted to figure out the answer so I did some research on my own. But then I figured out that it was this sort of question that didn't really have an exact answer, so I got even more interested in it. I suggested to the teacher to let us work in groups because if there are all sorts of possible solutions, I think it's helpful to work with other people to share ideas. I think that by working in a group and listening to others, a new idea that I hadn't thought about might come up.

When analyzed, the references to shared control and personal relevance in the classroom are apparent. A bit less apparent is the connection between Shawn's description of changes in the science classroom and all five aspects of reality pedagogy: cogenerative dialogues, cosmopolitanism, co-teaching, context studies, and content understanding. For example, Shawn's suggestion of group work as a good way to evaluate a problem, discuss ideas and create possible solutions indicated his comfort with expressing his ideas to the teacher. This exchange between Shawn and his teacher was an informal type of cogenerative dialogue, different from previously described cogenerative dialogues only in the setting and number of individuals involved. Shawn's suggestion of group work was also aligned to coteaching in that the student and the teacher were the individuals who determined what effective instruction looked like in this specific scenario. Thus, Shawn positioned himself as the expert in the classroom and engaged in the decision-making process that the teacher typically reserved for himself. Further, Shawn's suggestion to employ group work was not driven by a completely selfish desire for himself to succeed. Shawn mentioned that the communal act of sharing ideas had the benefit of allowing everyone involved to reflect on the situation at hand in a manner slightly different from if they were working alone. While not explicit, Shawn's cosmopolitan attitude toward students being able to help each other was dependent on his belief and acknowledgement that each student in his class had a unique cultural background and set of experiences. If this belief was not present, it is likely that Shawn would not have believed that he could learn from his classmates. The beginning of Shawn's response also aligned itself with the content and context aspects of reality pedagogy. By acknowledging not knowing the answer to Shawn's question, the teacher dismissed the long-held idea that teachers know everything. This action showed that

there are limits to the content that teachers might know and understand. By exposing this vulnerability, the teacher demonstrated to the students that learning is a continuous process that does not cease when one reaches adulthood. In this case, it was not the teacher's content expertise that was relevant, but rather the teacher's lack of expertise. This lack of expertise piqued Shawn's curiosity causing him to conduct his own research, as it was his own question to begin with. The question at hand was attached to a context relevant to Shawn, which is what prompted him to ask it in the first place. Had it simply been a question asked by the teacher, framed in an irrelevant context, Shawn might have disregarded the question with no further thought, an action observed frequently toward the beginning of this study.

5.3.4 Summary of Findings from the Cogenerative Dialogues and the Semi-Structured Interviews

The qualitative data presented in Section 5.3 of this chapter were analyzed in an effort to extract common themes between students from the Bronx and Dresden and to explain differences within each theme. From the data analyses, common themes related to issues preventing students from learning, the improvement of science lessons, and overall changes to the science class were identified.

While these themes were common within the qualitative data collected from both Bronx High School and the International School of Dresden, there were some variations within each of the themes between the two areas. For example, student interviews and plans of action from the International School of Dresden revealed that the teacher generally involved them in practices associated with reality pedagogy, such as co-planning lessons and co-creating assessments. Student interviews and plans of action from Bronx High School described changes in teachers' instructional

strategies that incorporated students' experiences and the process of scientific inquiry, while also welcoming student feedback and valuing student choice.

5.4 Summary of Qualitative Data Analyses

In this chapter, I described the results of my analyses of qualitative data gathered through classroom observations, student interviews, and cogenerative dialogues. The qualitative data were used to triangulate the results obtained from the quantitative instrument used in this study, the QuALESA. Specifically, the classroom observations were used to provide insight into the overall pretest–posttest changes associated with reality pedagogy in each of the learning environment and attitudinal scales of the QuALESA. Unlike the classroom observations, the interview questions and cogenerative dialogues did not directly address each of the QuALESA's five learning environment and two student attitude scales, but aspects of each of the scales were present in the students' responses and the plans of action. The student interviews and the cogenerative dialogues were used to extract common themes between students from the Bronx and Dresden and to explain differences within each theme.

As reality pedagogy was implemented in the different classrooms, I was able to determine that the outcomes of reality pedagogy were slightly different in the Bronx than in Dresden. An exploration of the qualitative data made it more apparent that reality pedagogy had a large positive effect on students from the Bronx in terms of perceptions of the learning environment and attitudes toward science, and a smaller yet still positive effect on the students from Dresden.

Compared with students from the Bronx, student from Dresden noticed fewer differences in their learning environment. Students' responses from Dresden

suggested that their teachers' instructional practices already incorporated many of the classroom emphases of reality pedagogy, including involving students in the learning process and nesting science content in a relevant context. However, while the other students in Dresden stated that they did not necessarily notice any changes in their classroom, Lance described a teacher behavior involving greater cooperation between students, thus building on the reality pedagogy aspect of cosmopolitanism. These responses are aligned with the quantitative data, described in Chapter 4, which indicated that students from Dresden responded fairly positively to items in the QuALESA during the pretest.

Interview responses from the Bronx painted a different picture in that students from the Bronx noticed a greater number of changes in their learning environment than students from Dresden. Nearly all three students interviewed from the Bronx initially expressed discontent with their classroom learning environment, which is aligned with the more negative perceptions of the learning environment and attitudes toward science expressed by students from the Bronx in their responses to the QuALESA pretest. However, as the school year progressed, students' interview responses described changes in teachers' instructional strategies that incorporated students' experiences and the process of scientific inquiry, while also welcoming student feedback and valuing student choice. Thus, students from the Bronx responded more positively on the QuALESA posttest for all scales and their responses were more closely aligned with students' responses from Dresden. Further, many of the instructional practices described by the Bronx students during the interviews were already being implemented by teachers in Dresden.

In Dresden, many of the cogenerative dialogue plans of action that were created by students dealt with being able to create or modify assessments before they

were given to the other students. The next most commonly created plan of action had to do with designing classroom activities that focused on the scientific inquiry process. Sporadically, a plan of action was created that explicitly focused on the idea of cosmopolitanism, and this typically involved focusing attention on a few students in the class and creating opportunities to sustain their academic success in science. In the Bronx, many of the plans of action that were created by students specifically targeted the improvement of instructional practices enacted by the teacher. For example, students suggested that lessons should provide more opportunities for student discussions and involvement, activities that allow students to engage with the inquiry process, and the teacher's use of cultural artifacts as tangible entry points into the science content.

When the plans of action from Dresden and the Bronx were compared, some obvious similarities and differences emerged. In terms of similarities, both groups of students created plans of action aimed at improving the classroom experience for themselves and their classmates. Additionally, both groups of students called for greater opportunities to construct their own knowledge through the science inquiry process, although students from the Bronx did so more frequently. Further, both groups of students requested that the teacher focus on making science instruction more personally relevant but, once again, students from the Bronx created such plans of action more frequently than students from Dresden. However, there were also some stark differences in the types of plans of action created by the cogenerative dialogue groups from each geographic area. The most apparent of these differences was the nature of the plans of action. For instance, students in Dresden focused primarily on sharing control with the teacher to create and/or modify assessments. In contrast, the plans of action created by students from the Bronx focused primarily on

sharing control to change the activities and strategies used by the teacher to teach science. When the plans of action from each geographic area are considered, one can see that the cogenerative dialogues which occurred in the Bronx were geared more toward creating long-lasting changes in the overall instructional practices utilized by the teacher in order to create a more positive learning environment. However, the plans of action created by students in Dresden were intended to create short-term changes to the learning environment, primarily through student involvement in the assessment process.

Using this information, I am able to assert that, generally, students from Dresden perceived their learning environment favourably and were not looking to make any drastic changes. However, students from the Bronx did not initially perceive their learning environment very favourably, thus leading them to propose important changes during cogenerative dialogues. This supports the quantitative data reported in Chapter 4, Section 4.4, which showed that the sample of students from the Bronx initially perceived their learning environment more negatively than students from Dresden and which then became more positive and aligned with the perceptions of the sample of students from Dresden.

In the next, and final, chapter of this thesis, I describe the conclusions that I was able to draw from this study. Additionally, I discuss the limitations of this study and suggest recommendations for future directions for research dealing with reality pedagogy, learning environments, and student attitudes.

Chapter 6

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Introduction to the Chapter

The overarching goal of this mixed-methods study was to explore the implementation of reality pedagogy in science classrooms in the Bronx, New York and in Dresden, Germany. Accomplishing this goal meant posing a number of underlying research questions which were addressed throughout the various chapters of this thesis. In this chapter, I combine the vital elements from each of the previous chapters in an attempt to put forth sound conclusions from this research. Additionally, in this chapter, I aim to contextualize the results derived from the quantitative and qualitative data to ensure their appropriate application in the field of education.

This chapter begins with a summary of the thesis and the associated research objectives (Section 6.2). Next, a summary of the major findings of the study along with associated implications of those findings is presented in Section 6.3. This chapter also helps to bring the thesis to a close by describing and discussing the significance of the study (Section 6.4), associated limitations and biases (Section 6.5), and the next steps for this field of research (Section 6.6). Finally, the chapter comes to a close with a summary of the chapter as well as some concluding remarks (Section 6.7).

6.2 Overview of the Thesis

The research reported in this study combined the research areas involving classroom learning environments, student attitudes toward science, and reality pedagogy. The study was guided by a careful examination of the following four overarching research objectives:

1. To provide validity and reliability data for the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA) for use with samples in Dresden, Germany and the Bronx, New York.
2. To investigate the effectiveness of reality pedagogy in science classrooms in terms of changes in student perceptions of their learning environment and student attitudes toward science.
3. To investigate differences between science students from the Bronx and Dresden in terms of their classroom learning environment perceptions and attitudes toward science in response to reality pedagogy.
4. To determine associations between classroom learning environment dimensions and students' attitudes toward science.

The first chapter of this thesis provided an overview of my personal experiences as a student and a teacher, followed by an explanation of how these experiences shaped my views and beliefs as a researcher. A general idea of my personal experiences allowed a better understanding of my selection of paradigm, epistemology, and ontology as described in Chapter 3. The first chapter also provided background information necessary to make sense of much of the study, including statistics about achievement on international science assessments for students in both the Bronx and Dresden. Also included in Chapter 1 was a statement of the problem,

including a description of some underlying issues of current classroom instructional practices as well as a brief history of the fields of learning environments and student attitudes. The significance of the study was also described along with a discussion of its implications from a methodological and practical standpoint. The delimitations associated with the study, along with a set of definitions of pertinent terms, were also provided. Finally, the chapter was brought to a close with an overview of how the remainder of the thesis is organized and a brief description of each of the chapters.

