Science and Mathematics Education Centre

Effectiveness of Integrating Technology across the Curriculum:
Classroom Learning Environments among Middle-school Students in the USA

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DECLARATION

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

Signature:

Date: March, 2015

ABSTRACT

The major purpose of this study was to evaluate the effectiveness of integrating technology across the core curriculum in terms of students' perceptions of their classroom learning environment. The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) was administered to a sample of 966 Grades 6, 7, and 8 students in core curriculum classes. A pretest–posttest design was used to evaluate the integration of technology in terms of changes in the learning environment over a seven-month period.

To determine validity of the TROFLEI, principal axis factoring with varimax rotation and Kaiser normalization was used to confirm that the majority of items belonged to their *a priori* scale and no other scale (with 76 out of the 80 items having a factor loading of 0.30 or above on their own scale and less than 0.30 on all other scales) and that eigenvalues were above unity. The scales of the TROFLEI were all found to exhibit strong internal consistency reliability for both pre– and post–administrations, with Cronbach's alpha coefficients of at least 0.79 for all scales. The survey exhibited sound factorial validity and reliability.

To evaluate technology integration, only students completing both pretests and posttests (N=605) were used in investigating pre–post changes in TROFLEI scores. Because the multivariate test from MANOVA using Wilks' lamda criterion revealed statistically significant differences overall between the pretest and posttest, the univariate ANOVA results were examined. As well, the effect size (d) was calculated to express the magnitude of pre–post differences in standard deviation units. The

effect size was small (≤0.2) (Cohen, 1988) for all of the ten scales. Overall scores on six scales (Student Cohesiveness, Involvement, Investigation, Cooperation, Differentiation and Computer Usage) increased while scores on four scales (Teacher Support, Task Orientation, Equity and Young Adult Ethos) decreased between pretest and posttest. Pre–post differences not only were small, but also they were inconsistent in direction for perceptions of the classroom learning environment when integrating instructional technology across the core curriculum.

With the integration of technology into core curriculum classes, one would anticipate that scores on Involvement and Computer Usage would increase slightly between pretest and posttest. The decrease in Equity could be attributed to the students' technical abilities and the time allowed/required for technology usage and teacher interaction. Overall, instructional technology integrated into the core curriculum was neither advantageous nor disadvantageous in terms of classroom learning environment.

This study's finding of negligible differences between pretest and posttest scores for TROFLEI scales when evaluating technology integration into the core curriculum is an important finding. No significant differences associated with the evaluations of the use of educational technology has been a common pattern in past research (Russell, 1999). My findings suggest that technological integration into the core curriculum might not offer any direct educational advantages, but also that they are not detrimental to students' learning experiences.

This study contributes to the field of learning environments as one of only a few studies that have reported the validity and reliability of the TROFLEI, and also by adding to the body of educational research on learning environments as a source of process criteria of effectiveness in evaluating educational innovations.

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Chapter 1

BACKGROUND, CONTEXT AND RATIONALE

According to Barry J. Fraser, "The research shows that attention to the classroom environment is likely to pay off in terms of improving student achievement" (Fraser, 2001, p. 4).

1.1 Introduction

Students are accustomed to digital technologies as a fully integrated aspect of their daily lives (Green & Hannon, 2007) and they have spent much of their lives immersed with computers, video games, digital music players, video cams, cell phones, and the other toys and tools of the digital age (Prensky, 2005). These students typically seek real-world relevance and authenticity and learn by doing; technology facilitates their styles of learning (Oblinger & Oblinger, 2005). Technology provides new forms of communication for reinforcing learning by allowing students alternatives to demonstrate analysis and critical thinking skills (Saltman, 2011). According to a U.S. Department of Education survey of disengaged students, technology could improve interest and understanding in mathematics and science classes by allowing peer collaboration and access to the internet (Gillard, 2010). According to Fouts (2000), research suggests that students exhibit greater retention, enjoyment and a positive attitude when aided by technology. Zandvliet's (2006) research emphasizes the need to recognize the role of the computer when infused into the culture ecology of the classroom, instead of being isolated from the teacher's knowledge of the curriculum and understanding of learning styles. The teacher understands the aspects of the classroom culture and what can and cannot be digitalized. The teacher's pedagogical intent, when intertwined with the utilization of technology tools, can increase the effectiveness of the classroom environment (Zandvliet, 2006).

An aim of the school involved in this study is to utilize technologies to implement curricular design to meet 21st century expectations of student learning. Students use technology tools, such as computers, videos, smart devices, interactive whiteboards, and tablets, to interact, create, design, manipulate, communicate, and collaborate for relevant and interactive learning outcomes, presentations, practice, and/or reinforcement. The school-wide technology integration across the curriculum at this school incorporates technology applications such as email, instant messaging, word processing, internet, presentation software, electronic library resources, spreadsheets, course management systems, blogs, graphics, student response systems, video conferencing, and Web 2.0 applications to motivate active participants in real-time, interdisciplinary, multimedia engagement. Figure 1.1 shows a pamphlet for Texas Middle School promoting the integration of technology.

Figure 1.1: Texas Middle School Promotion for 21st Century Instruction

Seeking a better understanding of students' perceptions of their classroom learning environment while integrating technology across the core curriculum formed the foundation of this study. Because many benefits are claimed for educational technology, there is the need to evaluate whether technology really is as effective as various people have claimed.

This chapter provides an introduction and overview for the thesis under these sections:

1.2 Background and Context of the Study

- 1.2.1 Field of Learning Environments
- 1.2.2 Background of Texarkana, Texas

1.3 Purpose and Research Questions

1.4 Significance of the Study

1.5 Organization of the Thesis.

1.2 Background and Context of the Study

This section provides background information relevant to the present study, including a brief description of the field of learning environments (Section 1.2.1) and information on the location where the research was conducted (Section 1.2.2).

1.2.1 Field of Learning Environments

Students spend over 20,000 hours in classrooms during their educational career; therefore student perceptions of important aspects of the learning environment are an important factor for improving the effectiveness of schools. Few educators would dispute the fact that student achievement is a valuable indicator for evaluating schools;

however, it does not complete the picture of the educational process (Fraser, 2001). This study drew on and contributed to the field of learning environments. According to Fraser (1998a, p. 3), learning environment refers to “the social, psychological, and pedagogical contexts in which learning occurs and which affect student achievement and attitudes.” The learning environment is comprised of the collective perceptions of the students and sometimes those of the teacher. "It is the quality of life lived in classrooms that determines many of the things that we hope for from education ─ concern for community, concern for others, commitment to the task in hand" (Fraser, 2001, p. 2). Although classroom learning environment is a subtle concept, remarkable progress has been made in studying it through diverse and international research over the past four decades (Fraser, 1989).

A considerable number of studies of learning environments have provided compelling evidence that the classroom learning environment has a strong influence on student outcomes, including achievement which receives most attention in the world of education (Fraser, 2001, 2012). Fraser states that studies “hold hope for improving student outcomes through the creation of the types of classroom environments that are empirically linked to favorable student outcomes” (2007, p. 117). Classroom environment instruments can be used as valuable criteria in the evaluation of educational innovations (Fraser, 2007). This study drew from the rich history of research on learning environments and employed constructs and techniques that make sense in the extant circumstances by the application of theoretical frames and approaches from other areas of study (Tobin & Fraser, 1998). More details about the field of learning environments, such as its historical background, the development of learning environment instruments and past studies, are presented in Chapter 2.

1.2.2 Background of Texarkana, Texas

My research was conducted in Texarkana, USA, whose motto is "Where Life Is So Large It Takes Two States" because it is two cities located in the northeast corner of Texas and the southwest corner of Arkansas. Figure 1.2 illustrates the geographic location of Texarkana, USA.

Figure 1.2: The location of Texarkana, Texas in the USA

Texarkana, USA, of today is a thriving metro-center serving nineteen counties in four states. Its diversified economy is supported by manufacturing, agriculture, medicine, transportation, education and retail. Residents and visitors enjoy the subtropical climate and a variety of recreational and entertainment activities (Texarkana Independent School District, 2014).

The person responsible for actually naming Texarkana is up for debate. The most popular version credits Colonel Gus Knobel, who surveyed this section for the Iron

Mountain Railroad right-of-way from Little Rock, Arkansas. The story is told that Colonel Knobel wrote “Tex-Ark-Ana” on a board and nailed it to a tree and remarked that this was the name of the town which is going to be built here. Colonel Knobel thought he was at or near the spot where the borders of three states met. So, he named the city after these states – Texas, Arkansas, and Louisiana. Actually, the Louisiana border was approximately 30 miles away (Texarkana Independent School District, 2014). Figure 1.3 shows the United States Courthouse with the state line for Arkansas and Texas running through the middle of the building.

Figure 1.3: The United States Courthouse and Post Office in Texarkana, USA

Today, Texarkana reveals a host of historic treasures: annual festivals, entertainment from performing arts, art exhibits, shopping, great outdoors and sports, wonderful restaurants and a citizenry proud to call Texarkana home (Texarkana Independent School District, 2014).

Commercially, Texarkana consists of two separate municipalities with two sets of mayors, councilors and city officials. Texarkana also has two separate public school systems, one in Arkansas and one in Texas. The present study focused on public middle-school students within the Texarkana Independent School District (TISD) in Texarkana, Texas. Chapter 3, Section 3.3 entitled Selected School Site provides more information about the location, community and demographics of Texarkana, Texas, Texarkana Independent School District and Texas Middle School.

1.3 Purpose and Research Questions

The main purpose of this study was to evaluate the effectiveness of technology integration across the core curriculum in terms of the classroom learning environment. A review of literature about technology integration or instructional technology is presented in Chapter 2, Section 2.5. The author's original motivation to conduct this study was based on initial observations of elementary students within this same school district seemingly being more engaged as technology was integrated across their core curriculum in self-contained classes. These anecdotal observations seemed to suggest increased understanding and more task completion when utilizing technologies to implement curricular design to meet 21st century expectations of student learning. However, further evidence was needed about the effectiveness of integrating technology across the curriculum because there are many unsupported benefits claimed for educational technology.

Once the purpose of this study was conceived, the researcher chose the field of learning environments as the foundation for the current study as discussed in Section 1.2.1. Two specific aims guided this study among middle-school students in Texas. To check whether the instrument used in this study was valid and reliable, the first research question was constructed.

Research Question #1

> *Is the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) valid and reliable when used among middle-school students in Texas?*

To examine the effectiveness of integrating technology across the core curriculum, the second research question was formed.

Research Question #2

> *Is the integration of instructional technology across the core curriculum effective in terms of students' perceptions of the classroom learning environment?*

1.4 Significance and Limitations of the Study

The significance of the project is that it provides evidence about the effectiveness of integrating technology across the curriculum in terms of the students' perceptions of their classroom environment. Additionally, as far as is known, this is the first evaluation of the integration of technology across the curriculum in Texas in terms of learning environment criteria. By providing evidence about the effectiveness of the program in terms of changes between pretest and posttest in classroom environment, this research contributes to the growing body of studies that have involved evaluating educational innovations in terms of its impact on classroom environment (Fraser, 2012). Lastly, findings from this study could have practical implications for educators and provide new insights for teachers and educators to broaden their pedagogical perspectives and strengthen their sensitivity towards classroom environment and technological innovations.

Certain inherent limitations and constraints when studying human subjects possibly could affect the findings of this investigation. These include extraneous variables such as students' mood, fatigue or stress levels that could affect the completion the questionnaires with regard to students' honesty, seriousness, and interest in the research even when provided with clear explanations of the purposes, procedures, voluntary nature of participation, and confidentiality associated with the research. In addition, inability to control for instructional technology outside the core curriculum setting and to ensure that all teachers provide instruction in the exact same manner in each classroom are potential limitations of this study. These limitations are discussed in greater detail in Chapter 5.

1.5 Organization of the Thesis

This thesis is comprised of five chapters. Chapter 1, entitled Background, Context and Rationale, presented a background, framework and rationale for the study. Also, the research questions and the purpose of the study were delineated, as well as an overview of the thesis being provided.

Chapter 2, entitled Review of the Literature, comprehensively reviews literature on a range of topics relevant to my study. There are five major sections in Chapter 2. The first section provides an overview of the history of the field of classroom learning environments. The second section is devoted to 11 important learning environment instruments that have been designed and validated over the past 40 years, and reviews noteworthy studies associated with each instrument. Also included in the chapter is a more in-depth review of the large number of studies that have used the What Is Happening In this Class? (WIHIC), including those that investigated connections between the learning environment and student outcomes. The third section reviews past evaluations that employed learning environment dimensions as criteria of effectiveness in the evaluation of educational innovations. The fourth section defines technology integration and instructional technology, including information of effective technology integration. The last section reviews a pattern in past research in which evaluations of the use of educational technology have often revealed no significant differences.

Chapter 3, entitled Methodology, contains six major sections. The first section discusses the study's research questions, which were identified as validating the TROFLEI among middle-school students in Texas and evaluating the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment. The second describes the context of my study, including the school district, its location and community, the school demographics and the school's core curriculum courses. The next section describes the sample and the fourth major section describes the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) that was used in my study to assess the effectiveness of integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment. The next section clarifies the data-collection procedures and the last section describes the data-analysis methods for validating the TROFLEI and assessing the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of classroom learning environments.

Chapter 4, entitled Analyses and Results, describes the data analyses and reports the findings for the study, including the results for the validity and reliability of the instrument and how they compare with past research. Additionally, the chapter reports findings for the effectiveness of technology integration in terms of pre–post changes in TROFLEI scales.

Chapter 5, entitled Discussion and Conclusion, provides a summary of the thesis. The educational significance this study, the implications of my research findings and the limitations of the study are discussed. Recommendations for future research and concluding remarks are provided at the end of this chapter.

Chapter 2

REVIEW OF THE LITERATURE

According to Albert Einstein, “Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning” (Boerner, 2010, August 2).

2.1 Introduction to Review of Literature

Chapter 1 began with a discussion of the background and context of my research that led to the research problem that guided my research. This introductory chapter also focused on the theoretical framework of classroom learning environments. Lastly, the significance and purpose of the study were discussed and the study’s two research questions were defined.

My aim in this chapter is to support the importance of my research based on an extensive review of literature. First, literature is reviewed for the field of learning environments, such as its history and an overview of learning environments instruments. Secondly, past learning environments studies are reviewed, including evaluating outcomes-focused education and educational innovations and technology integration in context to my study. Lastly, a review of past educational technology studies that revealed no significant difference is presented. The content of the present chapter is outlined below:

2.2 Historical Background of Learning Environment Field

2.3 Classroom Learning Environment Instruments

2.2 Historical Background of Learning Environment Field

The field of learning environment's historical development began with the pioneering work in the field of social sciences by Lewin (1936) who conceptualized human behavior (*B*) as a function of the person (*P*) and the environment (*E*) by formulating *B*

= f (*P*, *E*). In Lewin's formula, behavior is a function of the person and the environment which would be later considered and studied. Murray (1938) followed Lewin's idea by analyzing the environment as perceived by observers and the participants. Stern, Stein, and Bloom (1956) later expanded this model by proposing that differences in perceptions can exist between inhabitants and external observers of an environment.

