Chapter 1

Introduction

Science classroom environments have changed significantly in the past twenty years. This change has been inspired by innovations in approaches to teaching as well as increases in accountability for student learning (1996). The National Science Education Standards (1996) provide recommendations for a baseline change in science teaching approaches. The recommendations included a renewed focus on inquiry-based learning and the critical importance of the study of science in our schools (NRC, 1996). These standards provided the impetus for pedagogical changes in the high school science environment. Educational accountability has also become increasingly important in practical teaching applications (NCLB; Public Law No.107-110, 115 Stat.1425, 2002). *No Child Left Behind* has forced a public evaluation of achievement in the public schools. Because of these transformations, it has become critically important to ensure that we have a valid measurement framework with which to examine the environments of the classroom learning within it.

An important part of effective measurement of the science classroom is accurate documentation and assessment of student attitudes toward their learning environment. According to several studies, student attitudes toward their learning environment are related to positive academic outcomes (Dorman & Adams, 2004; B. J. Fraser, 1998a, 1998b). The measures of the *Science Laboratory Environment Inventory* were created and validated in the early 1990's to assess student perceptions toward their science classroom laboratory environment (Fraser, McRobbie, & Giddings, 1993; , 1998a). The areas measured include student cohesiveness, open-endedness, integration, rule clarity and material environment (Fraser, McRobbie, & Giddings, 1993).

It has been 15 years since the original validation evidence for the measures of the SLEI was collected. These classroom changes and heightened scrutiny for accountability have fostered the creation of an instructional environment where students must think critically about the work they are completing. The modifications to the science classroom environment sufficiently warrant re-validation of the measures of the SLEI.

In addition to changes in the science classroom, the field of applied measurement theory has adopted more comprehensive approaches in the past 15 years. For example: Messick's validity framework has established a unified approach to examining the appropriateness of inferences and decisions that are made based on measures created by an instrument (Messick, 1989, 1995). Additionally, the application of Rasch Measurement Theory (Rasch, 1960) provides an opportunity for an in-depth understanding of the theoretical and technical construction of the measures of an instrument. These comprehensive approaches provide richer detail and greater depth of information about the validity of the measures than more traditional and outdated examination of the measures of an instrument through construct, criterion and content validity (Cronbach, 1951).

The validation of the measures of the SLEI using an up-to-date norming sample provide empirical evidence for further use of the instrument. The accountability movement has increased the need for measures to document student learning specifically as measured through achievement. Research has been completed linking students' perceptions of their learning environment to their academic achievement (Dorman & Adams, 2004; B. J. Fraser, 1998a; Nolen, 2003). Updating the evidence of validity for the measures from the SLEI provided an opportunity to further the research on the link between student perceptions of classroom environment and their academic outcomes.

Purpose of the Research

The purpose of this study was to generate up-to-date norms for the measures of the SLEI and to complete an examination of the validity of these measures within the frameworks of modern validity and measurement theory. This was necessary in order to ensure that inferences based on student perceptions of the lab environment are valid within the current context of science learning. The main focus of this research was to examine the evidence to support the validity of the measures of this instrument. The re-validated measures may then be used to enhance understanding and evaluation of the high school science classroom laboratory. The science classroom is complex and the use of the SLEI measures to understand the current lab environment will help educators and researchers to address gaps in pedagogical approaches as well as customize learning environments specific to student needs. The validity was examined through Messick's unified definition of validity as an integrated, evaluative judgment that encompasses a substantive comprehensive framework for elaborating and detailing the area that a measure may examine, as well as a detailed analytical framework for understanding the technical components of a particular measure or measures within an instrument (Messick, 1989, 1995). The six aspects of validity include content, substantive, structural, generalizability, external and consequential (Messick, 1989, 1995). The validity of the measures of the SLEI was examined through five of these aspects: content, substantive, structural, generalizability, and external validity. The following research questions were considered in our study:

- Research Question 1 (Dimensionality): What dimensional structure best depicts student attitudes toward their science laboratory environment?

- Research Question 2 (Rating Scale Structure): Which measurement model and rating scale configuration best depicts the rating scale structure of these data?

- Research Question 3 (Item Quality): What is the technical quality of the items?

- Research Question 4 (Reliability): What is the reliability of the subscale measures?

- Research Question 5 (Group Differences):

    o 5a Are there gender and ethnicity group differences across the measures?

    o 5b Are there differences between science experience levels across the measures?

    o 5c Are there differences between regular and honors students across the measures?

Research questions 1 through 5a are addressed in Chapter 4: the Validation Study article. These questions examine four aspects of validity in detail in an effort to re-validate the measures of the SLEI. Research questions 5b and 5c are addressed specifically in Chapter 5: Influential factors on student perceptions of the high school science laboratory environment. Research question five attempts to cull out further details and nuances between different groups in the science lab in order to understand any perceptual differences. These differences may influence how students learn, and further researcher and educator understanding of the diversity of the classroom as well as provide the opportunity to improve the entire learning experience.

Significance of the Study

In summary, three reasons for this revalidation work include the changing environment of science education; expanded detailed analyses to support the validity of the measures; and future research concerning student attitudes and academic achievement in science learning.

Pedagogical approaches to science teaching have changed significantly in the past 15 years due in part, to recommendations of the National Science Education Standards (NRC, 1996). This has brought about change in the way students learn in the high school classroom. The validation work for the measures of the instrument is out of date. Because the work is

outdated, detailed analyses were completed to support the validity of the measures of this instrument.

In addition, existing research has revealed a positive correlation between student attitudes toward learning environments and academic achievement (Fraser, McRobbie, & Giddings, 1993). My research provides the foundation for future assessment of the relationship between classroom environment and student achievement. Researchers need clear evidence to substantiate the connection between the classroom environment and academic outcomes.

This dissertation consists of an introductory chapter, a literature review, a methodological review, two journal quality articles and a concluding chapter summarizing the research. The literature review provides a detailed examination of the extant literature and theory as applicable to learning environment research, science classrooms and the original development of the SLEI. The methodological review provides an explanation of the sample as well as the procedures and analysis completed for this research.

The two journal articles each have a distinct focus. The first article focuses on the methodology and results of the validation study. The second article focuses on perceived differences in the science classroom based on academic achievement and grade in school. Each article has a different target audience. The validation article is targeted toward audiences in the measurement field. The group differences article is focused on understanding and applying the findings in the science education field.

Chapter 6 provides a summary of this research. This includes a description of the key reasons for the research, the sample, the methodology and the key findings from the work undertaken. This concluding chapter provides a summary of the critical points of this research.