Chapter 2 reviewed literature pertinent to my study. The chapter opened with an overview of the history of the field of learning environments, including various instruments used to study classroom learning environments. As this study made use of scales from the Constructivist Learning Environment Survey (CLES) and the What Is Happening In this Class? (WIHIC) questionnaire, these instruments and past studies utilizing them were reviewed more extensively. The literature review also examined different types of research involving classroom learning environments, because my study investigated the use of learning environment instruments in cross-national contexts to evaluate educational innovations and to study associations between student outcomes and the learning environment. The chapter also reviewed literature relevant to student attitudes, including the Test of Science-Related Attitudes (TOSRA), as this was also a student outcome measured in my study. A review of literature related to effective teaching and effective learning environments was also included as these set the expectation of what was trying to be achieved in my study. The chapter concluded by providing insight into the five aspects of reality pedagogy (cogenerative dialogues, cosmopolitanism, coteaching, context, and content) and describing past studies that have used either some or all of these aspects.

Chapter 3 outlined the research methods used in this study. The chapter began with an acknowledgement of the paradigm, epistemology, and ontology with which I worked. Insight into these perspectives provided the reader with an understanding of why I selected certain methods to carry out this study. Further, because of the nature of the research, I felt it pertinent to address certain ethical issues that arise when conducting research in schools. This discussion on ethical issues was novel because it focused on using reality pedagogy in an effort to move beyond the idea of conducting research on students and towards the idea of conducting research with students. As this study employed mixed methods, a portion of Chapter 3 was dedicated to identifying the benefits of using quantitative and qualitative data-collection methods together in learning environment and student attitude research. This chapter also described the geographical areas from which the school samples were selected, as well as the student samples (82 students from five classes from the International School of Dresden and 60 students from two classes from Bronx High School). Section 3.6 of the chapter provided information about the selection, modification, and translation of specific scales from the CLES, the WIHIC, and the TOSRA to create the Questionnaire Assessing the Learning Environment and Student Attitudes (QuALESA). The final instrument used in the study contained a total of 46 items from seven scales (Personal Relevance, Shared Control, and Critical Voice from the CLES, Involvement and Cooperation from the WIHIC, and Attitude to Scientific Inquiry and Enjoyment of Science Lessons from the TOSRA). This section also described the qualitative data (cogenerative dialogues, semi-structured interviews, and classroom observations) collected and used to provide greater insight into findings derived from the quantitative data. Further, Chapter 3 also described the methods used to analyze the quantitative and qualitative data in an attempt to respond to the

study's research questions. Finally, the chapter closed with a discussion of some of the limitations and biases of the study, including concerns related to sample size and representativeness, questionnaire construction and administration, and data collection and analyses.

Chapter 4 reported the quantitative data analyses and findings. Analyses of the data collected from 82 students attending seven different science classes in the Bronx and in Dresden were undertaken to investigate the validity and reliability of the 46-item QuALESA. Once the validity of the QuALESA had been established, three more stages of analyses were undertaken to assist in the investigation of the remaining research questions. The first of these was an analysis carried out to determine the effectiveness of reality pedagogy in science classrooms in terms of changes in student perceptions of their learning environment and student attitudes toward science. Further analysis of the data was undertaken to investigate differences between science students from the Bronx and Dresden in terms of their classroom learning environment perceptions and attitudes toward science. Finally, the data collected from administration of the QuALESA was analyzed to explore associations between students' perceptions of their learning environment and their attitudes toward science. The major findings from each of these analyses are discussed in Section 6.3 of this chapter.

The fifth chapter of this thesis reported the qualitative data analyses and findings. Plans of action from cogenerative dialogue, semi-structured student interviews, and classroom observations served as sources of qualitative data. Further, whereas the quantitative data were used to respond to all of research questions laid out in Chapter 1, the qualitative data were used to provide insight into and further support for the results for two of the research questions. The classroom observations were

used to further investigate differences in learning environment perceptions and attitudes toward science before and after the implementation of reality pedagogy. The classroom observations were organized in a timeline manner to allow the reader to understand the transformative nature of reality pedagogy on classrooms with regard to specific learning environment and student attitude scales. In contrast, the plans of action from cogenerative dialogues and the semi-structured student interviews were used to further explore differences between students from the Bronx and Dresden with regards to perceptions of the learning environment and attitudes toward science. The plans of action and interview responses were organized in a manner that brought to light some common themes which were not apparent from the quantitative data. The common themes which were extracted from the qualitative data included issues which prevented students from learning, questions and solutions regarding how the science classroom could be improved, and indicators of how the science class had changed since practices related to reality pedagogy had been enacted. The major findings from the qualitative data analyses are discussed in greater detail in Section 6.3 of this chapter.

This section served to provide the reader with a synthesis of the main ideas throughout the thesis, including an overview of the research objectives, a review of the literature relevant to the problem, an outline of the research methodology, and a summary of the quantitative and qualitative data analyses. Further, the ideas in this section serve as a reminder that this study was novel in the sense that it was the first to combine the research areas of learning environments, student attitudes, and reality pedagogy. The following section describes the major findings extracted from the data which tie together the three research areas previously identified.

6.3 Major Findings of the Study

The major findings of this study can be divided into four areas and are presented under the following headings:

- Validity and reliability of the QuALESA (Section 6.3.1)
- Changes in students' perceptions of the learning environment and students' attitudes toward science (Section 6.3.2)
- Learning environment perceptions and student attitude differences between students from the Bronx and Dresden (Section 6.3.3)
- Associations between the learning environment and student attitudes (Section 6.3.4).

6.3.1 Validity and Reliability of the QuALESA

Whenever a learning environment or student attitude questionnaire is used in a new research context, it must be scrutinized to ensure that it is both valid and reliable for use with a specific population of students. In many ways, my use of the QuALESA in this research could be considered a pilot study for two reasons. First, this was the first time that the specific learning environment and attitude scales from the CLES, WIHIC, and the TOSRA were combined in such a manner. Second, while the validity has been established separately for the CLES, WIHIC, and TOSRA with a variety of populations, this was one of the first studies which used a population of students from Germany. For these two reasons, data analyses were carried out to investigate the QuALESA's validity and reliability and thus add credibility to the results and conclusions made based on data obtained using this instrument.

One of the first analyses performed was factor analysis, whose purpose was to identify faulty questionnaire items that could be removed to improve the overall

structure of the QuALESA. Factor analysis was carried out using principal axis factoring with varimax rotation and Kaiser normalization. Eigenvalues were also calculated to determine factor strength. While separate analyses were conducted for pretest and posttest data for the QuALESA, because of the small sample sizes of the separate student populations, the analyses had to be carried out using the combined data collected from both Dresden and the Bronx, and treating them as a single sample. While not ideal, preliminary separate analyses of each sample revealed similar patterns to the combined sample, adding confidence to the validity analyses. For the QuALESA pretest and posttest, all of the items have a loading of at least 0.35 on their *a priori* scale and no other scale, indicating that the QuALESA's factor structure was sound for my sample. Two more pieces of evidence allow me to have confidence in the QuALESA's factorial validity. First, collectively, the seven scales on the QuALESA accounted for approximately 60% of the total variance. Second, the eigenvalue associated with each individual scale was greater than 1.

Evidence from the factor analysis allowed the retention of all 46 items of the QuALESA, which were used to investigate the questionnaire's internal consistency reliability and discriminant validity. The Cronbach alpha coefficient was used to determine the internal reliability of the QuALESA (i.e. whether items assigned to a specific scale reflect a common construct). Previous research (Cortina, 1993) indicates that Cronbach alpha values over 0.70 are typically desirable. The data analyses met this standard and thus support the reliability of each of QuALESA's scales.

An analysis of discriminant validity was carried out to ensure that raw scores on each scale were unique in the dimension which they assessed. Scales with poor discriminant validity would display a large mean correlation with the other scales,

whereas a small mean correlation coefficient would indicate good discriminant validity. Although an acceptable cut-off value for this type of analysis does not exist, the mean correlation coefficients calculated were on the smaller side, allowing me to conclude that the five learning environment scales and the two attitude scales probably were measuring a different construct.

A final analysis with regards to establishing the QuALESA's reliability and validity involved exploring the questionnaire's ability to differentiate between classrooms. This analysis was only relevant for the learning environment scales. In order to investigate this characteristic, a one-way analysis of variance (ANOVA) was used for each of the QuALESA's learning environment scales with class membership as the independent variable. If the QuALESA's scales could differentiate between the perceptions of students in different classrooms, then scale scores should be different from one class to the next. For the pretest, all learning environment scales except Involvement and Shared Control resulted in a significant difference. One reason why these two scales might not have been different from class to class for the pretest was that they were potentially influenced by a student's personality. On the other hand, data collected from the posttest indicated that each of the learning environment scales, including Involvement and Shared Control, was able to differentiate significantly between classrooms. One reason for this might have been that, in each of the seven classrooms, teachers probably enacted certain aspects of reality pedagogy slightly differently, resulting in different perceptions of what it means to be involved or have shared control.

The findings presented in this section with regards to the QuALESA's internal reliability, discriminant validity and ability to differentiate between classrooms replicate and are comparable with other studies that utilized scales from the CLES,

WIHIC, and TOSRA (Dorman, 2008; Nix, Fraser, & Ledbetter, 2005; Wong & Fraser, 1996).

6.3.2 *Changes in Students' Perceptions of the Learning Environment and Students' Attitudes toward Science*

Changes in students' perceptions of their learning environment and their attitudes towards science in response to reality pedagogy were investigated using a MANOVA with repeated measures. The multivariate test using Wilks' lambda criterion revealed a statistically significant change in the set of seven learning environment and attitude scales as a whole. Subsequently, the individual univariate ANOVA was interpreted separately for each dependent variable, and indicated that there were significant differences between the pretest and posttest for all scales assessing the learning environment and student attitudes, except for Attitude to Scientific Inquiry. Effect sizes were also calculated to support this significance test. The five learning environment scales showed 'medium' effects sizes (ranging from 0.25 to 0.56 standard deviations), while the two attitude scales showed 'small' effect sizes (0.17 and 0.19 standard deviations). Hence, it could be argued that implementation of reality pedagogy in science classrooms was effective in terms of changes in student perceptions of their learning environment.

The impact of reality pedagogy on each of the specific learning environment and attitudinal scales of the QuALESA was further explored using classroom observations. The classroom observations supported the quantitative data analyses described in this section as evident in the increase in frequency of teacher and student practices which align with the five components of reality pedagogy (cogenerative dialogues, cosmopolitanism, coteaching, content understanding, and context studies). For example, science classrooms at Bronx High School which were generally teacher-

centered began to utilize practices associated with cosmopolitanism and coteaching, such as allowing students to collaborate on their work and to use spaces in the classroom traditionally reserved for the teacher.

6.3.3 Differences Between Students from the Bronx and Dresden in Learning Environment Perceptions and Attitudes

A series of quantitative data analyses were carried out to investigate differences between Dresden and the Bronx across all scales for the pretest and posttest administrations of the QuALESA. The data analyses revealed significant differences between Dresden and the Bronx on the QuALESA pretest for the scales of Involvement, Cooperation, Personal Relevance, Critical Voice, Attitude to Scientific Inquiry, and Enjoyment of Science Lessons. However, when data collected from the posttest were analyzed, all of the significant differences that had been previously present no longer existed. Effect sizes were also calculated for each of the scales for both the pretest and the posttest. With regards to differences in learning environment scales between Dresden and the Bronx on the pretest, effect sizes suggest a ‘small’ difference for Shared Control (0.18 standard deviations), a ‘medium’ difference for Involvement (0.65 standard deviations) and Cooperation (0.58 standard deviations), and a ‘large’ difference for Personal Relevance (0.86 standard deviations) and Critical Voice (1.09 standard deviations). For the posttest, effect sizes suggest a ‘small’ difference for all learning environment scales. In a similar fashion, effect sizes for the two attitude scales were larger for the pretest than for the posttest.