With the basis of this field of study being formed by Lewin, Murray and others, Walberg and Moos began independent studies of the learning environments by working on various learning situations using participants' perceptions in the 1960s (Moos, 1974, 1979); this began the early development of learning environment assessment tools which laid the foundation for the field. The first study began in the late 1960s as part of evaluation activities of Harvard Project Physics, which led to the first questionnaire, the Learning Environment Inventory (LEI, Walberg & Anderson, 1968).

During this time period in the USA, Rudolf Moos was developing the first of his social climate scales for use in psychiatric hospitals and correctional institutions, which later led to the development of the Classroom Environment Scale (CES, Moos, 1974, 1979; Moos & Trickett, 1974, 1987). Moos' (1974) work was based on a premise that human environmental scales could be sorted into the three general dimensions of *relationship*, *personal development*, and *system maintenance and system change*. Relationship dimensions are those relating to the nature and intensity of personal relationships. Personal development dimensions refer to the path through which knowledge development progresses. System maintenance and system change dimensions refer the orderliness, clarity, control and responsiveness to change in the environment (Moos &

Trickett, 1974). Moos and Trickett's ideas influenced the expansion of learning environment instruments.

These early studies stimulated more research in the Netherlands (Wubbels & Levy, 1991, 1993) and Australia (Fraser, 1986), which led to the development of several learning environments questionnaires.

In Australian research, Fraser and his colleagues began focusing on student-centered classrooms using the Individualised Classroom Environment Questionnaire (ICEQ, Fraser, 1990; Fraser & Butts, 1982). The ICEQ differs from the LEI and CES, which focus on teacher-centered classrooms, because it measures those dimensions that are distinctive in open or individualised classroom settings. Subsequently, Fraser was instrumental in the development of other specific-purpose classroom environment instruments in Australia and cross-validation and application of them in many research studies around the world.

This line of learning environment research, birthed in USA and spread to The Netherlands and Australia, was taken up in other parts of the world. Fraser (2002) reviews Asian researchers who made significant contributions to the field in Singapore (Chionh & Fraser, 2009; Fraser & Teh, 1994; Khoo & Fraser, 2008; Quek, Wong, & Fraser, 2005; Teh & Fraser, 1995; Wong & Fraser, 1996), Indonesia (Fraser, Aldridge, & Adolphe, 2010; Wahyudi & Treagust, 2004), Korea (Fraser & Lee, 2009; Kim, Fisher, & Fraser, 1999), and Taiwan (Aldridge & Fraser, 2000; Aldridge, Fraser, & Huang, 1999).

This field of study has expanded and led to the development of a variety of learning environment surveys to suit specific research purposes. This work precipitated a great deal of other research which is reflected in historically-significant books (L.W. Anderson, 1996; Fraser, 1986; Fraser & Walberg, 1991; Moos, 1979; Walberg, 1979), more-recent books (Aldridge & Fraser, 2008; Fisher & Khine, 2006; Goh & Khine, 2002; Khine & Fisher, 2003), literature reviews (Fraser, 1994, 1998b, 2007, 2012, 2014), the American Educational Research Association's (AERA) Special Interest Group (SIG) on Learning Environments which began in the mid-1980s, the initiation in 1998 of Kluwer/Springer's *Learning Environments Research: An International Journal*, and the birth in 2008 of Sense Publishers' book series *Advances in Learning Environments Research* (Aldridge & Fraser, 2008), and numerous literature reviews focusing on learning environments included as chapters in the *Handbook of Research on Science Education* (Fraser, 2014) and the *Second International Handbook of Science Education* (Fraser, 2012).

2.3 Classroom Learning Environment Instruments

Teachers can promote a positive or negative atmosphere among students, which affects the classroom learning environment, which influences students' success (Fisher & Waldrip, 1999; Fraser, 2007, 2012). A variety of widely-accepted questionnaires have been developed for assessing student perceptions of the learning environments (Fraser, 1998a, 1998b, 2007, 2012). This range of questionnaires are accessible, economical and valid for evaluating students' perceptions of their classroom learning environment. Some earlier questionnaires are the My Class Inventory (Fisher & Fraser, 1981), a simplified version of the LEI for younger age students, and the Questionnaire of

Teacher Interaction (QTI, Wubbels & Levy, 1991) for assessing of students' perceptions of teacher behavior.

These questionnaires have evolved to permit the assessment of specific learning environments, such as the Science Laboratory Environment Inventory (SLEI, Fraser & McRobbie, 1995; Henderson, Fisher, & Fraser, 2000; Lightburn & Fraser, 2007), the Constructivist Learning Environment Survey (CLES, Kim et al., 1999; Nix, Fraser, & Ledbetter, 2005; Spinner & Fraser, 2005; P. C. Taylor, Fraser, & Fisher, 1997) and the What Is Happening In this Class? (WIHIC, Aldridge et al., 1999; Chionh & Fraser, 2009; Dorman, 2003; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007).

This section discusses the classroom learning environment instruments developed during the past three decades to assist teachers, administrators and researchers: Learning Environment Inventory, LEI (Section 2.3.1), Classroom Environment Scale, CES (Section 2.3.2), Individualized Classroom Environment Questionnaire, ICEQ (Section 2.3.3), My Class Inventory, MCI (Section 2.3.4), College and University Classroom Environment Inventory, CUCEI (Section 2.3.5), Questionnaire on Teacher Interaction, QTI (Section 2.3.6), Science Laboratory Environment Inventory, SLEI (Section 2.3.7), Constructivist Learning Environment Survey, CLES (Section 2.3.8), What Is Happening In this Class?, WIHIC (Section 2.3.9), Technology-Rich Outcomes-Focused Learning Environment Inventory, TROFLEI (Section 2.3.10), and Constructivist-Oriented Learning Environment Survey, COLES (Section 2.3.11). Table 2.1 summarizes various learning environment instruments in terms of the school level surveyed, the number of items, and the classification of each scale according to Moos' (1974) scheme.

2.3.1 Learning Environment Inventory (LEI)

Walberg focused on perceptions as the key aspect of psychology and realized that surveying student perceptions was cost-effective and less time-consuming than classroom observations (Walberg, 1976). Walberg and Anderson (1968) created the LEI as part of research and evaluation activities of Harvard Project Physics. The LEI contains105 statements (15 scales with 7 items in each scale) that describes a typical classroom. The individual conveys a level of agreement or disagreement with each statement on a four-point scale using the responses of Strongly Disagree, Disagree, Agree and Strongly Agree. The scoring direction is reversed for the negatively-phrased statements in the questionnaire. A sample item from the Cohesiveness scale reads "A student has the chance to get to know all other students in the class." A sample item from the Formality scale is "The class has rules to guide its activities."

2.3.2 Classroom Environment Scale (CES)

Developed by Rudolf Moos and Edison Trickett, the CES evolved from a wide-ranging program of research on perceptual measures of a variety of human environments, including psychiatric hospitals, prisons, university residences and work settings (Moos, 1974). The final published version, containing nine scales with 10 items of True–False response format in each scale, includes a test manual, a questionnaire, an answer sheet and a hand scoring key (Moos & Trickett, 1974). A sample item from the Affiliation scale is "Students in this class get to know each other really well." A sample item from the Teacher Support scale is "The teacher takes a personal interest in the students."

2.3.3 Individualized Classroom Environment Questionnaire (ICEQ)

Literature on individualised open and inquiry-based education, extensive interviewing of teachers and secondary school students, and the reactions to draft versions sought from selected experts, teacher and junior high students were the foundations for the initial development of the ICEQ by Rentoul and Fraser (1979). The final published version of the ICEQ contains 50 items in 5 scales (Fraser, 1990; Fraser & Butts, 1982). The ICEQ assesses those dimensions which distinguish individualized classrooms from traditional classrooms. Each item is responded to on a five-point frequency scale with the choices of Almost Never, Seldom, Sometimes, Often and Very Often. The scoring direction is reversed for many of the items. The published version has a copyright arrangement which gives permission to purchasers to make an unlimited number of copies of the questionnaires and response sheets (Fraser, 1990; Fraser & Butts, 1982). A sample item from the Personalization scale is "The teacher takes a personal interest in each student." A sample item from the Independence scale is "Students choose their own partners for group work."

The ICEQ was also validated in studies of students at different grade levels in various countries. In the Netherlands, the ICEQ was used to investigate associations between classroom learning environment and cognitive and attitudinal outcomes with 398 high school students in 9 physics classes (Wierstra, 1984). In Sydney Australia, the ICEQ was validated with 712 students in 30 junior high school classes (Fraser & Butts, 1982) and, in Tasmania, Australia, the ICEQ and CES were combined to study associations between classroom learning environment and student anxiety with 116 eighth and ninth grade students in 116 science classes (Fraser, Nash, & Fisher, 1983).

Table 2.1 Overview of Scales Contained in 11 Classroom Environment Instruments (LEI, CES, ICEQ, CUCEI, MCI, QTI, SLEI, CLES, WIHIC, TROFLEI and COLES)

Instrument	Level	Items per Scale	Scales Classified According to Moos' Scheme		
			Relationship Dimensions	Personal Development Dimensions	System Maintenance and Change Dimensions
Learning Environment Inventory (LEI)	Secondary	7	Cohesiveness Friction Favoritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal Direction Disorganization Democracy
Classroom Environment Scale (CES)	Secondary	10	Involvement Affiliation Teacher Support	Task Orientation Competition	Order and Organization Rule Clarity Teacher Control Innovation
Individualized Classroom Environment Questionnaire (ICEQ)	Secondary	10	Personalization Participation	Independence Investigation	Differentiation
College and University Classroom Environment Inventory (CUCEI)	Higher Education	7	Personalization Involvement Student Cohesiveness Satisfaction	Task Orientation	Innovation Individualization
My Class Inventory (MCI)	Elementary	6–9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
Questionnaire on Teacher Interaction (QTI)	Secondary/ Primary	8–10	Leadership Helpful/Friendly Understanding Student Responsibility and Freedom Uncertain Dissatisfied Admonishing Strict		
Science Laboratory Environment Inventory (SLEI)	Upper Secondary/ Higher Education	7	Student Cohesiveness	Open-Endedness Integration	Rule Clarity Material Environment
Constructivist Learning Environment Survey (CLES)	Secondary	7	Personal Relevance Uncertainty	Critical Voice Shared Control	Student Negotiation
What Is Happening In this Class? (WIHIC)	Secondary	8	Student Cohesiveness Teacher Support Involvement	Investigation Task Orientation Cooperation	Equity
Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)	Secondary	10	Student Cohesiveness Teacher support Involvement Young Adult Ethos	Investigation Task Orientation Cooperation	Equity Differentiation Computer Usage
Constructivist-Oriented Learning Environment Survey (COLES)	Secondary	11	Student Cohesiveness Teacher Support Involvement Young Adult Ethos Personal Relevance	Task Orientation Cooperation	Equity Differentiation Formative Assessment Assessment Criteria

(Fraser, 2012)

In Indonesia, an instrument consisting of nine seven-item scales based upon the ICEQ and CES was translated into the Indonesian language and used in investigating associations between students' outcomes (satisfaction and anxiety) and their perceptions of classroom learning environment with 373 eighth and ninth grade students in 18 social science classes (Fraser, Pearse, & Azmi, 1982). In Brunei Darussalam, classroom learning environment dimensions from the ICEQ were found to be predictors of students' attitudinal outcomes in lower-secondary schools (Asghar & Fraser, 1995).

2.3.4 My Class Inventory (MCI)

The MCI is a modified version of the LEI for use among children aged 8–12 years (Fraser, Anderson, & Walberg, 1982). Modifying the LEI to create the MCI involved: reducing the number of scales to five to reduce fatigue; simplifying wording to enhance readability for younger students; changing the four-point response format to a Yes or No response format; and allowing the student to answer on the questionnaire itself. A sample item from the Cohesiveness scale is "All pupils in my class are close friends." The original 38-item version was then simplified and modified to form a short 25-item version (Fisher & Fraser, 1981; Fraser & O'Brien, 1985). Although the MCI was developed originally for younger students, it also has been found to be very useful with below-reading-level students in the junior high school (Majeed, Fraser, & Aldridge, 2002).

The MCI has been modified to meet the needs of various research studies. The MCI has been modified from the Yes—No format to involve a three-point frequency response format of Seldom, Sometimes and Most of the Time and to include a Task

Orientation scale to use for research in Singapore among primary mathematics students (Goh & Fraser, 1998).

An English-language version of the MCI was used for research in Brunei Darussalam with 1565 lower-secondary mathematics students in 81 classes in 15 government schools. When the MCI's Satisfaction scale was removed and used as an outcome variable, a satisfactory factor structure and sound reliability were established for a refined three-scale version of the MCI assessing Cohesiveness, Difficulty and Competition. These researchers reported sex differences in learning environment perceptions and associations between students' satisfaction and the nature of the classroom environment (Majeed et al., 2002).

In the US, the MCI has been used successfully in Florida in an evaluation of a K–5 mathematics program called SMILE that was found to have a positive impact in that there was congruence between students' actual and preferred classroom environment perceptions (Mink & Fraser, 2005). In Texas, when the MCI was used in an evaluation of science kits among a sample of 588 grade 3–5 students, using science kits was linked with a more positive learning environment in terms of student satisfaction and cohesiveness (Scott Houston, Fraser, & Ledbetter, 2008). In an urban district in Washington state and for a large sample of 2835 grade 4-6 students, researchers found that an 18-item revision of the MCI (assessing cohesiveness, competitiveness, friction and satisfaction) was useful as an accountability tool for elementary school counsellors and was psychometrically sound (Sink & Spencer, 2007).

2.3.5 College and University Classroom Environment Inventory (CUCEI)

The CUCEI was developed by Fraser and Treagust to use in small classes (up to 30 students) sometimes referred to as 'seminars' (Fraser & Treagust, 1986; Fraser, Treagust, & Dennis, 1986). The CUCEI in its final form includes 49 statements (7 scales with 7 items in each). There is a four-point response scale (Strongly Agree; Agree, Disagree, Strongly Disagree) and the scoring direction is reversed for approximately half of the items. A sample item for the Personalization scale is "The instructor goes out of his/her way to help me." A sample item for Student Cohesiveness is "I make friends easily in this class."

The CUCEI has been effectively used in an evaluation of alternative high schools in Australia. More involvement, satisfaction, innovation and individualization was reported in the alternative schools for a sample of 536 students in 45 classes (Fraser, Williamson, & Tobin, 1987).

In Wellington, New Zealand, a modified version of the CUCEI was used in two independent studies of computing classrooms involving 265 students in secondary schools and 239 students at the university level. It was found that psychometric performance of the CUCEI was not completely satisfactory for either sample (Logan, Crump, & Rennie, 2006).

2.3.6 Questionnaire on Teacher Interaction (QTI)

The QTI originated in The Netherlands from research focusing on the nature and quality of interpersonal relationships between teachers and students (Créton, Hermans, & Wubbels, 1990; Wubbels & Brekelmans, 2005; Wubbels, Brekelmans, & Hooymayers, 1991; Wubbels & Levy, 1993). It was developed based on a theoretical model of proximity (cooperation–opposition) and influence (dominance–submission (Wubbels & Brekelmans, 2005). The Questionnaire on Teacher Interaction (QTI, Wubbels, 1993) was developed to assess student perceptions of eight behavior aspects with six items in each scale. Each item has a five-point response scale ranging from Never to Always. A sample item from the Admonishing behavior scale is "She/he gets angry" and from the Student Responsibility/Freedom scale is "She/he gives us a lot of free time."

In the Netherlands, the QTI was first used at the senior high school level. Then successful cross-validation and comparative work was undertaken at various grade levels in the USA (Wubbels & Levy, 1993), Australia (Fisher, Henderson, & Fraser, 1995), and Singapore (Goh & Fraser, 1996) with a more economical 48-item version. Also, the QTI was modified to form the Principal Interaction Questionnaire (PIQ) which assesses teachers' or principals' perceptions of the same eight dimensions of a principal's interaction with teachers (Fisher & Cresswell, 1998).

The QTI has been validated and found to be useful in studies around the world. In Singapore, Quek et al. (2005) validated an English version of the QTI with 497 gifted and non-gifted secondary-school chemistry students and reported some stream (i.e. gifted and non-gifted) and sex differences in QTI scores.

As research on teacher–student interpersonal behavior spread to many countries, the QTI was cross-validated at various grade levels in Korea (Kim, Fisher, & Fraser, 2000; S. S. U. Lee, Fraser, & Fisher, 2003), Singapore (Goh & Fraser, 1996; Quek et al., 2005), Indonesia (Soerjaningsih, Aldridge & Fraser, 2010) and the United Arab Emirates (MacLeod & Fraser, 2010).

In Brunei Darussalam, Khine and Fisher (2002) validated and used the English version of the QTI with 1,188 science students, whereas Scott and Fisher (2004) validated a version of the QTI in Standard Malay with 3,104 upper-primary students in 136 elementary-school classrooms. The later study showed that achievement had a positive relationship with cooperative behaviors and a negative relationship with submissive behaviors (Scott & Fisher, 2004).

2.3.7 Science Laboratory Inventory (SLEI)

The SLEI was developed to assess the unique laboratory setting for science classes at the senior high school or higher-education levels (Fraser, Giddings, & McRobbie, 1995; Fraser & McRobbie, 1995; Fraser, McRobbie, & Giddings, 1993). The SLEI contains 35 statements (5 scales with 7 statements in each scale) and the five frequency response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often. A sample item of Student Cohesiveness is "Members of this laboratory class help me." A sample item of Open-Endedness is "I decide the best way to proceed during laboratory experiments." The Open-Endedness scale was included because of the importance of open-ended laboratory activities often claimed in the literature (Hodson, 1988).

The SLEI was field tested and originally validated simultaneously in six different countries (the USA, Canada, England, Israel, Australia and Nigeria) with a sample of over 5,447 students in 269 classes, and cross-validated in Australia with 1,594 students in 92 classes (Fraser & McRobbie, 1995) and with 489 senior high-school biology students (Fisher et al., 1995).

In Singapore, in a study of 1,592 tenth-grade chemistry students in 56 classes in 28 schools, the English version of the SLEI was cross-validated (Wong & Fraser, 1995). In another Singaporean study of 497 gifted and non-gifted secondary-school chemistry students, the QTI was validated and also some stream (gifted versus non-gifted) and gender differences in QTI scores were reported (Quek et al., 2005). In Korea, a Korean translation of the SLEI was used in a study of differences between the classroom environments for three streams (science-independent, science-oriented and humanities) with 439 high-school science students (Fraser & Lee, 2009). The SLEI's validity and reliability were supported in each of these three studies.

In Miami, USA, the SLEI was used to in a study among 761 high-school biology students (Lightburn & Fraser, 2007) that supported the instrument's factorial validity, internal consistency reliability and ability to differentiate between classrooms. As well, this study supported the positive influence of using anthropometric activities in terms of classroom learning environment and student attitudes.

2.3.8 Constructivist Learning Environment Survey (CLES)

The CLES was designed to help to assess the development of learning environments while implementing classroom practices consistent with a constructivist epistemology (Taylor & Fraser, 1991). The CLES was field tested for validity in Australia with science and mathematics students in a public high school and at an all-girls private high school (P. C. Taylor et al., 1997). Quantitative and qualitative data were gathered and validation analyses substantiated that both results were generally compatible. However, the design of the CLES posed some questions regarding past learning environments and present learning environments as well as confusion with negatively-worded items. Therefore, modifications were made so that each question read "in this science class.....", the use of negatively-worded items was minimized, and questions were organized into blocks according to their individual scales.

The final version of the CLES consists of 30 statements (6 statements each of 5 scales) with a five-point frequency response scales with choices ranging from Almost Always to Almost Never (P. C. Taylor, Fraser, & White, 1994, April). A sample item from the Personal Relevance scale reads "In this class, I learn about the world outside of school."

The CLES has been used in the United States to study science classes focusing on an innovative teacher development program based on the Integrated Science Learning Environment, ISLE model (Nix, Fraser & Ledbetter, 2005). Using data collected from 1079 students in 59 classes in north Texas, principal components factor analysis with varimax rotation and Kaiser normalization confirmed the *a priori* structure of the CLES. The internal consistency reliability, discriminant validity, and the ability to distinguish different classes and groups were also supported.

In Miami, USA, 739 grade K–3 science students were administered a modified version of the CLES in both Spanish and English (Peiro & Fraser, 2009). Through data analyses, the factor structure and internal consistency reliability of the CLES were supported and strong and positive associations were revealed between the nature of the classroom learning environment and students' attitudes.

The CLES was validated in a study aimed at assisting South African teachers in becoming reflective practitioners in their mathematics classroom teaching (Aldridge, Fraser, & Sebela, 2004). This study cross-validated actual and preferred forms of a modified version of the CLES with a sample of 1868 mathematics students in grades 4–6 in South African classrooms.

The CLES was also translated into the Korean language and administered to 1083 science students in 24 classes in 12 school (Kim, Fisher & Fraser, 1999). The original five-factor format was replicated for the Korean-language version of both an actual and preferred form.

The CLES was also translated into Chinese for use in Taiwan (Aldridge, Fraser, Taylor, & Chen, 2000) for a cross-national study, with 1081 Australian science students in 50 classes being administered the original English version and 1879 students in 50 science classes from Taiwan being administered the translated Chinese version. The same five-factor structure emerged for the CLES in the two countries and scale reliabilities were similar.

In Singapore, a modified version of the CLES was used to evaluate the effectiveness of a pedagogical model known as mixed-mode delivery (MMD) model by comparing 2,216 secondary school students taught by preservice teachers in an mixed-mode delivery group and 991 students in a control group (Koh & Fraser, 2013). The findings supported the validity of the CLES and the effectiveness of the mixed-mode delivery model.

2.3.9 What Is Happening In this Class? (WIHIC)

Around the world, the WIHIC instrument currently is the most-commonly used questionnaire for assessing classroom learning environments (Fraser, 2012). This economical measure combines significant scales from a wide range of existing questionnaires with additional scales that accommodate contemporary education concerns of equity and constructivism (Dorman, 2008). The WIHIC originated as a 90-item nine-scale survey but it was refined by statistical analysis of data from 355 junior high school science students, as well as extensive interviewing of students about their views of their classroom environments in general, the wording and salience of individual items and their questionnaire responses (Fraser, Fisher & McRobbie, 1996). This procedure reduced the number of items to only 54 in seven scales, although this set of items was expanded to 80 items in eight scales for the field testing of the second version of the WIHIC with junior high school science classes in Australia and Taiwan. Aldridge, Fraser and Huang (1999) reported that an Australian sample of 1,081 students in 50 classes responded to the original English version, and a Taiwanese sample of 1,879 students in 50 classes responded to a Chinese version that had undergone careful procedures of translation and back translation. This study led to the final form of the WIHIC containing the seven eight-item scales. Additionally, Aldridge and Fraser (2000) reported strong factorial validity and internal consistency reliability and that each scale was capable of differentiating significantly between the perceptions of students in different classrooms for both the Australian and Taiwanese samples.

Dorman's (2003) comprehensive validation of the WIHIC using a using a cross-national sample of 3980 high school students from Australia, the UK and Canada which supported the WIHIC as a valid measure of classroom psychosocial environment with international applicability. Additionally, when a second study was conducted by Dorman (2008) using both the actual and preferred forms of the WIHIC with a sample of 978 secondary-school students from Australia, the WIHIC's validity again was strongly supported.

With the WIHIC being the most commonly-used classroom survey instrument throughout the world, it provides an economical measure of learning environments by combining modified versions of existing scales from a variety of questionnaires with additional scales for contemporary educational issues such as equity and constructivism (Dorman, 2008).

Table 2.2 summarizes details of 28 national and cross-national studies and their unique applications of the WIHIC in various countries and languages. This table indicates whether the WIHIC was used to investigate associations between classroom learning environments and various student outcomes, and identifies which student outcomes were involved. This table summarizes each study in relation to the country, languages of survey, sample sizes, whether factorial validity and reliability were reported, whether associations with student outcomes were reported, and unique contributions. For example, Zandvliet and Fraser (2004, 2005) investigated both physical (ergonomic) and psychosocial environments in their studies. Hanke and Fraser (2012) reported that American students perceived the classroom environment more favorably, but Hong Kong students enjoyed mathematics more. Other examples of two recent studies with unique contributions are a Canadian study in which Fraser and Raaflaub (2013) reported that learning environment perceptions were more positive for females than males and for science than mathematics, and with an American study by B. A. Taylor and Fraser (2013) who reported that mathematics anxiety had two distinct dimensions that yielded different patterns of sex differences and anxiety–environment associations.

The WIHIC has been used at all educational levels and in a variety of classrooms: the elementary level (Allen & Fraser, 2007; Pickett & Fraser, 2009), middle-school level (den Brok, Fisher, Rickards, & Bull, 2006; Ogbuehi & Fraser, 2007), high schools (Chionh & Fraser, 2009; Dorman, 2003), teacher education programs (Martin-Dunlop & Fraser, 2008; Pickett & Fraser, 2009), the tertiary level (Khoo & Fraser, 2008), science classes (Aldridge & Fraser, 2000; Wolf & Fraser, 2008), mathematics classes (Hanke & Fraser, 2013) and technology-rich classes (Khoo & Fraser, 2008; Zandvliet & Fraser, 2004) as listed in Table 2.2.

The use of the WIHIC instrument for various research purposes and in various languages throughout the world include cross-national studies in Australia and Taiwan in two languages (Aldridge & Fraser, 2000), in Australia, the UK and Canada in English (Dorman, 2003), in Australia and Indonesia in two languages (Fraser, Aldridge & Adolphe, 2010), in Australia and Canada (Zandvliet & Fraser, 2005), and in the USA and Hong Kong (Hanke & Fraser, 2013).

Other national studies involving the use of the WIHIC in English have been conducted in Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008; Peer & Fraser, 2015), India (Koul & Fisher, 2005), Australia (Dorman, 2008; Velayutham & Aldridge, 2013), South Africa (Aldridge, Fraser, & Ntuli, 2009) and Canada (Fraser & Raaflaub, 2013).

The WIHIC instrument has been translated into other languages and used to research classroom environments in the Korean language in Korea (Kim et al., 2000), in the Indonesian language in Indonesia (Wahyudi & Treagust, 2004) and in the Arabic language in the United Arab Emirates (Afari, Aldridge, Fraser, & Khine, 2013; MacLeod & Fraser, 2010).

In the USA, numerous research studies used the WIHIC instrument to assess students' learning environments. Studies were conducted in California (den Brok et al., 2006; Martin-Dunlop & Fraser, 2008; Ogbuehi & Fraser, 2007; B. A. Taylor & Fraser, 2013), in New York (Cohn & Fraser, 2013; Wolf & Fraser, 2008), and in Florida (Adamski, Fraser & Peiro, 2013; Allen & Fraser, 2007; Helding & Fraser, 2013; Pickett & Fraser, 2009; Robinson & Fraser, 2013).

These national and international studies reported evidence about factorial validity and internal consistency reliability of the WIHIC and the survey's ability to differentiate between the perceptions of students in different classrooms.

The WIHIC scales have been embedded in specific-purpose questionnaires designed to research unique environments. In South Africa, a classroom learning environment questionnaire was developed and validated in the Sepedi language for monitoring the implementation of outcomes-based classroom environments (Aldridge, Laugksch, Seopa, & Fraser, 2006). The Outcomes-Based Learning Environment Questionnaire (OBLEQ) contains four scales from the WIHIC, one scale each from the ICEQ and CLES, and a new scale (called Responsibility for Own Learning). As well as validating a widely-applicable questionnaire suited for outcomes-based education, the researchers used case studies to support and check the accuracy of profiles of OBLEQ scores for specific classes (Aldridge et al., 2006).

Another learning environments questionnaire was developed in Australia for secondary schools that combined seven scales of the WIHIC and three scales from the CLES to form an instrument that was used to investigate associations between student academic efficacy and classroom environments (Dorman, 2003). This study with a sample of 3980 high school students from Australia, Britain and Canada (Dorman, 2003) revealed that items loaded strongly on their own scale and that the factor structure was invariant for country, grade level and gender. Generally, the study strongly supported the international applicability of the WIHIC as a valid measure of classroom psychosocial environment (Dorman, 2003).

The next two instruments discussed in Section 2.3.10 (Technology-Rich Outcomes-Focused Learning Environment Inventory, TROFLEI) and Section 2.3.11 (Constructivist-Oriented Learning Environment Survey, COLES) were derived from the WIHIC.