The findings in this section are quite peculiar and represent much of what is at the core of this study. Usually, when conducting studies involving a pretest and a posttest, the expectation is that introducing an intervention or innovation will lead to improvements in scores. At the beginning of this study, for nearly all of the

QuALESA scales, students in Dresden had more positive perceptions of the learning environment and attitudes toward science than did students from the Bronx. When compared to the pretest, posttest scores for learning environment and attitudes towards science for students in Dresden changed very little. This is in stark contrast to the Bronx population who, by the time of the posttest, reported increased scores across nearly all the QuALESA scales. Hence, the perceptions and attitudes of students from Bronx High School became more closely aligned to those held by students at the International School of Dresden, thus causing the elimination of the previously identified statistical differences. One interpretation of this could be that reality pedagogy had a greater impact on the Bronx population than the Dresden population.

The qualitative data support the assertion that reality pedagogy probably had a larger positive effect on students from the Bronx than those from Dresden in terms of their perceptions of the learning environment and attitudes toward science. However, as revealed by the quantitative data, reality pedagogy also had an effect, albeit a smaller one, on students from the International School of Dresden. The qualitative data revealed that many of the classrooms in the International School of Dresden were already functioning using the norms established by reality pedagogy. Further, the qualitative data suggested that many practices associated with reality pedagogy were non-existent in classrooms at Bronx High School. However, as the school year continued and students and teachers engaged with reality pedagogy, it was noticed that many of the reality pedagogy-aligned teaching practices were occurring in the Bronx with nearly the same frequency and rigor as they were in Dresden. Additionally, there were some differences in how various aspects of reality pedagogy were manifested in the different geographic area. For example, while data analyses

allow me to extract common themes related to issues preventing students from learning, the improvement of science lessons, and overall changes to the science class, there were some clear variations between the two populations within each of the themes. For example, as described in Chapter 5, student interviews and plans of action from the International School of Dresden reported that the teacher generally involved them in practices associated with reality pedagogy, such as co-planning lessons and co-creating assessments. Student interviews and plans of action from Bronx High School described changes in teachers' instructional strategies that incorporated students experiences and the process of scientific inquiry, while also welcoming student feedback and valuing student choice.

6.3.4 Associations Between the Learning Environment and Student Attitudes

Associations between students' perceptions of their learning environment and their attitudes toward science were investigated using simple correlation and multiple regression analyses.

Simple correlation analyses of students' responses for the QuALESA pretest indicated that the learning environment scales of Involvement, Cooperation, Personal Relevance, and Critical Voice were positively correlated with the Attitude to Scientific Inquiry scale. However, the same analysis uncovered that, for the QuALESA posttest, only the scale of Critical Voice was positively correlated with the Attitude to Scientific Inquiry scale. With regards to the Enjoyment of Science Lessons attitude scale, the results of the simple correlation analysis indicated a positive correlation with the learning environment scales of Involvement, Cooperation, Personal Relevance, and Critical Voice.

Multiple regression analyses were used to determine which of the specific learning environment scales explained most of the variance for each of the attitude scales of the QuALESA when all other learning environment scales are controlled. According to the data analyses, Personal Relevance was a statistically significant independent predictor of Attitude to Scientific Inquiry for the pretest and the posttest data. For the pretest, Cooperation, Personal Relevance, and Critical Voice had about equal independent influences and were statistically significant independent predictors of Enjoyment of Science Lessons. For the posttest, the scale of Personal Relevance had the largest independent influence on Enjoyment of Science Lessons, although Involvement and Shared Control were also statistically significant independent predictors of Enjoyment of Science Lessons.

6.4 Significance and Implications of the Study

This section contains a discussion on the significance of this research and the implications of its findings for the fields of reality pedagogy, science education, and classroom learning environments. Reality pedagogy is a strategy of teaching that involves gaining insight into students' cultures, actions, and attitudes. The results of this study add to a small, but already existing and growing, body of research concerning the implications of reality pedagogy for students' participation and engagement in science. Reality pedagogy is an effective way to involve students in the multiple facets of the classroom while increasing shared control, full participation, and student engagement in science.

This research is distinctive in that it made use of mixed-methods to explore the effectiveness of reality pedagogy. This is in stark contrast to many of the previous studies exploring reality pedagogy which have typically employed only qualitative

research methods. While this study also included qualitative data, what differentiates it from previous research is that it evaluated the effectiveness of reality pedagogy in terms of classroom learning environment and student attitudes. Critics often cite past studies of reality pedagogy as being too subjective to yield valuable results, but the present study has allowed the impact of reality pedagogy to be quantified. Additionally, this study is distinctive in that it was the first time that the three distinct research areas of classroom learning environments, student attitudes, and reality pedagogy were investigated simultaneously. This has far-reaching implications for future research as this study can serve as a starting point for those considering investigating the impact of reality pedagogy on students' perceptions of the learning environment and their attitudes toward science.

Another major contribution of this study was the establishment of the validity and reliability of the QuALESA for use in Dresden, Germany and the Bronx, New York. The QuALESA was created by adapting a number of scales from the CLES, the WIHIC, and the TOSRA. Some of the items from the scales were modified to fit the aims and contexts of this study. Further, the QuALESA was carefully translated and back translated for use with two populations whose primary language was English, German, or Spanish. It should be noted that, in many ways, this research could be considered a pilot study because it was the first time that this combination of scales from the different questionnaires was used in such a manner. Thus, while this research opens up opportunities for future studies with research objectives similar to mine to use the QuALESA with confidence, it also offers opportunities for future researchers to continue to establish the validity and reliability of the QuALESA.

The research presented in this thesis is also unique because it extended the study of reality pedagogy beyond the traditional urban minority population and

moved across national borders to involve a population of students at an international school in Dresden, Germany. Studies of the outcomes of reality pedagogy have traditionally been carried out using a small, confined sample from a large urban area, such as New York City or Philadelphia. By exploring reality pedagogy across context, I observed that reality pedagogy was successful in transforming teaching practices used to teach science to traditionally marginalized students. Thus, the results of this research add to the body of evidence suggesting that urban minority youth can also engage with, enjoy, be interested and participate in science.

Finally, the results of this study support a recent push, particularly in universities in the northeast United States, to include practices associated with reality pedagogy in teacher education programs. Therefore, there exists the potential for future science educators to use reality pedagogy as a tool to allow traditionally marginalized students greater access to and success with science content.

6.5 Limitations of the Study

As with all research, there are a number of associated limitations when interpreting the findings of this study. This section addresses my study's limitations and biases with regards to sample size and sample selection, instrument construction and administration, and data collection and analyses.

The first limitation of this study is related to the application of the findings to other populations. While it might be possible to generalize the findings of the present study to other urban minority students in New York City and students attending German international schools, it would not be appropriate to try and apply the findings to other populations, including minority students in other cities across the United States, international schools in countries other than Germany, or German

students attending public schools. Thus, caution should be used when generalizing the findings to ensure that the sample used in this study is representative of the population to which the findings are to be applied. In a similar vein, care should be taken to ensure that the findings are not applied to school subjects other than science, because this study explored the impact of reality pedagogy solely in science classrooms. Additionally, the QuALESA was meant to be used in science classrooms as two of the seven scales investigated student attitudes toward science.

The second limitation of this research is related to the sample size and selection. The size of the sample ($N=142$ students), while large enough to carry out certain data analyses, would need to be larger to overcome some data analysis constraints. For example, the minimum sample size required for factor analysis is usually five times the number of questionnaire items. As the QuALESA contained a total of 46 items, a minimum of 230 students should have responded to ensure that the data analyses are robust. Further, validity and reliability analyses could be strengthened with a larger sample size. Additionally, a larger sample size would allow greater confidence in the results of correlational and multiple regression analyses as well significance tests.

The method of sample selection for this study could also be considered a limitation. Ideally, sample selection should be random to ensure that results are valid. However, in educational research, this is rarely accomplishable for a variety of reasons, including difficulties with accessing students and approval from cooperating schools and teachers. The sample of students in this study was not a true random sample. The two schools that participated in this study were selected out of convenience as I was able to easily gain access to the sites. Most of the students in the classrooms selected to participate consented along with their parents. Only a

handful of parents selected not to have their children participate in the study. Regardless of these limitations, I believe the sample selected for this study was representative of the overall population of the school from which it was selected. In the case of the sample of students selected from Bronx High School, the sample was also representative of other schools in the Bronx. In the case of the sample of students selected from the International School of Dresden, the sample was representative of other international schools throughout Germany.

Besides limitations related to sample size and selection, there were also limitations associated with the construction and administration of the QuALESA. As described earlier, this study could be considered a pilot test for the QuALESA because its validity and reliability were not known because of the pioneering approach of combining scales from two learning environment questionnaires and a science-related attitudes questionnaire into a single instrument. Another possible limitation involved the method by which data from the QuALESA were gathered. While exactly the same questionnaires and instruction sheets for administration were given to each teacher, there existed the possibility of variation in the method of distribution. Even though I was not present in every classroom during the administration of the questionnaires, conversations with the cooperating teachers allowed me to conclude that no significant discrepancies occurred in questionnaire administration that would compromise the integrity of students' responses.

Finally, limitations related to data collection and analyses might have been present in this study, even though I believe that I did as much as I could as a researcher to minimize the potential effect of these limitations. The first limitation in this area related to the authenticity of students' responses to the various items on the QuALESA. To ensure that students responded honestly to each item on the

QuALESA, students were assured that their responses to the questionnaire would have no impact on their course grade and that any identifying information would not be shared with the teacher. While I am fairly confident in the students' responses, the fact that I was the science teacher for some students possibly would make this assurance irrelevant.

While making an effort to avoid personalizing the research, over-interpreting data, and imposing my own expectations on the outcomes of the research, the qualitative data collected in this study were also subject to certain limitations and biases. In an attempt to diminish the effects of the researcher on the analysis, certain protocols were put into place. For example, all efforts were made to ensure that cogenerative dialogues and student interviews occurred in a comfortable physical space. Next, limitations resulting from the use of video cameras to record classroom observations were addressed through the use of multiple qualitative data sources. For example, an event which occurred in the classroom but was out of the camera's recording frame could have been brought to light during a cogenerative dialogue or student interview. In essence, this was a form of triangulation in that multiple forms of data were used to construct a common understanding and a more accurate representation of the data.