2.3.10 Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)

Outcomes-focused education, which has been advocated as a method for school reform in many countries, involves planning, delivery and assessment that all focus on the

Table 2.2 Details of 28 Studies Involving the Use of WIHIC

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial Validity & Reliability	Associations with Environment for:	Unique Contributions
Aldridge, Fraser & Huang (1999); Aldridge & Fraser (2000)	Australia Taiwan	English Mandarin	1081 (Australia) & 1879 (Taiwan) junior high science students in 50 classes	✓	Enjoyment	Mandarin translation Combined quantitative and qualitative methods
Dorman (2003)	Australia UK Canada	English	3980 high school students	✓	NA	Confirmatory factor analysis substantiated invariant structure across countries, grade levels & sexes.
Fraser, Aldridge & Adolphe (2010)	Australia Indonesia	English Bahasa	567 students (Australia) and 594 students (Indonesia) in 18 secondary science classes	✓	Several attitude scales	Differences were found between countries and sexes.
Zandvliet & Fraser (2004, 2005)	Australia Canada	English	1404 students in 81 networked classes	✓	Satisfaction	Involved both physical (ergonomic) and psychosocial environments
Hanke & Fraser (2012)	USA Hong Kong	English Chinese	1309 grade 8 & 9 mathematics students	✓	Attitudes Efficacy	American students perceived the classroom environment more favorably, but Hong Kong students enjoyed mathematics more.
Chionh & Fraser (2009)	Singapore	English	2310 grade 10 geography & mathematics students	✓	Achievement Attitudes Self-esteem	Differences between geography & mathematics classroom environments were smaller than between actual & preferred environments.
Khoo & Fisher (2008)	Singapore	English	250 working adults attending computer education courses	✓	Satisfaction	Adult population Males perceived more trainer support & involvement but less equity.

Table 2.2 (continued)

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial Validity & Reliability	Associations with Environment for:	Unique Contributions
Peer & Fraser (2015)	Singapore	English	1081 primary students in 55 classes	✓	Attitudes	Identified sex, grade-level and stream differences
Koul & Fisher (2005)	India	English	1021 science students in 31 classes	✓	NA	Differences in classroom environment according to cultural background
Dorman (2008)	Australia	English	978 secondary school students	✓	NA	Multitrait–multimethod modelling validated actual and preferred forms
Velayutham & Aldridge (2013)	Australia	English	1360 grades 8–10 students in 5 schools	✓	Motivation Self-regulation	Identified classroom environment features that influence student motivation
Aldridge, Fraser & Ntuli (2009)	South Africa	English	1077 grade 4–7 students	✓	NA	Preservice teachers undertaking a distance-education program used environment assessments to improve teaching practices.
Kim, Fisher & Fraser (2000)	Korea	Korean	543 grade 8 science students in 12 schools	✓	Attitudes	Korean translation Sex differences in WIHIC scores
Wahyudi & Treagust (2004)	Indonesia	Indonesian	1400 lower-secondary science students in 16 schools	✓	NA	Indonesian translation Urban students perceived greater cooperation & less teacher support than suburban students.
MacLeod & Fraser (2010)	UAE	Arabic	763 college students in 82 classes	✓	NA	Arabic translation Students preferred a more positive actual environment

Table 2 .2 (continued)

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial Validity & Reliability	Associations with Environment for:	Unique Contributions
Afari et al. (2013)	UAE	Arabic	352 college students in 33 classes	✓	Enjoyment Academic efficacy	Arabic translation Use of games promoted a positive classroom environment.
Fraser & Raaflaub (2013)	Canada	English	1173 grade 7–12 students in 73 mathematics and science classes	✓	Attitudes	Learning environment perceptions were more positive for females and for science (relative to mathematics).
den Brok et al. (2006)	California, USA	English	665 middle-school science students in 11 schools	✓	NA	Girls perceived the environment more favorably.
Martin-Dunlop & Fraser (2008)	California, USA	English	525 female university science students in 27 classes	✓	Attitude	Very large increases in learning environment scores for an innovative course
Ogbuehi & Fraser (2007)	California, USA	English	661 middle-school mathematics students	✓	Two attitude scales	Used 3 WIHIC & 3 CLES scales Innovative teaching strategies promoted task orientation.
B. A. Taylor and Fraser (2013)	California, USA	English	745 high-school students in 34 mathematics	✓	Attitudes Anxiety	Mathematics anxiety had two distinct dimensions that yielded different patterns of sex differences and anxiety–environment associations.
Wolf & Fraser (2008)	New York, USA	English	1434 middle-school science students in 71 classes	✓	Attitudes Achievement	Inquiry-based laboratory activities promoted cohesiveness & were differentially effective for males and females
Cohn & Fraser (2013)	New York, USA	English	1097 grade 7 & 8 science students in 47 classes	✓	Attitudes Achievement	Use of Student Response Systems was evaluated based on learning environment criteria

Table 2.2 (continued)

Reference(s)	Country(ies)	Language(s)	Sample(s)	Factorial Validity & Reliability	Associations with Environment for:	Unique Contributions
Allen & Fraser (2007)	Florida, USA	English Spanish	120 parents and 520 grade 4 & 5 students	✓	Attitudes Achievement	Involved both parents and students Actual–preferred differences were larger for parents than students
Pickett & Fraser (2009)	Florida, USA	English	573 grade 3–5 students	✓	NA	Monitoring program for beginning teachers was evaluated in terms of changes in learning environment in teachers' school classrooms.
Robinson & Fraser (2013)	Florida, USA	English Spanish	78 parents and 172 kindergarten science students	✓	Achievement Attitudes	Kindergarten level Involved parents Spanish translation Relative to students, parents perceived a more favorable environment but preferred a less favorable environment.
Helding & Fraser (2013)	Florida, USA	English Spanish	924 students in 38 grade 8 & 10 science classes	✓	Attitudes Achievement	Spanish translation Students of NBC teachers had more favorable classroom environment perceptions.
Adamski, Fraser, and Peiro (2013)	Florida, USA	Spanish	223 Hispanic grade 4–6 students	✓	Attitudes Achievement	Spanish translation Involved the subject of Spanish Student outcomes were related to both parental involvement and classroom environment.

Based on an updated version of Fraser (2012, 2014) student's outcomes/results from teaching rather than on a syllabus or curriculum. In Australia, a study was conducted on an innovative new post-secondary school that had an outcomes focus. As part of the formative and summative evaluation of this new school, a new learning environment survey, called the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge & Fraser, 2008), was designed and used.

The validated learning environment questionnaire selected for my study was the TROFLEI, which is an extension of Fraser et al.'s (1996) What Is Happening In this Class? (WIHIC) instrument reviewed in Section 2.3.9. The TROFLEI includes seven scales from the WIHIC and three scales that focus on technology and outcomes in secondary school classrooms. My decision to use the TROFLEI was based on the relevance of its scales for the purposes of my study, as well as its established validity.

The TROFLEI contains 80 items with 8 items in each of 10 scales: Student Cohesiveness (students knowing, helping and supporting each other); Teacher Support (the teacher supporting and being interested in the students); Involvement (students being encouraged to participate in the discussions, asking questions and sharing ideas); Investigation (emphasis on problem solving and inquiry); Task Orientation (the teacher ensuring that students know what needs to be achieved and stay on task); Cooperation (students cooperating rather than competing with each other to complete tasks); Equity (the teacher providing an inclusive environment in which all students are valued); Differentiation (the teacher catering for differences in students' abilities, rates of learning and interests); Computer Usage (extent to which students use computers in various ways for email, accessing the internet, discussion forums, etc.);

and Young Adult Ethos (teachers giving their students responsibility for their own learning).

Table 2.3 provides for each TROFLEI scale both a scale description and a sample item. Items are responded to on a five-point frequency scale with the alternatives of Almost Never, Seldom, Sometimes, Often and Almost Always. This 10-scale instrument "investigates how information and communication technologies can be used effectively to maximize educational outcomes for individual students" (Clayton, 2007, p. 40).

The validation and application of the TROFLEI involved a sample of 2317 students from 166 grade 11 and 12 classes in Western Australia and Tasmania (Aldridge & Fraser, 2008). This study supported the strong factorial validity and internal consistency reliability of both the actual and preferred forms of the TROFLEI, as well as its ability to differentiate between the perceptions of the students in different classrooms. In the same study, when Aldridge and Fraser (2008) used the TROFLEI to investigate some determinants of classroom environment, interesting differences in classroom environment perceptions emerged between males and females and between students enrolled in university-entrance examinations and in wholly school-assessed subjects.

Aldridge, Dorman and Fraser (2004) used multitrait–multimethod modelling with a subsample of 1249 students, of whom 772 were from Western Australia and 477 were from Tasmania. The results supported the TROFLEI's construct validity and sound psychometric properties when the 10 TROFLEI scales were used as traits and the actual and preferred forms of the instrument as methods.

Table 2.3 Scale Description and Sample Item and for Each TROFLEI Scale

Scale Name	Description	Sample Item
Student Cohesiveness	Extent to which students know, help, and are supportive of one another.	Students in this class like me.
Teacher Support	Extent to which the teacher helps, befriends, trusts, and is interested in students.	The teacher is interested in my problems.
Involvement	Extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class.	I explain my ideas to other students.
Investigation	Emphasis on the skills and processes of inquiry and their use in problem solving and investigation.	I find out answers to questions by doing investigations.
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter.	I know the goals for this class.
Cooperation	Extent to which students cooperate, rather than compete, with one another on learning tasks.	I work with other students on projects in this class.
Equity	Extent to which students are treated equally by the teacher.	The teacher gives as much attention to my questions as to other students' questions.
Differentiation	Extent to which the teacher caters for students differently on the basis of ability, rates of learning and interests.	I work at my own speed.
Computer Usage	Extent to which students use their computers as a tool to communicate with others and to access information.	I use the computer to obtain information from the Internet.
Young Adult Ethos	Extent to which teachers give students responsibility and treat them as young adults.	I am expected to think for myself.

Based on Aldridge & Fraser (2008)
All items are scored 1, 2, 3, 4, and 5, respectively, for the responses Almost Never, Seldom, Sometimes, Often, and Almost Always.

The TROFLEI was used to support the efficacy of a school's educational program which promoted outcomes-focused education by evaluating the success of a new school in terms of changes in students' perceptions of their classroom environments over four years (Aldridge & Fraser, 2008).

Use of the TROFLEI also established associations between students' affective outcomes and their classroom environment perceptions in an investigation that involved using structural equation modelling with a sample of 4146 grade 8–13 students (Dorman & Fraser, 2009). Also cluster analysis was used with TROFLEI data for this sample to identify five relatively homogeneous groups of classroom environments which were labelled as exemplary, safe and conservative, non-technological teacher-centered, contested technological, and contested non-technological (Dorman, Aldridge, & Fraser, 2006).

To establish the cross-cultural validity and reliability of the TROFLEI, a study was designed to explore the relationship between the learning environment and students' achievement with approximately 980 students attending grades 9–12 in Turkey and 130 students attending grades 9–12 in the USA (Welch, Cakir, Peterson, & Ray, 2012). The TROFLEI was translated into Turkish, followed by an independent back translation of the Turkish version into English by bilingual colleagues who were not involved in the original translation. Scale reliability analysis and factor analysis for both actual and preferred responses to the TROFLEI were performed for the Turkish and the USA participants independently to confirm the structure of the TROFLEI across these two distinct samples.

In New Zealand, another study using the TROFLEI with a sample of 1027 high-school students from 30 classes cross-validated the TROFLEI in both its actual and preferred forms. Also this study revealed sex and grade-level differences in perceptions, as well as establishing associations between students' attitudes and their classroom environment perceptions (Koul, Fisher & Shaw, 2011).

A slightly modified TROFLEI (nine scales instead of ten scales) was used to study a sample of 705 students in 15 science classes in a technology-supported classroom setting in India (Gupta & Koul, 2007). This study involved the modification and validation of the TROFLEI for assessing students' perceptions of their classroom learning environments in technology-supported secondary science classrooms in an Indian school setting.

2.3.11 Constructivist-Oriented Learning Environment Survey (COLES)

The Constructivist-Orientated Learning Environment Survey (COLES) incorporates numerous WIHIC scales into an instrument that is designed to deliver feedback as a foundation for reflection in teacher action research. Aldridge, Fraser, Bell, and Dorman (2012) were especially aware of the exclusion of important characteristics related to the assessment of student learning in all existing classroom environment questionnaires. COLES incorporates six of the WIHIC's seven scales (namely, Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Cooperation and Equity), while omitting the WIHIC's Investigation scale. Like the TROFLEI, the COLES also includes the scales of Differentiation and Young Adult Ethos. In addition, the COLES includes the Personal Relevance scale from the CLES (the extent to which learning activities are related to the student's everyday out-of-school experiences).

The two new COLES scales related to assessment are Formative Assessment, which is the extent to which students feel that the assessment tasks given to them make a positive contribution to their learning, and Assessment Criteria, which is the extent to which assessment criteria are explicit so that the basis for judgments is clear and public (Aldridge et al., 2012).

Data analysis supported the sound factorial validity and internal consistency reliability of both actual and preferred versions of the COLES for a sample of 243 grade 11 and 12 students from 147 classes in 9 schools in Western Australia. Additionally, both versions were capable of differentiating between the perceptions of students in different classrooms. A significant methodological feature of this study was that the Rasch model was used to convert data collected using a frequency response scale into interval data suitable for parametric analysis. Differences between validity results for Rasch and raw scores (e.g. reliability, discriminant validity and ability to differentiate between classrooms) were negligible (Aldridge et al., 2012).

Aldridge et al. (2012) made use of student feedback from both the actual and preferred versions of the COLES in conjunction with reflective journals, written feedback, discussion at a forum, and teacher interviews. This study reported the experiences of these teachers regarding the practicality of using feedback from the COLES as part of their action research aimed at improving their classroom environments (Aldridge et al., 2012).

2.4 Past Studies of Learning Environments

Over the past half a century, learning environment as a field of research has established the importance of a student's perception of the classroom as a mediating influence on student learning (Stern et al., 1956). A starting point for many reform movements to improve student achievement was to begin by improving the learning environment (Fisher & Khine, 2006, p. v). The field of learning environments has progressed from research on relationships between learning environments and student outcomes and research on the influence of interventions or curriculum reform on learning environments to intervention studies and action research (Fisher & Khine, 2006).