6.6 Next Steps for the Field of Research

The underlying purpose of any study is to spark interest in and influence the research field. Hence, the completion of a research study should not be viewed as the end of a journey, but rather as an opportunity to lay the groundwork for future research. While there has already been some research concerning the impact of reality pedagogy, and most of it supports the findings of this study, it is my

recommendation that additional similar studies continue to be conducted. As additional studies are undertaken, replication of results similar to mine would continue to establish the validity and reliability of the QuALESA, as well as to build confidence in reality pedagogy as a pedagogical practice for improving student engagement and participation in science. Another future direction for this type of research would be to incorporate larger samples of students. A larger sample would further support the validity and reliability of the QuALESA. Additionally, using a more diverse sample of students from a larger variety of schools and geographic areas would also support the use of reality pedagogy across a variety of contexts.

Depending upon the creativity of future researchers, a wide array of future studies which use this one as a base could be conducted. For example, while this study was limited to gathering data regarding the perceptions and attitudes of students, it might be a possibility to investigate changes in the perceptions of the teachers who are utilizing a reality pedagogy approach to teaching science. Another research possibility lies in inquiring about students' academic performance when engaging with reality pedagogy. While this study showed that reality pedagogy positively impacted upon students' perceptions and attitudes toward science, this does not necessarily mean that students also will perform better academically, such as on standardized examinations. Because this study did not track students' academic performance throughout the academic year, it would be of much interest in future studies to investigate whether students not only felt more comfortable in the classroom, but if reality pedagogy also impacted on their academic performance.

6.7 Concluding Remarks

As I have been asserting throughout much of this thesis, teaching practices which are aligned with reality pedagogy and aimed at increasing communality in the classroom, are fundamental for the creation of a learning environment fostering success in science. Reality pedagogy is one avenue by which corporate practices can be transformed into more communal ones by allowing students to be involved in some of the decision making and learning that occurs in the classroom, as well as providing teachers with opportunities to increase their awareness of students' cultural experiences while incorporating student artifacts as a context for learning. Previous studies exploring reality pedagogy reported that classrooms where participants are not engaged in reality pedagogy are more likely to have instances of misalignments between the teacher's perception of the students' realities and students' own perceptions of their realities. These studies also suggest that implementing reality pedagogy has led to an increase in communal practices which in turn have led to increased cooperation between classmates, increased class participation, improvement of student-teacher relationship, a reduction in classroom management issues, an overall increase in interest in science, and better scores on examinations (Beers & LaVan, 2005; Emdin, 2007; Tobin, Elmesky, & Seiler, 2005).

In the research presented in this thesis, I observed that reality pedagogy had a positive impact in science classrooms at Bronx High School and the International School of Dresden. Improvements were noted in student participation, group work, cooperation, and asking and answering of questions. Simultaneously, the frequency of side conversations, inappropriate comments, time spent off task, students getting out of their seats, and students talking out of turn all decreased. Therefore, based on a combination of quantitative and qualitative evidence collected during this study, I

recommend that reality pedagogy be used as a general classroom support strategy, primarily to help to transform corporate classroom structures and to improve students' perceptions of the learning environment and attitudes toward science. Reality pedagogy offers educators a way to improve learning environments by listening to the needs of students and involving them in their own learning. Plainly, students will become more interested in a teacher's class when the teacher takes an interest in the students' cultures and experiences outside the classroom.

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APPENDICES

APPENDIX A

STUDENT INFORMATION SHEET AND INFORMED CONSENT FORM

ENGLISH / GERMAN AND ENGLISH / SPANISH

Curtin University of Technology
Science & Mathematics Education Centre
Zentrum für Pädagogik in Mathe und den
Naturwissenschaften

Student Participant Information Sheet
Teilnehmerinformationsblatt für Schüler

My name is George Sirrakos. I am currently completing a piece of research for my Doctor of Philosophy in Science Education at Curtin University of Technology.

Mein Name ist George Sirrakos. Ich schreibe zur Zeit an meiner Abschlussarbeit für meinen Dokortitel im Fach Pädagogik der Naturwissenschaften an der Curtin University in Australien.

Purpose of Research

I am investigating the effectiveness of a reality pedagogy approach to teaching in a variety of contexts, namely, classrooms in different geographic and socioeconomic locations, as well as by different science teachers, in Dresden, Germany and the Bronx, New York. Reality pedagogy is an approach to teaching that utilizes collaboration between students and teachers to transform teaching practice by incorporating the social and lived experiences of students in science lessons. The outcomes of this research will be explored in terms of changes in how students perceive their learning environment and student attitudes. By undertaking the proposed research, I hope to understand how students make sense of their classrooms by examining events and experiences that occur outside the classroom.

Zweck der Forschung

Ich untersuche die Effektivität der "Realitäts-Pädagogik" sowohl an verschiedenen Schulen, zum Beispiel an verschiedenen geographischen und socio-ökonomischen Orten als auch von verschiedenen Lehrern unterrichtet, in Dresden und in der Bronx, New York. "Realitäts-Pädagogik" bedeutet, dass die Zusammenarbeit zwischen Lehrern und Schülern sehr eng ist, indem die Lehrkräfte das soziale Leben der Schüler sowie ihre Lebenserfahrungen in den naturwissenschaftlichen Unterricht integrieren. Die Resultate dieses Forschungsprojekts wurden in Hinsicht auf die Veränderungen der Wahrnehmung der Lernatmosphäre und der Einstellung der Schüler zum Unterricht ausgewertet. Auf diesem Wege möchte ich herausfinden, wie Schüler einen sinnvollen Zusammenhang zwischen dem Unterricht und ihren Erfahrungen außerhalb des Unterrichts herstellen können.

Your Role

I will ask you to participate in a variety of activities. These include the completion of a questionnaire twice (once at the beginning of the school year and again at the end), keeping a reflective journal, participation in open interviews, and voluntary conversations with other students about your experiences in the science classroom. During these conversations, I will ask you to describe issues in the science classroom that are important to you. The questionnaire is expected to take about 25 minutes, the interview about 15 minutes, the reflective journal about 15 minutes, and the conversations could vary in their length of time from five to 15 minutes.

Ihre Rolle

Ich bitte um Ihre Teilnahme an einer Vielzahl von Aktivitäten im Laufe des Naturwissenschaftsunterrichts. Dazu gehören: 1.) Sie füllen am Anfang und am Ende des Schuljahres einen Fragebogen aus, 2.) Sie führen ein Tagebuch mit Reflektionen/Anmerkungen zum Unterricht, 3.) Sie nehmen an Interviews über den Unterricht teil und 4.) Sie beteiligen sich an Gesprächen mit anderen Schülern über Ihre Erfahrungen im Naturwissenschaftsunterricht. Während dieser Gespräche werde ich Sie bitten, Bestandteile des Unterrichts, die Ihnen wichtig sind, zu beschreiben und zu bewerten. Der Fragebogen wird voraussichtlich etwa 25 Minuten in Anspruch nehmen, das Interview ca. 15 Minuten, das Tagebuch etwa 15 Minuten, und die Gespräche könnten in ihrer Dauer von fünf bis 15 Minuten variieren.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form, I will assume that you have agreed to participate and allow me to use your data in this research.

Die Zustimmung zur Teilnahme

Ihre Beteiligung an der Untersuchung ist absolut freiwillig. Sie haben zu jedem Zeitpunkt das Recht, sich von dem Projekt zurückzuziehen, ohne dass es irgendwelche Auswirkungen auf Ihre Rechte oder auf meine Verantwortung hätte. Mit Ihrer Unterschrift erklären Sie Ihr Einverständnis und Ihre Zustimmung der Teilnahmebedingungen. Damit erlauben Sie mir auch projektbezogene Daten, die sich aus den obenbeschriebenen Aktivitäten ergeben werden, zu Zwecken des Forschungsprojekts zu verwenden.

Confidentiality

The information that you provide will be kept separate from your personal details, and only myself and my doctoral supervisor will have access to this. Your name or any other identifying information will not be used in the study or in any reports. Paper-based questionnaires, interview tapes and transcribed information will be kept in a locked facility throughout the duration of the study (after which time they will be destroyed). Questionnaire responses and transcriptions will be stored electronically at Curtin University for five years after the conclusion of the doctorate.

Vertraulichkeit

Die von Ihnen bereitgestellten Informationen werden getrennt von Ihren persönlichen Daten aufbewahrt. Zugang zu diesen Informationen wird nur mir und meinem Doktorvater gestattet. Weder Ihr Name noch weitere identifizierende Informationen werden an Dritte weitergegeben. Papier-Fragebögen, Interviewaufnahmen und andere Arten von Informationen werden während der gesamten Dauer der Studie in einer abgeschlossenen Anlage aufbewahrt. Ausgefüllte Fragebögen, Aufnahmen und weitere schülerbezogene Daten werden höchstens fünf Jahre nach Beendigung der Doktorarbeit an der Curtin Universität elektronisch aufbewahrt.

Further Information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number SMEC-33-10). If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/o Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784. As well, If you would like further information about the study, please feel free to contact me by email at GS1404@gmail.com or by telephone on +49 (0)351440070. Alternatively, you can contact my supervisor, Professor Barry Fraser, at b.fraser@curtin.edu.au.

Weitere Informationen

Dieses Forschungsprojekt wurde von der Curtin University of Technology Human Research Ethics Committee überprüft und genehmigt (Zulassungsnummer SMEC-33-10). Eine Bestätigung dieser Genehmigung kann man über die Curtin University Human Research Ethics Committee erhalten (c/o Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 Australien). Auch per Telefon ist dieses Komitee unter folgender Telefonnummer erreichbar: 9266.2784. Wenn Sie sich weitere Informationen zur Studie wünschen, wenden Sie sich bitte per E-Mail (GS1404@gmail.com) oder per Telefon unter +49 (0) 351.440.070 an mich. Alternativ können Sie auch meinen Doktorvater, Professor Barry Fraser (b.fraser@curtin.edu.au), kontaktieren.

Thank you very much for your involvement in this research.

Ich danke Ihnen herzlich für Ihre Teilnahme an meinem Forschungsprojekt!

STUDENT CONSENT FORM

Einverständniserklärung

- I understand the purpose and procedures of the study.
Ich verstehe den Zweck und die Methoden des Forschungsprojekts.
- I have been provided with a participation information sheet.
Ich habe das "Teilnehmerinformationsblatt" erhalten.
- I understand that the procedure itself might not benefit me.
Ich verstehe, dass das Projekt eventuell keine Vorteile für mich erbringen könnte.
- I understand that my involvement is voluntary and that I can withdraw at any time without problem or penalty.
Ich verstehe, dass meine Teilnahme vollkommen freiwillig ist und dass ich zu jedem Zeitpunkt ohne Nachteil aus dem Projekt austreten kann.
- I understand that no personal identifying information like my name and address will be used in any published materials.
Ich verstehe, dass keine personenbezogenen Daten (wie zum Beispiel mein Name oder meine Adresse) werden veröffentlicht oder weitergegeben.
- I understand that all information will be securely stored for 5 years before it will be destroyed.
Ich verstehe, dass alle aus dem Projekt entstandenen Daten werden fünf Jahre lang gespeichert und nach fünf Jahren vernichtet.
- I have been given the opportunity to ask questions about this research.
Die Möglichkeit offene Fragen zu dem Forschungsprojekt zu klären wurde mir geboten.
- I agree to participate in the study outlined to me.
Ich erkläre hiermit meine Zustimmung zu den Projektbedingungen und zu meiner Teilnahme am Projekt.

Name: _____

Signature: _____

Date: _____

Curtin University of Technology
Science & Mathematics Education Centre
Centro de Educación de Ciencias & Matemáticas

Student Participant Information Sheet
Hoja de información para el estudiante participante

My name is George Sirrakos. I am currently completing a piece of research for my Doctor of Philosophy in Science Education at Curtin University of Technology.

Mi nombre es George Sirrakos. Actualmente estoy terminando una investigación para mi Doctorado en Filosofía en la Educación de Ciencias, en la Universidad Tecnológica de Curtin.

Purpose of Research

I am investigating the effectiveness of a reality pedagogy approach to teaching in a variety of contexts, namely, classrooms in different geographic and socioeconomic locations, as well as by different science teachers, in Dresden, Germany and the Bronx, New York. Reality pedagogy is an approach to teaching that utilizes collaboration between students and teachers to transform teaching practice by incorporating the social and lived experiences of students in science lessons. The outcomes of this research will be explored in terms of changes in how students perceive their learning environment and student attitudes. By undertaking the proposed research, I hope to understand how students make sense of their classrooms by examining events and experiences that occur outside the classroom.

Objetivo de la investigación

Estoy investigando la eficacia de un enfoque de la pedagogía real para la enseñanza en una variedad de contextos, en particular salones de clases ubicados en diferentes localizaciones geográficas y socio-económicas, así como con otros profesores de Ciencias, en Dresden, Alemania y en Bronx, Nueva York. La falta del éxito en Ciencias de los estudiantes urbanos se atribuye a menudo al desinterés general en la escuela, y los educadores han tratado de eliminar la diferencia de éxito entre estudiantes urbanos y sus homólogos sub-urbanos. Mi investigación trata de comprender por qué muchos estudiantes urbanos no progresan bien en Ciencias. Investigaré la eficacia de la pedagogía real en las clases de Ciencias en términos de cambios dentro del ambiente de aprendizaje y de las actitudes estudiantiles.

Your Role

I will ask you to participate in a variety of activities. These include the completion of a questionnaire twice (once at the beginning of the school year and again at the end),

keeping a reflective journal, participation in open interviews, and voluntary conversations with other students about your experiences in the science classroom. During these conversations, I will ask you to describe issues in the science classroom that are important to you. The questionnaire is expected to take about 25 minutes, the interview about 15 minutes, the reflective journal about 15 minutes, and the conversations could vary in their length of time from five to 15 minutes.

Su Papel

Le pediré participar en una variedad de actividades. Éstas incluyen: la realización de un cuestionario, dos veces (una vez a principios del año escolar y otra vez al final), llevar un diario reflexivo, participar en entrevistas abiertas, y conversaciones voluntarias con otros estudiantes acerca de sus experiencias en la clase de Ciencias. Durante estas conversaciones, le pediré describir asuntos en la clase de Ciencias que son importantes para Usted. Se espera que el cuestionario tome aproximadamente 25 minutos, la entrevista 15 minutos, el diario reflexivo 15 minutos, y las conversaciones podrían variar en su duración entre 5 a 15 minutos.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form, I will assume that you have agreed to participate and allow me to use your data in this research.

Consentimiento para participar

Su participación en la investigación es completamente voluntaria. Usted tiene el derecho de retirarse en cualquier etapa sin que con ello se vean afectados sus derechos o mis responsabilidades. Cuando Usted haya firmado la forma de consentimiento, supondré que Usted ha consentido en participar y permitir que yo use sus datos en esta investigación.

Confidentiality

The information that you provide will be kept separate from your personal details, and only myself and my doctoral supervisor will have access to this. Your name or any other identifying information will not be used in the study or in any reports. Paper-based questionnaires, interview tapes and transcribed information will be kept in a locked facility throughout the duration of the study (after which time they will be destroyed). Questionnaire responses and transcriptions will be stored electronically at Curtin University for five years after the conclusion of the doctorate.

Confidencialidad

La información que Usted provee será resguardada separadamente de sus datos personales, sólo mi supervisor doctoral y yo tendrá el acceso a ellos. Su nombre o cualquier otra información de identificación no se usarán en el estudio ni para ningún informe. Los cuestionarios en papel, las entrevistas grabadas y la información transcrita serán resguardadas en una instalación cerrada con llave durante el presente estudio (después de finalizar el estudio serán destruídas). Las respuestas de los cuestionarios y las transcripciones serán almacenadas electrónicamente en la Universidad de Curtin durante cinco años después de la conclusión del doctorado.

Further Information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number SMEC-33-10). If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/o Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784. As well, If you would like further information about the study, please feel free to contact me by email at GS1404@gmail.com or by telephone on +49 (0)351440070. Alternatively, you can contact my supervisor, Professor Barry Fraser, at b.fraser@curtin.edu.au.

Información Adicional

Este estudio ha sido aprobado por el Comité de Ética de Recursos Humanos de la Universidad de Curtin (bajo el número de aprobación SMEC-33-10). De ser necesario, la verificación de la aprobación puede ser obtenida escribiendo al Comité de Ética de Recursos Humanos de la Universidad de Curtin, a la atención de la Oficina de la Investigación y Desarrollo, Universidad Tecnológica de Curtin, Código Postal GPO U1987, Perth, 6845 o llamando por el teléfono 9266 2784. También, si Usted estuviera interesado en alguna información adicional sobre el estudio, por favor no dude en ponerse en contacto conmigo a través del correo electrónico en GS1404@gmail.com o por el teléfono en +49 (0) 351440070. O bien, Usted puede ponerse en contacto con mi supervisor, el Profesor Barry Fraser, en b.fraser@curtin.edu.au.

Thank you very much for your involvement in this research.

Muchas gracias por su participación en esta investigación.

STUDENT CONSENT FORM

FORMA DE CONSENTIMIENTO ESTUDIANTIL

- I understand the purpose and procedures of the study.
Entiendo el objetivo y los procedimientos del estudio.
- I have been provided with a participation information sheet.
Me han entregado la hoja de información de participación.
- I understand that the procedure itself might not benefit me.
Entiendo que el procedimiento en sí mismo no podrá beneficiarme.
- I understand that my involvement is voluntary and that I can withdraw at any time without problem or penalty.
Entiendo que mi participación es voluntaria y que puedo retirarme en cualquier momento sin problema o sanción.
- I understand that no personal identifying information like my name and address will be used in any published materials.
Entiendo que ninguna información de identificación personal, como mi nombre y dirección será usada en cualquier material publicado.
- I understand that all information will be securely stored for 5 years before it will be destroyed.
Entiendo que toda la información será almacenada con seguridad durante 5 años antes de que ella sea destruída.
- I have been given the opportunity to ask questions about this research.
Me han dado la oportunidad de hacer preguntas sobre esta investigación.
- I agree to participate in the study outlined to me.
Consiento en participar en el estudio descrito para mí.

Name: _____

Signature: _____

Date: _____

APPENDIX B
PARENT INFORMATION SHEET AND INFORMED CONSENT FORM
ENGLISH / GERMAN AND ENGLISH / SPANISH

Curtin University of Technology
Science & Mathematics Education Centre
Zentrum für Pädagogik in Mathe und den
Naturwissenschaften

Parent Information Sheet
Informationsblatt für Eltern

My name is George Sirrakos. I am currently completing a piece of research for my Doctor of Philosophy in Science Education at Curtin University of Technology.

Mein Name ist George Sirrakos. Ich schreibe zur Zeit an meiner Abschlussarbeit für meinen Dokortitel im Fach Pädagogik der Naturwissenschaften an der Curtin University in Australien.

Purpose of Research

I am investigating the effectiveness of a reality pedagogy approach to teaching in a variety of contexts, namely, classrooms in different geographic and socioeconomic locations, as well as by different science teachers, in Dresden, Germany and the Bronx, New York. Reality pedagogy is an approach to teaching that utilizes collaboration between students and teachers to transform teaching practice by incorporating the social and lived experiences of students in science lessons. The outcomes of this research will be explored in terms of changes in how students perceive their learning environment and student attitudes. By undertaking the proposed research, I hope to understand how students make sense of their classrooms by examining events and experiences that occur outside the classroom.

Zweck der Forschung

Ich untersuche die Effektivität der "Realitäts-Pädagogik" sowohl an verschiedenen Schulen, zum Beispiel an verschiedenen geographischen und socio-ökonomischen Orten als auch von verschiedenen Lehrern unterrichtet, in Dresden und in der Bronx, New York. "Realitäts-Pädagogik bedeutet, dass die Zusammenarbeit zwischen Lehrern und Schülern sehr eng ist, indem die Lehrkräfte das soziale Leben der Schüler sowie ihre Lebenserfahrungen in den naturwissenschaftlichen Unterricht integrieren. Die Resultate dieses Forschungsprojekts wurden in Hinsicht auf die Veränderungen der Wahrnehmung der Lernatmosphäre und der Einstellung der Schüler zum Unterricht ausgewertet. Auf diesem Wege möchte ich herausfinden, wie Schüler einen sinnvollen Zusammenhang zwischen dem Unterricht und ihren Erfahrungen außerhalb des Unterrichts herstellen können.

Your Role

I will ask your child to participate in a variety of activities. These include the completion of a questionnaire twice (once at the beginning of the school year and again at the end), keeping a reflective journal, participation in open interviews, and voluntary conversations with other students about their experiences in the science classroom. During these conversations, I will ask your child to describe issues in the science classroom that are important to him/her. The questionnaire is expected to take about 25 minutes, the interview about 15 minutes, the reflective journal about 15 minutes, and the conversations could vary in their length of time from five to 15 minutes.

Ihre Rolle

Ich bitte um die Beteiligung Ihres Sohnes bzw. Ihrer Tochter an einer Vielzahl von Aktivitäten im Laufe des Naturwissenschaftsunterrichts. Dazu gehören: 1.) Das Ausfüllen am Anfang und am Ende des Schuljahres eines Fragebogens, 2.) Das Führen eines Tagebuches mit Reflektionen/Anmerkungen zum Unterricht, 3.) Die Teilnahme an Interviews über den Unterricht und 4.) Die Teilnahme an Gesprächen mit anderen Schülern über die Erfahrungen im Naturwissenschaftsunterricht. Während dieser Gespräche werde ich Ihren Sohn bzw. Ihre Tochter bitten, Bestandteile des Unterrichts, die ihm bzw. ihr wichtig sind, zu beschreiben und zu bewerten. Der Fragebogen wird voraussichtlich etwa 25 Minuten in Anspruch nehmen, das Interview ca. 15 Minuten, das Tagebuch etwa 15 Minuten, und die Gespräche könnten in ihrer Dauer von fünf bis 15 Minuten variieren.

Consent to Participate

Your child's involvement in the research is entirely voluntary. Your child has the right to withdraw at any stage without it affecting their rights or my responsibilities. When you have signed the consent form, I will assume that you have agreed to allow your child to participate and allow me to use his/her data in this research.