Learning environment studies include identified lines of past research (Fraser, 1998a, 2012). Three main lines of research are focused on below: (1) associations between student outcomes and the environment (Chionh & Fraser, 2009; Fraser et al., 2010; Margianti, Fraser, & Aldridge, 2001; Ogbuehi & Fraser, 2007; Quek et al., 2005); (2) evaluation of educational innovations (Khoo & Fraser, 2008; Mink & Fraser, 2005; Nix et al., 2005; Scott Houston et al., 2008; Spinner & Fraser, 2005); and (3) teachers' use of learning environment perceptions in guiding improvements in classrooms (Aldridge, Fraser, & Sebela, 2004; Yarrow, Millwater, & Fraser, 1997). Past learning environments research in other areas that is less developed, such as differences between student and teacher perceptions (Allen & Fraser, 2007; P. C. Taylor & Maor, 2000); mixed-methodology research (Adamski et al., 2013; Aldridge et al., 1999; Aldridge, Fraser, & Sebela, 2004; Campbell, 2009; Fraser & Tobin, 1998; Spinner & Fraser, 2005); cross-national studies (Aldridge & Fraser, 2000; Dorman, 2003; Fraser et al., 2010; Hanke & Fraser, 2012; Zandvliet & Fraser, 2004); incorporating educational environment ideas into school psychology (Burden & Fraser, 1993, 1994; Fraser, 1987; Sink & Spencer, 2007); links between different educational environments (Aldridge, Fraser, & Laugksch, 2011; Dorman, Fraser, & McRobbie, 1997; Fraser & Kahle, 2007; Fraser & Rentoul, 1982); changes across transitions between levels of schooling (Ferguson & Fraser, 1998); and typologies of classroom environments (den Brok, Telli, Cakiroglu, Taconis, & Tekkaya, 2010; Dorman et al., 2006; Rickards, den Brok, & Fisher, 2005). Discussed in subsections below are the three lines that are relevant to this study.

2.4.1 Past Studies of Outcome–Environment Associations

A major emphasis in past classroom learning environments research has involved investigations of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classroom learning environments (Fraser, 2014; Fraser & Fisher, 1982b; Haertel, Walberg, & Haertel, 1981; McRobbie & Fraser, 1993).

Psychosocial learning environment has been incorporated as one factor in Walberg's (1981) multi-factor psychological model of educational productivity. Walberg's theory holds that learning is a multiplicative, diminishing-returns function of student age, ability and motivation; of quality and quantity of instruction; and of the psychosocial environments of the home, the classroom, the peer group and the mass media. Extensive meta-analyses involving the correlations of learning with the factors in the educational productivity model were reviewed by Fraser, Walberg, Welch, and Hattie (1987). Also secondary analyses were conducted with National Assessment of Educational Achievement data by Walberg, Fraser, and Welch (1986) and National Assessment of Educational Progress data by Fraser, Welch, and Walberg (1986) and Walberg et al. (1986). Classroom and school environment was found to be a strong predictor of both achievement and attitudes even when a comprehensive set of other factors was held constant. Supplementary evidence supporting the connection of educational environments and student outcomes was synthesised by Fraser, Walberg, Welch and Hattie (1987) and reported in numerous other studies (Chionh & Fraser, 2009; Fraser et al., 2010; Margianti et al., 2001; Ogbuehi & Fraser, 2007; Quek et al., 2005).

Student perceptions account for significant variance in learning outcomes as shown in numerous research studies. Fraser (1994) summarized replicated associations between outcome measures and classroom environment perceptions in 40 past studies in science education involving a variety of cognitive and affective outcomes, classroom environment instruments and samples across numerous countries and grade levels.

Associations with cognitive and affective outcomes have been reported using the SLEI for a sample of approximately 80 senior high school chemistry classes in Australia (Fraser & McRobbie, 1995; Fraser et al., 1993), 489 senior high school biology students in Australia (Fisher, Henderson, & Fraser, 1997) and 1,592 grade 10 chemistry students in Singapore (Wong & Fraser, 1996). A study using an instrument for computer-assisted instruction classrooms with a sample of 671 high school geography students in 24 classes in Singapore established associations between classroom environment, achievement and attitudes (Teh & Fraser, 1995). The QTI was used to establish associations between student outcomes and perceived patterns of teacher–student interaction in research in Australia with 489 senior high school biology students (Fisher et al., 1995) and in Singapore with 1512 primary school mathematics students (Goh, Young, & Fraser, 1995). In an investigation of associations between teacher–student interpersonal behaviour and students' attitudes to science researchers for a sample of 7484 grade 9 to 11 students in 278 classes in 55 public schools in 13 major Turkish cities, use of a translated version of the QTI and an attitude questionnaire (Fraser, 1981) revealed that the influence dimension of the QTI was related to student enjoyment and the proximity was associated with attitudes to inquiry (Telli, den Brok, & Cakiroglu, 2010).

In a study using the TROFLEI in Western Australia and Tasmania among 4146 high school students to investigate classroom antecedent variables and student affective outcomes, student outcomes measures were attitude to subject, attitude to computer use and academic efficacy (Dorman & Fraser, 2009). This investigation revealed that "improving classroom environment had the potential to improve student outcomes; antecedents did not have any significant direct effect on outcomes; and academic efficacy mediated the effect of several classroom environment dimensions on attitude to subject and attitude to computer use" (Fraser, 2012, p. 1225).

Cross-national studies involving classroom environments have been used to explore educational practices or cultural beliefs and their impact on improving educational practices or identifying unique cultural trends (Aldridge & Fraser, 2000; Aldridge et al., 1999; Aldridge et al., 2000; Dorman, 2003; Dorman, Adams, & Ferguson, 2003; Fraser et al., 2010). In addition, researchers have investigated the differential perceptions of males and females regarding the classroom environments (Quek et al., 2005; Teh & Fraser, 1995), as well as ethnic differences in classroom environment perceptions (Castillo, Peiro, & Fraser, 2006; Peer & Fraser, 2015).

2.4.2 Evaluation of Educational Innovations

The groundbreaking work of Walberg (1968) in his evaluation of Harvard Project Physics has led to a variety of learning environment studies directed at evaluating educational innovations at all levels of education throughout the world. For example, learning environment questionnaires have been used in past research as a source of process criteria of effectiveness in evaluating educational innovations, including computer-assisted learning (Maor & Fraser, 1996; Teh & Fraser, 1994), computer courses for adults (Khoo & Fraser, 2008) and an innovative science courses for elementary-school teachers (Martin-Dunlop & Fraser, 2008). Other researchers have used learning environment criteria in evaluating educational innovations in science instruction (Nix et al., 2005; Scott Houston et al., 2008) and mathematics instruction (Mink & Fraser, 2005; Spinner & Fraser, 2005).

Fraser (1979) reported that students perceived their classrooms as being more satisfying and individualised and having a better material environment in his evaluation of the Australian Science Education Project (ASEP). The importance of this evaluation is that classroom environment variables differentiated revealingly between curricula, although nonsignificant differences between the ASEP students and the control group were found for various outcome measures.

An evaluation of the use of a computerised database using a classroom environment instrument showed that students' perceptions of their class became more inquiry oriented while using the innovation (Maor & Fraser, 1996). Classroom environment instruments were used to provide dependent variables in evaluations of computer-assisted learning (Teh & Fraser, 1994) and computer application courses for adults (Khoo & Fraser, 2008) in two Singaporean studies.

The CLES was used to evaluate an innovative science teacher development program in terms of types of school classroom environments created by these teachers as perceived by their 445 students in 25 classes (Nix, Fraser, & Ledbetter, 2005). The study revealed that students of teachers who had experienced the professional development perceived their classrooms as having appreciably higher levels of the

CLES scales of Personal Relevance and Uncertainty relative to the comparison classes. In a follow-up study over three semesters involving 17 teacher and 845 students, Nix and Fraser (2010) revealed that using that innovative model in the science teacher education program cultivated a more positive learning environment in their middle-school science classrooms.

An innovative science course for prospective elementary teachers in a large urban university in California was evaluated using learning environment scales selected from the WIHIC and SLEI with 525 females in 27 classes (Martin-Dunlop & Fraser, 2008). Very large differences were found on all scales between students' perceptions of the innovative course and their previous courses.

In Texas, a study used the MCI and qualitative methods to evaluate the effectiveness of science instruction using a textbook, science kits, or a combination of both with a sample of 588 third to fifth-grade students (Scott Houston et al., 2008). The study suggested that using science kits was associated with a more positive learning environment in terms of student Satisfaction and Cohesiveness.

To assess the effectiveness of an innovative mathematics program which enables teachers to use constructivist ideas and approaches, the ICEQ, CLES, attitude scales, and concept map tests were used with fifth-grade students as pretests and posttests over an academic year in Miami-Dade County (Spinner & Fraser, 2005). The students using the program experienced more favorable changes in terms of mathematics concept development, attitudes to mathematics, and perceived classroom environments on several dimensions of the CLES.

In Florida, the MCI has been used successfully with an evaluation of a K–5 mathematics program by showing that there was congruence between students' actual and preferred classroom environment (Mink & Fraser, 2005).

The TROFLEI was used in an evaluation of the success of an innovative new senior high school in Western Australia in promoting outcomes-focused education (Aldridge & Fraser, 2008). For samples of 448 students in 2001, 626 students in 2002, 471 students in 2003 and 372 students in 2004, statistically significant changes in student perceptions of the classroom environment over the four years supported the efficacy of the school's educational programs. Other qualitative information revealed that differences in the degree of change in the learning environments for different learning areas were attributed to teachers' proactivity in using outcomes-focused learning/teaching principles (Aldridge & Fraser, 2008).

Pickett and Fraser (2009) drew on the field of learning environments in their evaluation of a two-year mentoring program in science for beginning elementary-school teachers and defined success in terms of participants' classroom teaching behavior as assessed by their school students' perceptions of their classroom learning environment in the participating teachers' school classroom. Using a modified version of the WIHIC with seven beginning Grade 3–5 teachers in south-eastern U.S. and their 573 elementary school students, data supported the efficacy of the mentoring program in terms of some improvements over time in classroom learning environment, as well as in students' attitudes and achievement (Pickett & Fraser, 2009).

2.5 Technology Integration/Instructional Technology

Section 2.5 is included in this literature review to provide a foundation of integrating technology into the core curriculum which is the educational innovation that was evaluated in my study. This section also reviews past studies that examined the effects of technology integration in order to present a balanced view of the positive and negative impacts of using technology. Later in Section 2.6, the focus is specifically on past research which revealed no significant results in evaluations of using different types of technology in education over several decades.

Technology integration and/or instructional technology mean many things in today's classrooms. According to the Association for Educational Communications and Technology (AECT) Definitions and Terminology Committee, educational technology and instructional technology are interchangeable and involve theories and practices of design, development, utilization, management, and evaluation of processes and resources for learning (Lowenthal & Wilson, 2010). Instructional technology has evolved over time as educators integrated technology into the core curriculum. Integrating technology into classroom instruction is more than providing instruction in basic computer skills and software programs in a separate computer class. Effective technology integration must occur across the curriculum in ways that research shows extend and enrich the instructional process and the use of technology must be routine, transparent and support the core curricular goals. This integration must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts (Green & Hannon, 2007).

Zandvliet's (2006) research emphasizes the need to recognize the role of the computer when infused into the culture ecology of the classroom instead of being isolated from the teacher's knowledge of the curriculum and understanding of learning styles. The teacher understands the aspects of the classroom culture and what can and cannot be digitalized. The intertwining of teacher's pedagogical intent with the utilization of technology tools increases the effectiveness of the classroom environment (Zandvliet, 2006).

According to the National Education Technology Standards for Students (ISTE), effective integration of technology occurs when students are able to utilize technology tools to obtain timely information, analyze and synthesize the information, and present it professionally. The technology should become an integral part of how the classroom functions and be as accessible as all other classroom tools (Malitz, Rogers, & Szuba, 2005). Effective technology integration occurs when educators teach technology and a core curricular class simultaneously while enhancing the teaching and learning process. Technology offers opportunities to enrich educational experiences, expand academic opportunities and develop critical thinking skills for employment (Wilson, 2002). Technology integration can facilitate fundamental, qualitative changes in the nature of teaching and learning (Thompson, Schmidt, & Stewart, 2000). The National School Board Association also comments that boards of education must realize that technology integration is as much about change as it is about technology. Educator ability and attitudes about change are vital to successful technology integration (Malitz et al., 2005).

The Benton Foundation Communications Policy Program (2002) suggests that, for technology integration to support real gains in educational outcomes, the leadership around technology use must be anchored in solid educational objectives and sustained with intensive professional development surrounded by those educational objectives. These leaders must also recognize that real change and lasting results take time (Benton, 2002). Technology integration transforms the delivery of instruction by offering educators effective ways to reach different types of learners and assess student understanding through multiple media. When technology is effectively integrated into core curricular subject areas, teachers develop the roles of adviser, content expert, and coach.

Past research into the effects of technology within educational settings is summarized in several comprehensive meta-analyses of studies. A meta-analysis of 26 studies conducted between 1992 and 2002 that compared students writing with computers with students writing with paper-and-pencil concluded that students using computers were more engaged and motivated in their writing and produced written work of greater length and higher quality (Goldberg, Russell & Cook, 2003). A meta-analysis of 85 independent effect sizes extracted from 46 primary studies involving a total of 36,793 learners indicated statistically significant positive effects for using computer technology in terms of mathematics achievement (Li & Ma, 2010). A meta-analysis of 42 investigations of the effect of computer-assisted instruction on student achievement in science yielded 108 effect sizes and suggested that a typical student moved from the 50th percentile to the 62nd percentile in science when using computer-assisted instruction; however, research on the effectiveness of computer-assisted instruction did not provide consistent results (Bayraktar, 2001). Further, a research synthesis involving 30 research and evaluation studies on the implementation of one-to-one computing initiatives revealed that, although few studies had rigorous designs, still they consistently supported the positive effects of technology use on technology literacy and writing skills (Penuel, 2006).

2.6 The Critics: The No Significant Difference Phenomenon Regarding Educational Technology

Thomas L. Russell (1999), in his book entitled *The No Significant Difference Phenomenon,* discusses a thought-provoking pattern of research findings regarding educational technology usage that started in 1928 and continues todays. When Russell began documenting outcomes associated with integrating technology into classroom instruction, surprisingly, he found few studies that resulted in any measurable positive effect for technology in education. Most effects were inconsistent in direction and small in size. His conclusion was that using educational technology generally resulted in no significant differences (Russell, 1999).

Starting with the introduction of digital technologies in the early part of the 20th century, pioneer inventors imagined a future without textbooks. In 1913, Thomas Edison is quoted as stating: “Books will soon be obsolete in the schools…Our school system will be completely changed in 10 years” (Saettler, 2004, p. 98) when referring to the advent of motion pictures as a new medium for education. Today, 100 years later, textbooks are still commonly used in classrooms.