Die Zustimmung zur Teilnahme

Die Teilnahme Ihres Sohnes bzw. Ihrer Tochter an dem Forschungsprojekt ist absolut freiwillig. Ihr Sohn bzw. Ihre Tochter hat zu jedem Zeitpunkt das Recht, sich von dem Projekt zurückzuziehen, ohne dass es irgendwelche Auswirkungen auf seine bzw. ihre Rechte oder auf meine Verantwortung hätte. Mit Ihrer Unterschrift erklären Sie Ihr Einverständnis, dass Ihr Sohn bzw. Ihre Tochter an dem Projekt teilnimmt und Ihre Zustimmung der Teilnahmebedingungen. Damit erlauben Sie mir auch projektbezogene Daten, die sich aus den obenbeschriebenen Aktivitäten ergeben werden, zu Zwecken des Forschungsprojekts zu verwenden.

Confidentiality

The information that is provided by your child will be kept separate from his/her personal details, and only myself and my doctoral supervisor will have access to this. The name of your child or any other identifying information will not be used in the study or in any reports. In adherence with university policy, paper-based questionnaires, interview tapes and transcribed information will be kept in a locked facility throughout the duration of the study (after which time they will be destroyed). Questionnaire responses and transcriptions will be stored electronically at Curtin University for five years after the conclusion of the doctorate.

Vertraulichkeit

Die von Ihrem Kind bereitgestellten Informationen werden getrennt von seinen persönlichen Daten aufbewahrt. Zugang zu diesen Informationen wird nur mir und meinem Doktorvater gestattet. Weder der Name Ihres Kindes noch weitere identifizierende Informationen werden an Dritte weitergegeben. Papier-Fragebögen, Interviewaufnahmen und andere Arten von Informationen werden während der gesamten Dauer der Studie in einer abgeschlossenen Anlage aufbewahrt. Ausgefüllte Fragebögen, Aufnahmen und weitere schülerbezogene Daten werden höchstens fünf Jahre nach Beendigung der Doktorarbeit an der Curtin Universität elektronisch aufbewahrt.

Further Information

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Weitere Informationen

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Thank you very much for your involvement in this research.

Ich danke Ihnen herzlich für Ihre Unterstützung meines Forschungsprojekts!

PARENT CONSENT FORM

Einverständniserklärung für Eltern

- I understand the purpose and procedures of the study.
Ich verstehe den Zweck und die Methoden des Forschungsprojekts.
- I have been provided with a parent information sheet.
Ich habe das Informationsblatt für Eltern erhalten.
- I understand that the procedure itself might not benefit my child.
Ich verstehe, dass das Projekt eventuell keine Vorteile für mein Kind erbringen könnte.
- I understand that my child's involvement is voluntary and that my child can withdraw their participation at any time without problem or penalty.
Ich verstehe, dass die Teilnahme meines Kindes vollkommen freiwillig ist und dass er/sie zu jedem Zeitpunkt ohne Nachteil aus dem Projekt austreten kann.
- I understand that no personal identifying information like my child's name and address will be used in any published materials.
Ich verstehe, dass keine personenbezogenen Daten (wie zum Beispiel der Name Ihres Kindes oder Ihre Adresse) werden veröffentlicht oder weitergegeben.
- I understand that all information will be securely stored for 5 years before it will be destroyed.
Ich verstehe, dass alle aus dem Projekt entstandenen Daten werden fünf Jahre lang gespeichert und nach fünf Jahren vernichtet.
- I have been given the opportunity to ask questions about this research.
Die Möglichkeit offene Fragen zu dem Forschungsprojekt zu klären wurde mir geboten
- I agree to allow my child to participate in the study outlined to me.
Ich erkläre hiermit meine Zustimmung zu den Projektbedingungen und zu der Teilnahme meines Kindes am Projekt.

Name: _____

Signature: _____

Date: _____

Curtin University of Technology
Science & Mathematics Education Centre
Centro de Educación de Ciencias & Matemáticas

Parent Information Sheet
Hoja de información para los padres

My name is George Sirrakos. I am currently completing a piece of research for my Doctor of Philosophy in Science Education at Curtin University of Technology.

Mi nombre es George Sirrakos. Actualmente estoy terminando una investigación para mi Doctorado en Filosofía en la Educación de Ciencias, en la Universidad Tecnológica de Curtin.

Purpose of Research

I am investigating the effectiveness of a reality pedagogy approach to teaching in a variety of contexts, namely, classrooms in different geographic and socioeconomic locations, as well as by different science teachers, in Dresden, Germany and the Bronx, New York. Reality pedagogy is an approach to teaching that utilizes collaboration between students and teachers to transform teaching practice by incorporating the social and lived experiences of students in science lessons. The outcomes of this research will be explored in terms of changes in how students perceive their learning environment and student attitudes. By undertaking the proposed research, I hope to understand how students make sense of their classrooms by examining events and experiences that occur outside the classroom.

Objetivo de la investigación

Estoy investigando la eficacia de un enfoque de la pedagogía real para la enseñanza en una variedad de contextos, en particular salones de clases ubicados en diferentes localizaciones geográficas y socio-económicas, así como con otros profesores de Ciencias, en Dresden, Alemania y en Bronx, Nueva York. La falta del éxito en Ciencias de los estudiantes urbanos se atribuye a menudo al desinterés general en la escuela, y los educadores han tratado de eliminar la diferencia de éxito entre estudiantes urbanos y sus homólogos sub-urbanos. Mi investigación trata de comprender por qué muchos estudiantes urbanos no progresan bien en Ciencias. Investigaré la eficacia de la pedagogía real en las clases de Ciencias en términos de cambios dentro del ambiente de aprendizaje y de las actitudes estudiantiles.

Your Role

I will ask your child to participate in a variety of activities. These include the completion of a questionnaire twice (once at the beginning of the school year and again at the end), keeping a reflective journal, participation in open interviews, and voluntary conversations with other students about their experiences in the science classroom. During these conversations, I will ask your child to describe issues in the science classroom that are important to him/her. The questionnaire is expected to take about 25 minutes, the interview about 15 minutes, the reflective journal about 15 minutes, and the conversations could vary in their length of time from five to 15 minutes.

Su Papel

Le pediré a su hijo(a) participar en una variedad de actividades. Éstas incluyen: la realización de un cuestionario, dos veces (una vez a principios del año escolar y otra vez al final), llevar un diario reflexivo, participar en entrevistas abiertas, y conversaciones voluntarias con otros estudiantes acerca de sus experiencias en la clase de Ciencias. Durante estas conversaciones, le pediré a su hijo (a) describir asuntos en la clase de Ciencias que son importantes para él/ella. Se espera que el cuestionario tome aproximadamente 25 minutos, la entrevista 15 minutos, el diario reflexivo 15 minutos, y las conversaciones podrían variar en su duración entre 5 a 15 minutos.

Consent to Participate

Your child's involvement in the research is entirely voluntary. Your child has the right to withdraw at any stage without it affecting their rights or my responsibilities. When you have signed the consent form, I will assume that you have agreed to allow your child to participate and allow me to use his/her data in this research.

Consentimiento para participar

La participación de su hijo(a) en la investigación es completamente voluntaria. Su hijo(a) tiene el derecho de retirarse en cualquier etapa sin que con ello se vean afectados sus derechos o mis responsabilidades. Cuando Usted haya firmado la forma de consentimiento, supondré que Usted ha consentido en que su hijo(a) participe y ha permitido que yo use sus datos en esta investigación.

Confidentiality

The information that is provided by your child will be kept separate from his/her personal details, and only myself and my doctoral supervisor will have access to this. The name of your child or any other identifying information will not be used in the study or in any reports. In adherence with university policy, paper-based questionnaires, interview tapes and transcribed information will be kept in a locked facility throughout the duration of the study (after which time they will be destroyed). Questionnaire responses and transcriptions will be stored electronically at Curtin University for five years after the conclusion of the doctorate.

Confidencialidad

La información que es proporcionada por su hijo(a) será resguardada separadamente de sus datos personales, sólo mi supervisor doctoral y yo tendrá el acceso a ellos. El nombre de su hijo(a) o cualquier otra información de identificación no será usada en este estudio ni para ningún informe. En conformidad con la política universitaria, los cuestionarios en papel, las entrevistas grabadas y la información transcrita serán resguardados en una instalación cerrada con llave durante el presente estudio (después de finalizar el estudio serán destruidas). Las respuestas de los cuestionarios y las transcripciones serán almacenadas electrónicamente en la Universidad de Curtin durante cinco años después de la conclusión del doctorado.

Further Information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number SMEC-33-10). If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/o Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784. As well, If you would like further information about the study, please feel free to contact me by email at GS1404@gmail.com or by telephone on +49 (0)351440070. Alternatively, you can contact my supervisor, Professor Barry Fraser, at b.fraser@curtin.edu.au.

Información Adicional

Este estudio ha sido aprobado por el Comité de Ética de Recursos Humanos de la Universidad de Curtin (bajo el número de aprobación SMEC-33-10). De ser necesario, la verificación de la aprobación puede ser obtenida escribiendo al Comité de Ética de Recursos Humanos de la Universidad de Curtin, a la atención de la Oficina de la Investigación y Desarrollo, Universidad Tecnológica de Curtin, Código Postal GPO U1987, Perth, 6845 o llamando por el teléfono 9266 2784. También, si estuviera interesado en una información adicional sobre el estudio, por favor no dude en ponerse en contacto conmigo a través del correo electrónico en GS1404@gmail.com o por el teléfono en +49 (0) 351440070. O bien, Usted puede ponerse en contacto con mi supervisor, el Profesor Barry Fraser, en b.fraser@curtin.edu.au.

Thank you very much for your involvement in this research.

Muchas gracias por su participación en esta investigación.

PARENT CONSENT FORM
FORMA DE CONSENTIMIENTO DE LOS PADRES

- I understand the purpose and procedures of the study.
Entiendo el objetivo y los procedimientos del estudio.
- I have been provided with a parent information sheet.
Me han entregado la una hoja de información del representante estudiantil.
- I understand that the procedure itself might not benefit my child.
Entiendo que el procedimiento en sí mismo no podrá beneficiar a mi hijo(a).
- I understand that my child's involvement is voluntary and that my child can withdraw their participation at any time without problem or penalty.
Entiendo que la participación de mi hijo(a) es voluntaria y que mi hijo(a) puede retirarse en cualquier momento sin problema o sanción.
- I understand that no personal identifying information like my child's name and address will be used in any published materials.
Entiendo que ninguna información de identificación personal como el nombre y dirección de mi hijo(a) será usada en cualquier material publicado.
- I understand that all information will be securely stored for 5 years before it will be destroyed.
Entiendo que toda la información sera almacenada con seguridad durante 5 años antes de que ella sea destruída.
- I have been given the opportunity to ask questions about this research.
Me han dado la oportunidad de hacer preguntas sobre esta investigación.
- I agree to allow my child to participate in the study outlined to me.
Consiento en permitir que mi hijo(a) participe en el estudio descrito para mí.

Name: _____

Signature: _____

Date: _____

APPENDIX C
TEACHER INFORMATION SHEET AND INFORMED CONSENT FORM
ENGLISH ONLY



Curtin University of Technology Science & Mathematics Education Centre

Teacher Participant Information Sheet

My name is George Sirrakos. I am currently completing a piece of research for my Doctor of Philosophy in Science Education at Curtin University of Technology.

Purpose of Research

I am investigating the effectiveness of a reality pedagogy approach to teaching in a variety of contexts, namely, classrooms in different geographic and socioeconomic locations, as well as by different science teachers, in Dresden, Germany and the Bronx, New York. Reality pedagogy is an approach to teaching that utilizes collaboration between students and teachers to transform teaching practice by incorporating the social and lived experiences of students in science lessons. The outcomes of this research will be explored in terms of changes in how students perceive their learning environment and student attitudes. By undertaking the proposed research, I hope to understand how students make sense of their classrooms by examining events and experiences that occur outside the classroom.

Your Role

I will ask you to participate in and facilitate a variety of activities. These include the implementation of a reality pedagogy approach in your daily science lessons, the administration of a questionnaire twice (once at the beginning of the school year and again at the end), assistance in helping student participants maintain a reflective journal, conducting and facilitating open interviews with students, and having voluntary conversations with student participants about their experiences in the science classroom. During these conversations, I will ask you to facilitate discussions that will allow student participants to describe issues in the science classroom that are important to them. Administration of the questionnaire is expected to take about 25 minutes, the interviews about 15 minutes, and the conversations could vary in their length of time from five to 15 minutes.

Consent to Participate

Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form, I will assume that you have agreed to participate and allow me to use data from your class in this research.

Confidentiality

The information that you and your students provide will be kept separate from any identifying details, and only myself and my doctoral supervisor will have access to this. Your name, your students' names, or any other identifying information will not be used in the study or in any reports. In adherence with university policy, paper-based questionnaires, interview tapes and transcribed information will be kept in a locked facility throughout the duration of the study (after which time they will be destroyed). Questionnaire responses and transcriptions will be stored electronically at Curtin University for five years after the conclusion of the doctorate.

Further Information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number SMEC-33-10). If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784. As well, If you would like further information about the study, please feel free to contact me by email at GS1404@gmail.com or by telephone on +49 (0)351440070. Alternatively, you can contact my supervisor, Professor Barry Fraser, at b.fraser@curtin.edu.au.

Thank you very much for your involvement in this research.

Your participation is greatly appreciated.

TEACHER CONSENT FORM

- I understand the purpose and procedures of the study.
 - I have been provided with a teacher participation information sheet.
 - I understand that the procedure itself might not benefit me or my students.
 - I understand that my involvement is voluntary and that I can withdraw at any time without problem or penalty.
 - I understand that no personal identifying information like my name and address will be used in any published materials.
 - I understand that all information will be securely stored for 5 years before it will be destroyed.
 - I have been given the opportunity to ask questions about this research.
 - I agree to participate in the study outlined to me.
-

Name: _____

Signature: _____

Date: _____

APPENDIX D
ENGLISH-GERMAN VERSION OF THE QuALESA

Identification Code: _____

Questionnaire Assessing Learning Environment and Student Attitudes
Fragebogen zur Lernumgebung und zur Lerneinstellung der Schüler

Directions/Anweisungen:

1. This questionnaire contains a number of statements about this science class. You will be asked how often you think each statement is true. There are no “right” or “wrong” answers. Your opinion is what is wanted.

Dieser Fragebogen enthält eine Reihe von Behauptungen über den Naturwissenschaftsunterricht. Gefragt wird wie oft Ihre Meinung mit jeder Behauptung übereinstimmt. Es geht nicht um eine "korrekte" Antwort, sondern einfach um Ihre Meinung.

2. For each statement, draw a circle around the number corresponding to how often you feel each statement is true. **Please circle only ONE number per statement.**

*Für jede Behauptung wählen Sie bitte eine Zahl, die Ihrer Meinung nach der angegebenen Behauptung entspricht. **Bitte kreisen Sie jeweils nur eine Zahl ein.***

5 = Almost Always / *fast immer*

4 = Often / *häufig*

3 = Sometimes / *manchmal*

2 = Seldom / *selten*

1 = Almost Never / *fast nie*

3. If you change your mind about an answer, cross it out or erase it and circle another one.

Falls Sie mal Ihre Meinung ändern, gehen Sie bitte sicher, dass nur eine Nummer als Antwort erkennbar ist.

4. Although some statements in this questionnaire are fairly similar to other statements, you are asked to indicate your opinion about all statements.

Obwohl einige der Behauptungen in diesem Fragebogen ähnlich klingen, gehen Sie bitte sicher, dass Sie Ihre Meinung zu jeder der Behauptungen angeben.

Statement / Behauptungen	Almost Always	Often	Sometimes	Seldom	Almost Never
1. I discuss ideas in class. <i>Ich diskutiere Ideen im Unterricht.</i>	5	4	3	2	1
2. I give my opinions during class discussions. <i>Ich äußere meine Meinungen während Diskussionen im Unterricht.</i>	5	4	3	2	1
3. The teacher asks me questions. <i>Der Lehrer bzw. die Lehrerin stellt mir Fragen.</i>	5	4	3	2	1
4. My ideas and suggestions are used during classroom discussions. <i>Meine Ideen und Vorschläge werde im Unterricht wahrgenommen und in die Diskussion aufgenommen.</i>	5	4	3	2	1
5. I ask the teacher questions. <i>Ich stelle Fragen an den Lehrer bzw. an die Lehrerin.</i>	5	4	3	2	1
6. I explain my ideas to other students. <i>Ich erkläre anderen Schülern meine Ideen.</i>	5	4	3	2	1
7. Students discuss with me how to go about solving problems. <i>Andere Schüler diskutieren mit mir, wie sie Aufgaben lösen sollen.</i>	5	4	3	2	1
8. I am asked to explain how I solve problems. <i>Ich werde gefragt, wie ich Aufgaben gelöst habe.</i>	5	4	3	2	1
9. I cooperate with other students when doing assignment work. <i>Ich arbeite mit anderen Schülern zusammen, wenn ich Aufgaben erledige.</i>	5	4	3	2	1
10. I share my books and resources with other students when doing assignments. <i>Ich teile meine Bücher und anderes Schulmaterial mit Klassenkameraden, wenn ich Aufgaben erledige.</i>	5	4	3	2	1

Statement / Behauptungen	Almost Always	Often	Sometimes	Seldom	Almost Never
11. When I work in groups in this class, there is teamwork. <i>Wenn ich Gruppenarbeit in dieser Klasse mache, herrscht eine Atmosphäre von Teamgeist.</i>	5	4	3	2	1
12. I work with other students on projects in this class. <i>Ich arbeite mit anderen Schülern zusammen, wenn ich Projektarbeit in dieser Klasse leiste.</i>	5	4	3	2	1
13. I learn from other students in this class. <i>Ich lerne von meinen Klassenkameraden in dieser Klasse.</i>	5	4	3	2	1
14. I work with other students in this class. <i>Ich arbeite mit anderen Schülern in dieser Klasse.</i>	5	4	3	2	1
15. I cooperate with other students on class activities. <i>Ich kooperiere mit anderen Schülern bei Aktivitäten in dieser Klasse.</i>	5	4	3	2	1
16. Students work with me to achieve class goals. <i>Andere Schüler kooperieren mit mir um Lernziele in dieser Klasse zu erreichen.</i>	5	4	3	2	1
17. I learn about the world outside of school. <i>Ich lerne die Welt außerhalb der Schule kennen.</i>	5	4	3	2	1
18. My new learning starts with problems about the world outside of school. <i>Ich lerne am besten, wenn ich mich mit weltechnen Problemen außerhalb der Schule auseinandersetze.</i>	5	4	3	2	1
19. I learn how science can be part of my out-of-school life. <i>Ich lerne in welcher Weise die Naturwissenschaften eine Rolle in meinem Leben außerhalb der Schule spielen können.</i>	5	4	3	2	1
20. I get a better understanding of the world outside of school. <i>Mein Verständnis von der Welt außerhalb der Schule wächst durch den Naturwissenschaftsunterricht.</i>	5	4	3	2	1

Statement / Behauptungen	Almost Always	Often	Sometimes	Seldom	Almost Never
21. I learn interesting things about the world outside of school. <i>Ich lerne interessante Tatsachen über die Welt außerhalb der Schule.</i>	5	4	3	2	1
22. What I learn is related to my out-of-school life. <i>Was ich im Unterricht lerne, ist relevant für mein Leben außerhalb der Schule.</i>	5	4	3	2	1
23. It's OK for me to ask the teacher 'why do I have to learn this?'. <i>Es ist in Ordnung, wenn ich mal den Lehrer bzw. die Lehrerin frage, "Wieso muss ich das lernen?".</i>	5	4	3	2	1
24. It's OK for me to question the way I'm being taught. <i>Es ist in Ordnung, wenn ich hinterfrage, wie ich unterrichtet werde.</i>	5	4	3	2	1
25. It's OK for me to complain about teaching activities that are confusing. <i>Es ist in Ordnung, wenn ich mich beschwere, weil die Lernaktivitäten im Unterricht verwirrend sind.</i>	5	4	3	2	1
26. It's OK for me to complain about anything that prevents me from learning. <i>Ich darf mich über alles beschweren, was mich vom Lernen abhält.</i>	5	4	3	2	1
27. It's OK for me to express my opinion. <i>Ich darf meine Meinungen frei äußern.</i>	5	4	3	2	1
28. It's OK for me to speak up for my rights. <i>Es ist in Ordnung, wenn ich meine Rechte als Schüler verlange.</i>	5	4	3	2	1
29. I help the teacher to plan what I am going to learn. <i>Ich darf meine Lernziele mitbestimmen.</i>	5	4	3	2	1
30. I help the teacher to decide how well I am learning. <i>Ich bin daran beteiligt, meine Leistungen im Unterricht zu bewerten.</i>	5	4	3	2	1

Statement / Behauptungen	Almost Always	Oft	Sometimes	Seldom	Almost Never
31. I help the teacher to decide which activities are best for me. <i>Ich darf mitbestimmen, welche Lernaktivitäten zu mir passen.</i>	5	4	3	2	1
32. I help the teacher to decide how much time I spend on learning activities. <i>Ich darf mitbestimmen, wie lange ich bei einer bestimmten Lernaktivität verbringe.</i>	5	4	3	2	1
33. I help the teacher to decide which activities I do. <i>Ich darf mitentscheiden, welche Lernaktivitäten ich machen muss.</i>	5	4	3	2	1
34. I help the teacher to assess my learning. <i>Ich helfe dem Lehrer bzw. der Lehrerin, meine Leistungen zu bewerten.</i>	5	4	3	2	1
35. I would prefer to find out why something happens by doing an experiment than by being told. <i>Um Begriffe und Konzepte zu entdecken, bevorzuge ich Experimente gegenüber Vorlesungen und Erklärungen.</i>	5	4	3	2	1
36. I would prefer to do experiments rather than to read about them. <i>Experimente führe ich lieber selbst durch als einfach über sie zu lesen.</i>	5	4	3	2	1