Beginning with some of the first focused research on correspondence education using media such as loudspeakers (Loder, 1937) and phonographic recordings (Rulon, 1943), neither study showed significant differences. Other studies with instructional radio (Woelfel & Tyler, 1945), sound films (Van der Meer, 1950), instructional television (Kanner, Runyon, & Desiderato, 1954; Seibert & Honig, 1960; Thornton & Brown, 1968), Computer-Aided Instruction (Beard, Lorton, Searle, & Atkinson, 1973; Goldberg, 1997; Judd, Bunderson, & Bessent, 1970; O. M. Lee, 1985), movies (L. L. Atherton, 1971), the Spitz Student Response system (Brown, 1972), audio-conferencing (Holdampf, 1983), electronic blackboard (Partin & Atkins, 1984), video simulations (J. Atherton & Buriak, 1988; Thomas & Hooper, 1991) and interactive video (Cennamo, 1990) all revealed no significant differences. In reviewing the use of educational technology, Thompson, Simonson and Hargrave (Thompson, Simonson, & Hargrave, 1996) stated that, for every study showing educational benefits for a medium, there was another that suggests the opposite.

More recent studies with a new focus for evaluation using quantitative and qualitative educational research methods have been conducted with online software integrated into the classroom (Goldberg, 1997; Klass & Crothers, 2000), exclusive online classes (Hiltz & Wellman, 1997; Horn, 1994; Johnson, 2002; Martin & Rainey, 1993; Mock, 2000), and interactive whiteboards (Moss et al., 2007) also generally revealed no significant differences associated with using educational technology. When the US Department of Education commissioned a study of the effectiveness of reading and mathematics software widely used by primary schools, test scores showed no statistically significant differences between students who used the software and those who did not (Campuzano, Dynarski, Agodini, & Rall, 2009). A university study of students using digital technologies, such as Amazon Kindle, Sony eReader Touch, Apple iPad, entourage eDGe, and CourseSmart, showed no significant differences in learning relative to students using traditional textbooks (Weisberg, 2011).

In the US, two recent studies on student perceptions of the learning environment on technology innovations using an outcomes-focus also showed no significant differences. The first study involved a sample of 322 high-school students in 21 science classes in investigating the effectiveness of virtual laboratories in terms of students' perceptions of the learning environment, attitudes towards science and achievement using the Laboratory Assessment in Genetics (LAG) containing selected scales from the TROFLEI (Aldridge & Fraser, 2008), SLEI (Fraser, Giddings, & McRobbie, 1995), and the TOSRA (Fraser, 1981), as well as some achievement items from previously validated science examinations (Oser, 2013). This study revealed no significant differences between instructional groups for any criteria of effectiveness.

The second study of a sample of 949 students in grades 6–8 in 49 classrooms involved evaluating the effectiveness of the online mathematics software program, FCAT Explorer, in terms of students' perceptions of their learning environment and attitudes towards mathematics in middle-school classrooms in Florida; as well, associations between students' perceptions of technology-supported classroom environments and their attitudes towards mathematics were investigated (Earle, 2014). The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI; Aldridge & Fraser, 2008) and scales selected from the Test of Mathematics Related Attitudes (TOMRA) – a modified form of the Test of Science Related Attitudes (TOSRA; Fraser, 1981a) – were used in a pretest–posttest design while the online program was used as a major curriculum tool over a 10-week period. In addition, a qualitative component involved using student interviews to construct a narrative of a typical day in the classroom and to identify recurring themes. This study also revealed negligible differences.

Section 2.6 is included in my literature review to alert readers that findings of no significant differences associated with the use of educational technology have been common in past research. My results are reported in Chapter 4.

2.7 Summary of Literature Review

This chapter comprehensively reviewed literature about the history of and important research on learning environments, together with establishing my study's framework for assessing students' perceptions of the effectiveness of the integration of instructional technology across the core curriculum in terms of classroom learning environments in Grades 6, 7, and 8 in Texas. This literature review was included to support the validity of the instruments used in past educational research in many different countries and in a diversity of educational settings.

Section 2.2 described the historical background of the learning environment field and provided a definition for the term 'learning environment'. Building on Lewin (1936), and following Walberg and Anderson's pioneering evaluation of Harvard Project Physics program and Moos' scheme of classifying human environment in the USA, the focus of learning environments research shifted to Australia and the Netherlands.

Section 2.3 – Classroom Learning Environments Instruments – highlighted 11 noteworthy questionnaires that have been developed, validated and used in research over the past 40 years: the Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualized Classroom Environment Questionnaire (ICEQ), My Class Inventory (MCI), College and University Classroom Environment Inventory (CUCEI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Inventory (SLEI), Constructivist Learning Environment Survey (CLES), What Is Happening In this Class? (WIHIC), Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) and Constructivist-Oriented Learning Environment Survey (COLES). Special emphasis was given to the development and validity of the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) because it is the survey instrument that was used in my study.

Section 2.4 reviewed past lines of learning environments research, especially outcome–environment associations and the evaluation of innovative educational programs, including innovations in technology use, curricula, and teacher education.

Section 2.5 provided a framework for my study by reviewing literature on technology integration and instructional technology. Section 2.6 entitled The Critics: No Significant Difference Phenomenon Regarding Educational Technology reviews a pattern in past research in which evaluations of the use of educational technology typically have revealed no significant differences. Readers are alerted to nonsignificant differences associated with the use of educational technology in past research.

Through this comprehensive review of the literature, researchers can have a clearer understanding of the areas involved in my research, as well as potential areas for further research. This review provided a better understanding of students' perceptions of learning environments, as well as illustrating the importance of the learning environment instruments, specifically the TROFLEI, which was used in this study.

Chapter 3 presents the research methodology used in my study, including the context, the data sources, the assessment instrument, procedures, and data-analysis methods for evaluating the effectiveness of the integration of instructional technology across the core curriculum in terms of classroom learning environments in Grades 6, 7, and 8 in Texas.

Chapter 3

METHODOLOGY

According to William Blake, “The true method of knowledge is experiment…” (2007, p. 115).

3.1 Introduction to Methodology Chapter

Research methodology is a description of process or procedures of inquiry in a study. It is essential for the validity of the research because it establishes an understanding of the infrastructure of the research and it provides meaning and credibility to the results (G. J. Anderson, 1998). This chapter discusses the research methods of the present study and thereby enhances its credibility.

The purpose of this exploratory study was to investigate whether integrating technology across the core curriculum affects the classroom learning environment perceptions of middle-school students in the Texarkana, Texas. The previous chapters provide insight into the theoretical framework that formed a foundation for this research study. Chapter 1 discussed the background, context and rationale for the present study. Chapter 2 provided a literature review about both the history of classroom learning environments and also the theoretical framework for the study of classroom learning environments.

Chapter 3 describes the research methodology of the present study. The first section defines the research questions. The subsequent sections describe the school where the study took place, the selection and demographics of the sample, the instrument used, the procedures implemented in carrying out the study, techniques used to analyze the data, and limitations of the study. The content of the present chapter is outlined below:

3.2 Study's Research Questions

3.3 Selected School Site

3.3.1 Texas Middle School's Location and Community

3.3.2 Texas Middle School's Student Demographics

3.3.3 Texas Middle School's Core Curriculum Classes

3.4 Selection of Sample

3.5 Instrument

3.6 Data-Collection Procedures

3.7 Methods of Data Analysis

3.7.1 Validation of Instrument

3.7.2 Effectiveness of Integration of Instructional Technology across the Core Curriculum in Terms of Student Perceptions of the Classroom Learning Environment

3.8 Summary of Methods.

3.2 Study's Research Questions

The desire to gain a better understanding of students' perceptions of their classroom learning environment while integrating technology across the core curriculum formed the foundation of this study. Because the expense associated with the purchase and operation of educational technology requires a substantial commitment of resources by educational institutions, there is a clear need to evaluate whether technology really is as effective as various people have claimed. Student questionnaires can provide evidence regarding how its use affects the classroom learning environment. Several instruments for surveying classroom environment exist. After reviewing literature about various questionnaires available, I chose the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser, 2008), which is an extension of Fraser, Fisher and McRobbie's (1996) What Is Happening In this Class? (WIHIC) instrument, was chosen to serve as a measure of classroom climate. Although the TROFLEI had been validated in a few past studies, it was important to establish the validity and reliability of the TROFLEI amongst the Grades 6, 7, and 8 middle-school students in Texas who voluntarily agreed to participate in my study. Consequently, the first research question emerged:

Research Question #1

> *Is the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) valid and reliable when used among middle-school students in Texas?*

After selecting the instrument, data were to be collected to answer the main question of the present study. As previously discussed in the literature review provided in Chapter 2, of the various types of past learning environment research reviewed by Fraser (2012), one of these types focuses on associations between student outcomes and environment. A major emphasis in past classroom learning environments research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classroom learning environments (Fraser, 2014; Fraser & Fisher, 1982a; Haertel, Walberg, & Haertel, 1981; McRobbie & Fraser, 1993). Additionally, learning environment questionnaires have been used in past research as a source of process criteria of effectiveness in evaluating educational innovations. For example, previous evaluations of educational innovations that employed specific learning environments criteria have focused on computer-assisted learning or computer courses for adults (Khoo & Fraser, 2008; Maor & Fraser, 1996; Teh & Fraser, 1994) and an innovative science course for elementary-school teachers (Martin-Dunlop & Fraser, 2008).

In a study using the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge & Fraser, 2008) in Western Australia and Tasmania among 4146 high school students, Dorman and Fraser (2009) investigated classroom antecedent variables and the student affective outcomes of attitude to subject, attitude to computer use, and attitude to academic efficacy. Further investigation revealed that "improving classroom environment had the potential to improve student outcomes; antecedents did not have any significant direct effect on outcomes; and academic efficacy mediated the effect of several classroom environment dimensions on attitude to subject and attitude to computer use" (Fraser, 2012, p. 1225).

Research in the field of learning environments has focused on many topics and, while studies investigating outcome–environment associations are common, few have examined student perceptions of technology in the classroom environment. In order to further research in this area, the decisions was made to investigate if integrating technology across the core curriculum affects the perceptions of the classroom learning environment of middle-school students in Texarkana, Texas. Therefore, the second research question emerged:

Research Question #2

> *Is the integration of instructional technology across the core curriculum effective in terms of students' perceptions of the classroom learning environment?*

3.3 Selected School Site

The present study focused on public middle-school students within the Texarkana Independent School District (TISD) in Texarkana, Texas. According to the Texas Education Agency Academic Excellence Indicator System (AEIS) 2009–2010 Campus Performance Report, a total of 6848 students in grades PreK–12 were enrolled in TISD during the 2009–2010 school year, during the same time when the present study was conducted. The middle school selected for this study, Texas Middle School (TMS), has 1464 students attending in Grades 6–8 (Texas Education Agency, 2010).

The treatment used by the school for integrating technology across the core curriculum involved utilizing technologies to implement curricular design to meet 21st century expectations of student learning during the time between pretest and posttest. Students used technology tools, such as computers, videos, smart devices, interactive whiteboards, and tablets, to interact, create, design, manipulate, communicate, and collaborate for relevant and interactive learning outcomes, presentations, practice, and/or reinforcement. The school-wide technology integration across the curriculum at this school incorporated technology applications such as email, instant messaging, word processing, internet, presentation software, electronic library resources, spreadsheets, course management systems, blogs, graphics, student response systems, video conferencing, and Web 2.0 applications to motivate active participants in real-time, interdisciplinary, multimedia engagement. Teachers were required to utilize these technology applications and tools in weekly lesson plans and grading projects. Students were to be active participants with these technology tools while teachers took on the role of facilitator. Professional development was provided to teachers and administrative observation of planning and instruction was monitored during each grading period.

This section discusses relevant information about Texas Middle School's location and community (Section 3.3.1) and it student demographics (Section 3.3.2), as well as the school's core curriculum classes (Section 3.3.3). Texas Middle School is pictured with two students in Figure 3.1. The information provided in this section is important for establishing the context in which the study took place.

Figure 3.1: Texas Middle School, Texarkana, Texas

3.3.1 Texas Middle School's Location and Community

Texas Middle School is positioned in the Texarkana Independent School District, which is a dynamic urban school district located in the Northeast corner of Texas. The district encompasses an area of 34 square miles and shares a border with the Texarkana Arkansas School District (TASD). The majority of the city of Texarkana, Texas, lies within the TISD boundaries, along with the cities of Wake Village and Nash, Texas. The community is classified by the Texas Education Agency as an 'independent town'. Texarkana ISD has grown to become the largest district in Bowie County and the largest district served by the Region VIII Education Service Center (Texarkana Independent School District, 2014).

At the time of the Census 2010, the population in Texarkana was 36,411, and the racial makeup consisted of 53.1% White non-Hispanic, 36.9% African-American, 0.4% Native American, 1.3% Asian, 6.4% Hispanic, and 1.8% from other races (United States Census Bureau, 2010). Furthermore, the median income for a household in the Texarkana area was $38,821 p.a., the median income for a family was $50,512 p.a., and 16.6% of the Texarkana families were below the poverty line (United States Census Bureau, 2012b). Finally, the Census 2010 revealed that 32.2% of Texarkana residents aged 25 years and older have earned an Associate degree or higher and that 24.3% have completed some college and/or received a high school diploma (United States Census Bureau, 2012a).

3.3.2 Texas Middle School's Student Demographics

Texas Middle School (TMS) had a total student enrollment of 1,464 in 2010. The student membership according to race consisted of 583 White non-Hispanic students, 713 Black non-Hispanic students, 138 Hispanic students, 30 Asian/Indian/Multiracial Students (Texas Education Agency, 2010). Table 3.1 reports the number of students and the percentage ethnic distribution for the entire school and for each grade level.

Table 3.1 Student Enrollment and Ethnic Distribution for Texas Middle School

Grade Level	Number of Students	Ethnicity			
		% White Non-Hispanic	% Black Non-Hispanic	% Hispanic	% Asian/ Indian/ Multiracial
6	488	40.5	47.8	9.7	1.9
7	508	40.2	48.4	8.9	2.4
8	468	38.6	49.8	9.7	1.8
Total	1464	39.8	48.7	9.4	2.0

(Texas Education Agency, 2010)

TMS has 886 students (60.5% of the total campus population) who receive free or reduced-cost meals, which indicates they come from low-income families. Because some of the students at TMS emigrated to the U.S. from foreign countries and speak very little English, they are labeled as Limited English Proficient (LEP) and receive services. TMS has a low number of LEP students (only 2.5% of the population). Lastly, Texas Middle School has 525 students (35.9%) of the student population who are at-risk of dropping out of school before their anticipated graduation date based on those students' previous performance on state-determined criteria. These state-determined criteria consist of any of a variety of indicators such as 1) failure in multiple core courses, 2) retention from year to year, 3) failure in state-mandated assessments, 4) obtaining the status of a parent, homelessness, drop-out, or LEP, 5) disciplinary action resulting in probation, mandatory alternative education placement, or expulsion, or 6) placement in a residential facility or in child-protective or regulatory services (Texas Education Agency, 2010).

3.3.3 Texas Middle School's Core Curriculum Classes

Texas Middle School sets high standards in an attempt to ensure that each student is academically successful and socially developed by offering a wide range of opportunities beyond the regular academic and extra-curricular activities. Students have the opportunity to explore, investigate and pursue their interests and aptitudes through career academies that focus on Arts & Communications, Health Science & Medicine and Science, Technology, Engineering & Mathematics (Texarkana Independent School District, 2014).

Being a public middle school in Texas, Texas Middle School follows the prescribed curriculum mandated by the state of Texas. The district's adopted curriculum is directly aligned with the Texas Essential Knowledge and Skills (TEKS) that mandate what each student living in the state of Texas is expected to master at each grade level. The core curriculum for students in grades 6, 7, and 8 consists of English language arts, mathematics, social studies and science. Table 3.2 provides an overview of the four core curriculum courses required for each student in the state of Texas, together with a brief description and the strands covered (Texas Curriculum Management Program Cooperative, 2014).

3.4 Selection of Sample

The target population, as defined by Gay and Airasian (1996), is the population to which the researcher would ideally like to generalize the findings. In this case, the target population is all Grade 6, 7, and 8 students in Texas Middle School. The population was suitable for study for several reasons. First, it was feasible to select a

Table 3.2 Overview of Core Curriculum Courses Offered at Texas Middle School

Course & Grade Level	Overview
English Grades 6-8	**Strands:** Reading; Writing; Research; Listening and Speaking; Oral and Written Conventions **Description:** The English Language Arts and Reading Texas Essential Knowledge and Skills (TEKS) are organized into the following strands: Reading, where students read and understand a wide variety of literary and informational texts; Writing, where students compose a variety of written texts with a clear controlling idea, coherent organization, and sufficient detail; Research, where students are expected to know how to locate a range of relevant sources and evaluate, synthesize, and present ideas and information; Listening and Speaking, where students listen and respond to the ideas of others while contributing their own ideas in conversations and in groups; and Oral and Written Conventions, where students learn how to use the oral and written conventions of the English language in speaking and writing. The standards are cumulative--students will continue to address earlier standards as needed while they attend to standards for their grade. In each grade, students will engage in activities that build on their prior knowledge and skills in order to strengthen their reading, writing, and oral language skills. Students should read and write on a daily basis. To meet Texas Education Code, §28.002(h), which states, "... each school district shall foster the continuation of the tradition of teaching United States and Texas history and the free enterprise system in regular subject matter and in reading courses and in the adoption of textbooks," students will be provided oral and written narratives as well as other informational texts that can help them become thoughtful, active citizens who appreciate basic democratic values of our state and nation.
Mathematics Grades 6-8	**Strands:** Mathematical Process Standards; Numbers and Operations; Proportionality; Expressions, Equations and Relationships; Measurement and Data; Personal Financial Literacy; Two Dimensional Shapes **Description:** The desire to achieve educational excellence is the driving force behind the Texas essential knowledge and skills for mathematics, guided by the college and career readiness standards. By embedding statistics, probability, and finance, while focusing on computational thinking, mathematical fluency, and solid understanding, Texas will lead the way in mathematics education and prepare all Texas students for the challenges they will face in the 21st century. The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful l problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, algorithms, paper and pencil, and technology and techniques such as mental math, estimation, number sense, and generalization and abstraction to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, computer programs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

Continued on the next page

Table 3.2 Overview of Core Curriculum Courses Offered at Texas Middle School Continued

Course & Grade Level	Overview
Social Studies Grades 6-8	**Strands:** History; Geography; Economics; Government; Citizenship; Culture; Science, Technology, Society; Social Studies Skills **Description:** Throughout social studies in Kindergarten-Grade 12, students build a foundation in history; geography; economics; government; citizenship; culture; science, technology, and society; and social studies skills. The content, as appropriate for the grade level or course, enables students to understand the importance of patriotism, function in a free enterprise society, and appreciate the basic democratic values of our state and nation as referenced in the Texas Education Code (TEC), §28.002(h). The eight strands of the essential knowledge and skills for social studies are intended to be integrated for instructional purposes. Skills listed in the social studies skills strand in subsection (b) of this section should be incorporated into the teaching of all essential knowledge and skills for social studies. A greater depth of understanding of complex content material can be attained when integrated social studies content from the various disciplines and critical-thinking skills are taught together. Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples. To support the teaching of the essential knowledge and skills, the use of a variety of rich primary and secondary source material such as biographies, autobiographies, novels, speeches, letters, diaries, poetry, songs, and images is encouraged. Motivating resources are available from museums, historical sites, presidential libraries, and local and state preservation societies. Students identify the role of the U.S. free enterprise system within the parameters of this course and understand that this system may also be referenced as capitalism or the free market system. Students understand that a constitutional republic is a representative form of government whose representatives derive their authority from the consent of the governed, serve for an established tenure, and are sworn to uphold the constitution. Students identify and discuss how the actions of U.S. citizens and the local, state, and federal governments have either met or failed to meet the ideals espoused in the founding documents.
Science Grades 6-8	**Strands:** Scientific Investigation & Reasoning; Matter and Energy; Force, Motion and Energy; Earth and Space; Organism and Environments **Description:** Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable. Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple, independent researchers. Students should know that scientific theories, unlike hypotheses, are well-established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information. Grades 6-8 science is interdisciplinary in nature; however, much of the content focus is on earth and space science. National standards in science are organized as multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale.

(Texas Curriculum Management Program Cooperative, 2014) large enough sample from this target population to allow generalizability of the study's findings. Second, access to these students was easily obtained because of my employment in this district and permission being granted by the superintendent. Third, as discussed in Chapter 1, the goal of the school to utilize technologies to implement curricular design to meet 21st century expectations for student learning established a need for a measurement tool to assess the learning environment.

As shown in Table 3.1, the middle school where permission was granted to conduct the study has a total enrollment of 1,464 students in Grades 6, 7 and 8. Although using only one school to collect data was a limitation in the study, it is important to acknowledge that the school is large (N=1,464 students in Grades 6, 7 and 8).

Because of the limitations of collecting data in only one school, it was not possible to select the students at random. Thus, a study permission letter was sent to the parents of all 1,464 students. Of that total, 1396 (95%) students obtained parental permission, were willing to volunteer, and completed a part of the study. Although the participants were not chosen at random, the high number of participants, namely, 1396, helped to make the sample relatively typical of the school.

The students' survey responses were reviewed to make sure that all questionnaire items had been completed, which resulted in a decreased sample size when only students who had provided both pretest and posttest data were included. The final sample was comprised of 966 students with complete pretest data and 860 students with complete posttest data in Grades 6, 7, and 8 core curriculum classes. The students were of diverse backgrounds and economic status. Because a longitudinal study with a pre–post design and the same sample group was employed to evaluate the integration of technology at the middle-school level in terms of changes in the learning environment, only those students who had provided complete pretest data and complete posttest data were included in analyses. Therefore, the final sample was smaller (*N*=605 students in Grades 6, 7 and 8) as shown in Figure 3.2.

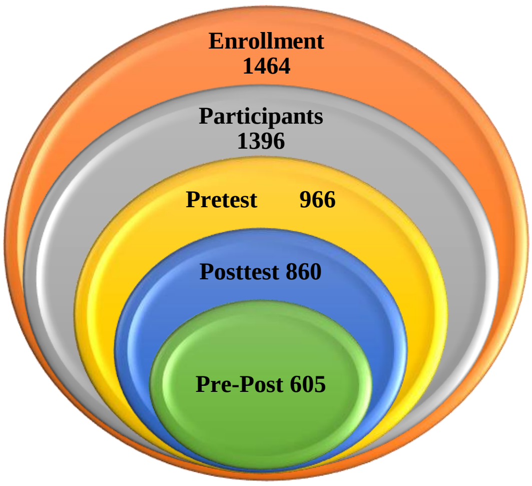

Figure 3.2: Sample of Middle-School Students in Grades 6, 7 & 8

Above, descriptive information is provided about the study sample and the school from which the sample was drawn so that others can determine the applicability of the findings of this study to other situations.

3.5 Instrument

The research question in this study of the effectiveness of integration of technology across the curriculum in terms of the classroom environment was answered by administering a validated instrument to obtain quantitative data. The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser, 2008), which is an extension of Fraser, Fisher and

McRobbie's (1996) What Is Happening In this Class? (WIHIC) instrument, was used in this study. The TROFLEI includes seven scales of WIHIC and three scales that focus on technology and outcomes of secondary school classrooms. The TROFLEI contains 80 items with 8 items in each of 10 scales: Student Cohesiveness (students knowing, helping and supporting each other); Teacher Support (the teacher supporting and being interested in the students); Involvement (students being encouraged to participate in the discussions, ask questions and share ideas); Task Orientation (the teacher ensuring that students' know what needs to be achieved and stay on task); Investigation (emphasis on problem solving and inquiry); Cooperation (students cooperating rather than competing with each other to complete tasks); Equity (the teacher providing an inclusive environment in which all students are valued); Differentiation (the teacher catering for differences in students' abilities, rates of learning and interests); Computer Usage (extent to which students use computers in various ways for email, accessing the internet, discussion forums, etc.); and Young Adult Ethos (teachers giving their students responsibility for their own learning). Items are responded to using a five-point frequency scale with the alternatives of Almost Never, Seldom, Sometimes, Often and Almost Always. Appendix A provides a copy of the TROFLEI which was administered in a pre–post design, and a review of literature on the TROFLEI was provided in Section 2.3.10.

Moos' (1974) scheme for classifying aspects of human environments include the three basic dimensions of *relationship dimensions* (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other), *personal development dimensions* (which assess basic directions along which personal growth and self-enhancement tend to occur), and *system maintenance and system change dimensions* (which involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change). Moos' scheme can be used to classify the 10 dimensions of the TROFLEI with the four scales of Student Cohesiveness, Teacher Support, Cooperation and Equity in the *relationship dimensions*, the three scales of Involvement, Investigation, and Young Adult Ethos in *personal development dimensions*, and the three scales of Task Orientation, Differentiation and Computer Usage in *system maintenance and system change*.

The TROFLEI uses only items with a positive scoring direction because research has revealed improved response accuracy and internal consistency reliability when negative items are avoided (Chamberlain & Cummings, 1984; Schriesheim, Eisenbach, & Hill, 1991; Schriesheim & Hill, 1981). To promote contextual cues and minimize confusion, the items of the same scale are grouped together in blocks (Aldridge, Fraser, Taylor, & Chen, 2000). The TROFLEI scales are sequenced so that more familiar issues (such as Student Cohesiveness) are placed before less familiar issues (such as Involvement).

Integrating technology into the core curriculum takes an outcomes focus by providing teachers with the means to manage the focus of individual student achievement required while emphasizing students' diverse educational needs and individual differences in backgrounds, interests and learning styles (Aldridge, Fraser, & Fisher, 2003). By using an instrument that assesses the perceptions of the student, one is provided with the practical benefit of allowing reflection upon, discussion of the systemic attempts to improve classroom environments (Fraser, 2002).

3.6 Data-Collection Procedures

Quantitative data were collected by administering the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) to a sample of 1,464 students in Grades 6, 7 and 8 in Texarkana, Texas, via an electronic survey through an individualized secure district database. Section 3.4 provided detailed information about the sample used for my study.

To ensure that the respondents' answers remained anonymous, all instruments were administered electronically through an individualized database that is monitored and kept secure by the Texarkana Independent School District's information technology department. The format and layout of the questions were the same as the paper version that had been validated in previous studies discussed in Chapter 2's literature review (Section 2.3.10).

To ensure consistency in the data-collection process, a short video with the instructions and directions for responding to the instrument was shown to all students before they volunteered to complete the instrument. All students could access instructions an unlimited number of times to ensure understanding. Students were given the same instructions during both the pretest administration of the survey in October and again during the posttest administration of the survey in May. The students were allowed the opportunity to complete the survey whenever it was convenient for them within a two-week time period and time was also provided during their technology class period. The instructions specified that the students' opinions were valued and would be used for school improvement; they also directed students to take their time and complete the survey at their convenience. The video of instructions also informed students that the teacher would provide clarification or reading assistance if needed.

Once the survey period had ended, student access to the survey was disabled in the database. I then assigned to each student an electronic identification number for tracking data and questionnaire responses were organized in an Excel spreadsheet which included each student's grade level, gender and ethnicity. The possible responses for the instrument were Almost Never, Seldom, Sometimes, Often, and Almost Always. Each item was coded with a numerical value from 1 to 5 with Almost Never being scored 1 and Almost Always being scored 5. Once the data were collected, a variety of analyses were conducted to check the validity and reliability of the TROFLEI before analyzing the data to answer my main research question.

3.7 Methods of Data Analysis

This study was designed to meet two main objectives: to validate the instrument used for data collection through statistical analyses (e.g. factor analysis) (Section 3.7.1); and to evaluate the effectiveness of the integration of instructional technology across the core curriculum in terms of changes in students' perceptions of the classroom learning environment using multivariate analysis or variance and effect sizes (Section 3.7.2).

3.7.1 Validation of Instrument

Quantitative data were collected with the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge, Fraser & Dorman, 2004;

Aldridge & Fraser, 2008) among students in core curriculum classes in Grades 6, 7, and 8. As discussed in Section 3.5, this instrument includes ten scales. Section 3.6 provided detailed information about the data collection in this study. The first research question is listed below:

Research Question #1

> *Is the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) valid and reliable when used among middle-school students in Texas?*

Instrument validity refers to the degree to which it measures the outcome, thus answering the questions of "does this instrument reflect reality?" and "are the data dependable?" The data from a valid instrument are meaningful and enable researchers to draw sound conclusions from the sample (Creswell, 2002). A commonly-used method of checking an instrument's internal structure is factor analysis, which allows researchers to condense a large set of variables to a more manageable set of 'common' factors using mathematical models. The degree to which data from an instrument are stable and consistent in measuring constructs is the reliability of an instrument. Validity and reliability give researchers confidence in the results obtained from the instrument. Comparing an instrument's results for one sample's factor analysis with other samples' factor analysis results increases the credibility of findings based on data obtained from the instrument.