Statement / Behauptungen	Almost Always	Often	Sometimes	Seldom	Almost Never
37. I would prefer to do my own experiments than to find out information from a teacher. <i>Ich führe lieber Experimente selbst durch, als einfach von meinem Lehrer bzw. meiner Lehrerin die Erklärung zu hören.</i>	5	4	3	2	1
38. I would rather solve a problem by doing an experiment than be told the answer. <i>Die Lösung zu einem Problem finde ich lieber selbst durch einen Versuch heraus als einfach die Lösung geschenkt zu bekommen.</i>	5	4	3	2	1
39. I would rather do an experiment to find out an answer than be told by a teacher. <i>Ich führe lieber ein Experiment durch als eine Lösung einfach von meinem Lehrer bzw. meiner Lehrerin zu bekommen.</i>	5	4	3	2	1
40. I would prefer to do an experiment on a topic than to read about it in science magazines. <i>Ich bevorzuge es, Experimente durchzuführen als Informationen in einer Naturwissenschaftszeitschrift zu lesen.</i>	5	4	3	2	1
41. Science lessons are fun. <i>Naturwissenschaftsunterricht macht Spaß.</i>	5	4	3	2	1
42. I find science lessons to be exciting and interesting. <i>Ich finde den Naturwissenschaftsunterricht spannend und interessant.</i>	5	4	3	2	1
43. I find science to be an interesting school subject. <i>Ich finde Naturwissenschaftsunterricht ist ein Interessantes Schulfach.</i>	5	4	3	2	1
44. I really enjoy going to science lessons. <i>Ich freue mich, wenn es gerade Zeit für den Naturwissenschaftsunterricht ist.</i>	5	4	3	2	1

Statement / Behauptungen

	Almost Always	Often	Sometimes	Seldom	Almost Never
45. The material covered in science class is interesting. <i>Die Unterrichtsthemen im Naturwissenschaftsunterricht interessieren mich.</i>	5	4	3	2	1
46. I look forward to science lessons. <i>Ich freue mich auf den Naturwissenschaftsunterricht.</i>	5	4	3	2	1

**This questionnaire is based on the CLES (Taylor & Fraser, 1991), WIHIC (Fraser, Fisher & McRobbie, 1996), and TOSRA (Fraser, 1981). These questionnaires were modified for use in my study with the permission of the authors.

APPENDIX E
ENGLISH-SPANISH VERSION OF THE QuALESA

Identification Code: _____

Questionnaire Assessing Learning Environment and Student Attitudes
Cuestionario de evaluación del ambiente de aprendizaje y de las actitudes estudiantiles

Directions/ Instrucciones:

1. This questionnaire contains a number of statements about this science class. You will be asked how often you think each statement is true. There are no “right” or “wrong” answers. Your opinion is what is wanted.
Este cuestionario contiene varias declaraciones sobre la clase de Ciencias. Se le preguntará con que frecuencia Usted piensa que cada declaración es verdadera. No hay respuestas “correctas” o “incorrectas”. Su opinión es lo que cuenta.
2. For each statement, draw a circle around the number corresponding to how often you feel each statement is true. **Please circle only ONE number per statement.**
*Para cada declaración, dibuje un círculo alrededor del número correspondiente, escogiendo con qué frecuencia Usted piensa que cada declaración es verdadera. **Por favor seleccione un solo número por declaración.***

5 = Almost Always / Casi siempre
4 = Often / A menudo
3 = Sometimes / A veces
2 = Seldom / Rara vez
1 = Almost Never / Casi nunca
3. If you change your mind about an answer, cross it out or erase it and circle another one.
Si usted cambia de idea sobre una respuesta, la tacha o la borra, y escoge otra respuesta.
4. Although some statements in this questionnaire are fairly similar to other statements, you are asked to indicate your opinion about all statements.
Aunque algunas declaraciones en este cuestionario sean bastante similares a otras, se le pide indicar su opinión sobre todas las declaraciones.

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
1. I discuss ideas in class. <i>Discuto ideas en clases.</i>	5	4	3	2	1
2. I give my opinions during class discussions. <i>Doy mis opiniones durante las discusiones en clases.</i>	5	4	3	2	1
3. The teacher asks me questions. <i>El profesor me hace preguntas.</i>	5	4	3	2	1
4. My ideas and suggestions are used during classroom discussions. <i>Mis ideas y propuestas son consideradas durante las discusiones en clases.</i>	5	4	3	2	1
5. I ask the teacher questions. <i>Hago preguntas al profesor.</i>	5	4	3	2	1
6. I explain my ideas to other students. <i>Explico mis ideas a otros estudiantes.</i>	5	4	3	2	1
7. Students discuss with me how to go about solving problems. <i>Los estudiantes discuten conmigo cómo hacer para resolver problemas.</i>	5	4	3	2	1
8. I am asked to explain how I solve problems. <i>Me piden explicar cómo soluciono problemas.</i>	5	4	3	2	1
9. I cooperate with other students when doing assignment work. <i>Coopero con otros estudiantes haciendo tareas.</i>	5	4	3	2	1
10. I share my books and resources with other students when doing assignments. <i>Comparto mis libros y recursos con otros estudiantes hacienda tareas.</i>	5	4	3	2	1

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
11. When I work in groups in this class, there is teamwork. <i>Cuando trabajo en grupo en esta clase, trabajamos en equipo.</i>	5	4	3	2	1
12. I work with other students on projects in this class. <i>Trabajo con otros estudiantes en proyectos en esta clase.</i>	5	4	3	2	1
13. I learn from other students in this class. <i>Aprendo de otros estudiantes en esta clase.</i>	5	4	3	2	1
14. I work with other students in this class. <i>Trabajo con otros estudiantes en esta clase.</i>	5	4	3	2	1
15. I cooperate with other students on class activities. <i>Coopero con otros estudiantes en actividades de la clase.</i>	5	4	3	2	1
16. Students work with me to achieve class goals. <i>Los estudiantes trabajan conmigo para lograr los objetivos en la clase.</i>	5	4	3	2	1
17. I learn about the world outside of school. <i>Aprendo sobre el mundo fuera de la escuela.</i>	5	4	3	2	1
18. My new learning starts with problems about the world outside of school. <i>Mi nuevo aprendizaje comienza con problemas sobre el mundo fuera de la escuela.</i>	5	4	3	2	1
19. I learn how science can be part of my out-of-school life. <i>Aprendo como las Ciencias puede ser parte de mi vida fuera de la escolar.</i>	5	4	3	2	1
20. I get a better understanding of the world outside of school. <i>Consigo un mejor entendimiento del mundo fuera de la escuela.</i>	5	4	3	2	1

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
21. I learn interesting things about the world outside of school. <i>Aprendo cosas interesantes sobre el mundo fuera de la escuela.</i>	5	4	3	2	1
22. What I learn is related to my out-of-school life. <i>Lo que aprendo está relacionado con mi vida fuera de la escuela.</i>	5	4	3	2	1
23. It's OK for me to ask the teacher 'why do I have to learn this?'. <i>Me parece bien preguntar al profesor ¿por qué tengo que aprender esto?</i>	5	4	3	2	1
24. It's OK for me to question the way I'm being taught. <i>Me parece bien cuestionar el modo de cómo me están enseñando.</i>	5	4	3	2	1
25. It's OK for me to complain about teaching activities that are confusing. <i>Me parece bien reclamar por las actividades docentes que son confusas.</i>	5	4	3	2	1
26. It's OK for me to complain about anything that prevents me from learning. <i>Me parece bien reclamar por cualquier cosa que me impide aprender.</i>	5	4	3	2	1
27. It's OK for me to express my opinion. <i>Me parece bien expresar mi opinión.</i>	5	4	3	2	1
28. It's OK for me to speak up for my rights. <i>Me parece bien reclamar mis derechos.</i>	5	4	3	2	1
29. I help the teacher to plan what I am going to learn. <i>Ayudo al profesor a planificar lo que voy a aprender.</i>	5	4	3	2	1
30. I help the teacher to decide how well I am learning. <i>Ayudo al profesor a decidir qué bien estoy aprendiendo.</i>	5	4	3	2	1

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
31. I help the teacher to decide which activities are best for me. <i>Ayudo al profesor a decidirse qué actividades son las mejores para mí.</i>	5	4	3	2	1
32. I help the teacher to decide how much time I spend on learning activities. <i>Ayudo al profesor a decidir cuánto tiempo utilizo en el aprendizaje de las actividades.</i>	5	4	3	2	1
33. I help the teacher to decide which activities I do. <i>Ayudo al profesor a decidir qué actividades hago.</i>	5	4	3	2	1
34. I help the teacher to assess my learning. <i>Ayudo al profesor a evaluar mi aprendizaje.</i>	5	4	3	2	1
35. I would prefer to find out why something happens by doing an experiment than by being told. <i>Prefiero averiguar por qué pasa algo haciendo un experimento a que me lo digan sin experimentarlo.</i>	5	4	3	2	1
36. I would prefer to do experiments rather than to read about them. <i>Prefiero hacer experimentos en vez que leer acerca de ellos.</i>	5	4	3	2	1
37. I would prefer to do my own experiments than to find out information from a teacher. <i>Prefiero hacer mis propios experimentos que recibir la información del profesor.</i>	5	4	3	2	1
38. I would rather solve a problem by doing an experiment than be told the answer. <i>Prefiero solucionar un problema haciendo un experimento a que me den la respuesta.</i>	5	4	3	2	1

Statement / Declaraciones	Almost Always	Often	Sometimes	Seldom	Almost Never
39. I would rather do an experiment to find out an answer than be told by a teacher. <i>Prefiero hacer un experimento para averiguar una respuesta a que el profesor me dé la respuesta.</i>	5	4	3	2	1
40. I would prefer to do an experiment on a topic than to read about it in science magazines. <i>Prefiero hacer un experimento sobre un tema que leer acerca de ello en revistas de Ciencias.</i>	5	4	3	2	1
41. Science lessons are fun. <i>Las clases de Ciencias son divertidas.</i>	5	4	3	2	1
42. I find science lessons to be exciting and interesting. <i>Considero que las clases de Ciencias son emocionantes e interesantes.</i>	5	4	3	2	1
43. I find science to be an interesting school subject. <i>Considero que las Ciencias es una material escolar interesante.</i>	5	4	3	2	1
44. I really enjoy going to science lessons. <i>Yo realmente disfruto atendiendo las clases de Ciencias.</i>	5	4	3	2	1
45. The material covered in science class is interesting. <i>El material visto en la clase de Ciencias es interesante.</i>	5	4	3	2	1
46. I look forward to science lessons. <i>Yo espero con motivación las clases de Ciencias.</i>	5	4	3	2	1

**This questionnaire is based on the CLES (Taylor & Fraser, 1991), WIHIC (Fraser, Fisher & McRobbie, 1996), and TOSRA (Fraser, 1981). These questionnaires were modified for use in my study with the permission of the authors.