To validate the TROFLEI for use among middle-school students in Texas, quantitative data from the sample of 6^{th}, 7^{th} and 8^{th} grade students were analyzed using principal axis factor analysis (to examine whether each scale assesses a unique construct) with varimax rotation and Kaiser normalization. This statistical analysis was conducted by using the IBM SPSS Statistics (2010) computer program. Factor analysis was conducted separately for the TROFLEI for the 966 students who completed the survey as a pretest and for the 860 students who completed the survey as a posttest. Varimax rotation with Kaiser normalization is a statistical technique used to identify probable factors by maximizing the variance and then isolating the factors for identification; hence, it yields information about the internal structure of an instrument. Factor loadings for individual items, which are the correlation coefficients between the variables (items) and factors, were calculated to determine whether the majority of items measured one and only one of the scales (Hanke, 2014). The criteria for an item to be retained were that it must have a factor loading of at least 0.30 on its own scale and less than 0.30 on all other scales. Additionally, calculations were performed to measure the amount of variation in scores attributed to each factor and to determine each individual scale's proportional contribution to the collective variance of all scales using the eigenvalues and the total percentage of variance for each scale.

Scale reliability indicates a scale's ability to be free from random error. The internal consistency reliability (a measure of the extent to which its items contribute to the same underlying construct) of each scale in the TROFLEI was assessed using Cronbach's alpha coefficient, which is one of the most common indicators of internal consistency. Cronbach's alpha coefficient provides an indication of the average correlation among all of the items that make up the scale (Pallant, 2007). Its value ranges from 1 to 0, with higher values indicating greater reliability.

The factor analysis, validity and reliability results are reported in Chapter 4, Section 4.2.

3.7.2 Effectiveness of Integration of Instructional Technology across the Core Curriculum in Terms of Student Perceptions of the Classroom Learning Environment

Section 3.5 provided detailed information about this longitudinal study with a pre–post design whose aim was to evaluate the integration of technology at the middle-school level in terms of changes in the learning environment. The sample included only those 605 students who had provided complete pretest data and complete posttest data for analysis. The second research question is listed below:

Research Question #2

> *Is the integration of instructional technology across the core curriculum effective in terms of students' perceptions of the classroom learning environment?*

Descriptive statistics were used to summarize the results using the average item mean (scale mean divided by the number of items in that scale) and average item standard deviation for each learning environment scale. The average item mean was used to enable comparisons of scores from scales with different numbers of items. Mean values range from 1 (almost never) to 5 (almost always) and indicate the frequency with which students perceive that a practice occurs in the classroom.

To evaluate the impact of integrating technology, the statistical significance of differences between the pretest and posttest scores was investigated using MANOVA with repeated measures with the ten TROFLEI scales as dependent variables. If the multivariate test using Wilks' lamda criterion reveals statistically significant differences for the whole set of dependent variables, the univariate ANOVA is interpreted separately for each learning environment scale.

Also, the effect size was used to provide evidence about the magnitude of the pre–post difference for each TROFLEI scale expressed in standard deviation units. The effect size is computed by dividing the difference between pretest and posttest means by the pooled standard deviation. Effect sizes can be interpreted as small (≤ 0.2 standard deviations), medium (0.5), or large (≥0.8) (Cohen, 1988).

The means, standard deviations, MANOVA/ANOVA results, and effect sizes are reported in Chapter 4, Section 4.3 entitled Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scales.

3.8 Summary of Methods

This chapter presented the research methods used in my study, including the context, data sources, instrument, procedures, and data-analysis methods for assessing the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of classroom learning environments in Grades 6, 7, and 8 in Texas.

In Section 3.2, the study's research questions were identified as validating the TROFLEI among middle-school students in Texas and evaluating the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment. In Section 3.3, I described the school district, its location and community (Section 3.3.1), the school demographics (Section 3.3.2) and the school's core curriculum courses (Section 3.3.3) in order to provide background, clarification and understanding of the study. The sample was described in Section 3.4 as consisting of those 605 students who had provided complete pretest responses and complete posttest responses in Grades 6, 7, and 8. By describing the sample, others might be able to determine the applicability of the findings of this study to other situations. Section 3.5 described the TROFLEI instrument used to assess the effectiveness of integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment. The data-collection procedures were clarified in Section 3.6.

Lastly, Section 3.7 described the methods of data analysis used to answer my study's two objectives. Data derived from the TROFLEI were subjected to factor analysis and reliability analysis to determine the validity and reliability of the questionnaire when used with middle-school students in Texas. Additionally, both descriptive statistics (in terms of the average item mean and average item standard deviation) and inferential statistics (in terms of analysis of variance) were used to determine the effectiveness of the integration of instructional technology across the core curriculum in terms of changes in students' perceptions of the classroom learning environment. To provide evidence about the magnitude of differences between pretest and posttest for each TROFLEI scale, effect sizes were calculated to express differences in standard deviation units.

The following chapter reports the results from each statistical analysis to answer the research questions investigated in my study.

Chapter 4

ANALYSES AND RESULTS

According to Mary Leakey, “Theories come and go, but fundamental data always remain the same” (cited in Massel, 2012, p. 35).

4.1 Introduction of Analyses and Results

In this study, I evaluated the effectiveness of integrating technology across the core curriculum in terms of students’ perceptions of the classroom learning environment. As discussed in Chapter 3, the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) was administered to a sample of students (966 for pretesting and 860 for posttesting), who were in Grades 6, 7, and 8 core curriculum classes at Texas Middle school in Texarkana, Texas. A longitudinal study with a pre–post design was employed to evaluate the integration of technology at the middle-school level in terms of changes in the learning environment.

The previous chapters provided insight into the theoretical framework that formed a foundation for this research study by discussing the background, context and rationale for the present study (Chapter 1), providing a literature review about the history of classroom learning environments including instruments used and previous studies (Chapter 2), and the research methods used in my study (Chapter 3). The present chapter reports analyses and results for the validity and reliability of the TROFLEI and an evaluation of technology integration in terms of pre–post changes in TROFLEI scales.

The first section of this chapter focuses on the validity and reliability for the TROFLEI scales by providing the results of principal axis factor analysis and reporting internal consistency reliability. The subsequent section reports the results of my evaluation of technology integration in terms of pre–post differences in TROFLEI scale scores. The content of the present chapter is outlined below:

4.2 Validity and Reliability of TROFLEI Scales

4.2.1 Validity of TROFLEI Scales

4.2.2 Internal Consistency Reliability

4.2.3 Comparison with Past Research

4.3 Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scales

4.4 Summary of Analyses and Results.

4.2 Validity and Reliability of the TROFLEI Scales

To answer the first research question of this study (*Is the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) valid and reliable when used among middle-school students in Texas?*), quantitative data from the sample of the 966 students who completed the survey as a pretest and for the 860 students who completed the survey as a posttest in Grades 6, 7 and 8 in the core curriculum classes were subjected to principal axis factor analysis with varimax rotation and Kaiser normalization. Factor analysis was conducted separately for the 966 students who completed the TROFLEI pretest administration and for the 860 students who completed the TROFLEI posttest administration. This technique has the ability to identify factors by maximizing the variance and then isolating the factors for easy identification.

Eigenvalues and the total percentage of variance from the factor analyses also were used to determine factor strength. In addition, internal consistency reliability was measured using Cronbach's alpha coefficient.

4.2.1 Validity of TROFLEI Scales

Table 4.1 shows the factor analysis results for the 80 items in the TROFLEI with 8 items in each of 10 scales: Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Investigation, Cooperation, Equity, Differentiation, Computer Usage and Young Adult Ethos. Data collected from 966 students for the pretest and 860 students for the posttest were analyzed separately with multiple methods to investigate the validity of the TROFLEI scales. Principal axis factor analyses with varimax rotation and Kaiser normalization confirmed that the majority of items belonged to one and only one of the ten scales. The two criteria for the retention of any item were that it must have a factor loading of at least 0.30 on its own scale and less than 0.30 on all other scales. The a priori ten-scale structure of the questionnaire was replicated in that all items had factor loadings of at least 0.30 on their own scale and less than 0.30 on all other scales, as shown in Table 4.1. The application of those criteria led to the deletion of only four items (namely, Items 6, 21, 57, 61) to improve the factorial validity. The four items that had factor loadings of less than 0.30 were omitted from the questionnaire for all subsequent analyses. These items were #6 (“I help other class members who are having trouble with their work.”) in Student Cohesiveness, #21 (“I ask the teacher questions.”) in Involvement, and #57 (“I work at my own speed.”) with #61 ("I am given work that suits my ability.") in Differentiation.

Table 4.1 Factor Analysis Results for the TROFLEI for Pretest and Posttest Administrations

Scale	Item No	Student Cohesiveness		Teacher Support		Involvement		Task Orientation		Investigation		Cooperation		Equity		Differentiation		Computer Use		Young Adult Ethos	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Student Cohesiveness	1	0.64	0.73																		
	2	0.47	0.56																		
	3	0.39	0.46																		
	4	0.65	0.71																		
	5	0.41	0.55																		
	7	0.65	0.65																		
	8	0.37	0.46																		
Teacher Support	9			0.59	0.57																
	10			0.68	0.62																
	11			0.66	0.66																
	12			0.59	0.52																
	13			0.58	0.63																
	14			0.69	0.65																
	15			0.55	0.64																
	16			0.51	0.55																
Involvement	17					0.64	0.60														
	18					0.66	0.64														
	19					0.45	0.31														
	20					0.63	0.49														
	22					0.58	0.36														
	23					0.47	0.44														
	24					0.49	0.38														
Task Orientation	25							0.57	0.68												
	26							0.60	0.66												
	27							0.65	0.69												
	28							0.65	0.67												
	29							0.62	0.71												
	30							0.61	0.67												
	31							0.64	0.73												
	32							0.55	0.63												
Investigation	33									0.58	0.68										
	34									0.61	0.66										
	35									0.71	0.73										
	36									0.58	0.62										
	37									0.68	0.71										
	38									0.69	0.73										
	39									0.64	0.73										
	40									0.57	0.62										
Cooperation	41											0.45	0.46								
	42											0.46	0.52								
	43											0.46	0.53								
	44											0.56	0.65								
	45											0.57	0.53								
	46											0.58	0.60								
	47											0.53	0.54								
	48											0.50	0.57								

Continued

Scale	Item No	Student Cohesiveness		Teacher Support		Involvement		Task Orientation		Investigation		Cooperation		Equity		Differentiation		Computer Usage		Young Adult Ethos	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Equity	49													0.59	0.54						
	50													0.61	0.58						
	51													0.64	0.66						
	52													0.66	0.66						
	53													0.67	0.67						
	54													0.65	0.66						
	55													0.61	0.57						
	56													0.61	0.61						
Differentiation	58															0.37	0.46				
	59															0.47	0.59				
	60															0.59	0.66				
	62															0.67	0.69				
	63															0.62	0.62				
	64															0.63	0.74				
Computer Usage	65																	0.53	0.42		
	66																	0.62	0.59		
	67																	0.65	0.61		
	68																	0.61	0.60		
	69																	0.66	0.71		
	70																	0.69	0.71		
	71																	0.53	0.58		
	72																	0.40	0.38		
Young Adult Ethos	73																			0.66	0.58
	74																			0.66	0.62
	75																			0.64	0.64
	76																			0.56	0.55
	77																			0.65	0.59
	78																			0.63	0.58
	79																			0.67	0.64
	80																			0.58	0.55
% Variance		1.68	1.87	3.08	4.92	2.31	1.36	6.87	38.04	3.83	6.47	2.04	1.61	4.44	3.60	1.86	2.14	2.62	1.73	28.47	3.06
Eigenvalue		1.35	1.49	2.46	3.94	1.84	1.09	5.49	30.43	2.71	5.17	1.63	1.28	3.55	2.88	1.48	1.71	2.09	1.38	22.78	2.45

N: Pre= 966, Post=860
Factor loadings less than 0.30 have been omitted from the table.
Principal axis factoring with varimax rotation and Kaiser normalization.
Item 6, 21, 57 and 61 were removed from this analysis.

Table 4.1 indicates that the optimal factor solution occurred for the set of 76 items. The percentage of variance for the different scales ranged from 1.68% for Student Cohesiveness to 28.47% for Young Adult Ethos for the pretest and from 1.36% for Involvement to 38.04% for Task Orientation for the posttest, with a total variance of 57.20% for the pretest and 64.80% for the posttest for all scales. Scale eigenvalues ranged from 1.35 to 22.78 for the pretest and from 1.09 to 30.43 for the posttest. Results from the factor analysis strongly supported the factorial validity of the scales from the TROFLEI for this study's sample of students.

4.2.2 Internal Consistency Reliability

As discussed in Section 3.7.1, internal consistency reliability, which is a measure of whether or not there is agreement of responses to similar items, is most commonly measured by Cronbach's alpha coefficient. In my study, the alpha coefficient was used as an index of the internal consistency reliability for the TROFLEI scales after the factor analyses led to the removal of Items 6, 21, 57 and 61. In terms of internal consistency reliability, Table 4.2 shows that Cronbach's alpha coefficient was high (≥0.79) for all TROFLEI scales, thus supporting the strong internal consistency of all scales for both pre- and post-administrations. Scales with a Cronbach alpha coefficient greater than 0.60 can be considered to have adequate internal consistency reliability (De Vellis, 1991). Using the individual as the unit of analysis, the reliability coefficients ranged from 0.79 (Differentiation) to 0.91 (Investigation and Equity) for the pre-administration and from 0.87 (Differentiation and Student Cohesiveness) to 0.94 (Investigation) for post-administration. Figure 4.1 displays alpha reliability coefficients for pretest and posttest for each TROFLEI scale. Alpha coefficients support the strong internal consistency reliability of all scales for my sample.

Table 4.2 Mean, Standard Deviation and Internal Consistency Reliability (Cronbach Alpha Coefficient) for each TROFLEI Scale

Scale	No of Items	Mean		SD		Alpha Reliability	
		Pre	Post	Pre	Post	Pre	Post
Student Cohesiveness	7	4.02	4.03	0.71	0.81	0.81	0.87
Teacher Support	8	3.65	3.56	0.89	0.98	0.89	0.92
Involvement	7	3.17	3.44	0.96	0.96	0.87	0.90
Task Orientation	8	4.31	4.22	0.71	0.84	0.88	0.93
Investigation	8	3.36	3.51	0.95	1.02	0.91	0.94
Cooperation	8	3.83	3.87	0.85	0.93	0.89	0.92
Equity	8	4.06	3.91	0.89	0.96	0.91	0.93
Differentiation	6	3.24	3.40	0.93	1.03	0.79	0.87
Computer Usage	8	3.12	3.35	0.97	1.01	0.86	0.88
Young Adult Ethos	8	4.09	4.03	0.84	0.90	0.89	0.91

N: Pre =966 students, Post= 860 students

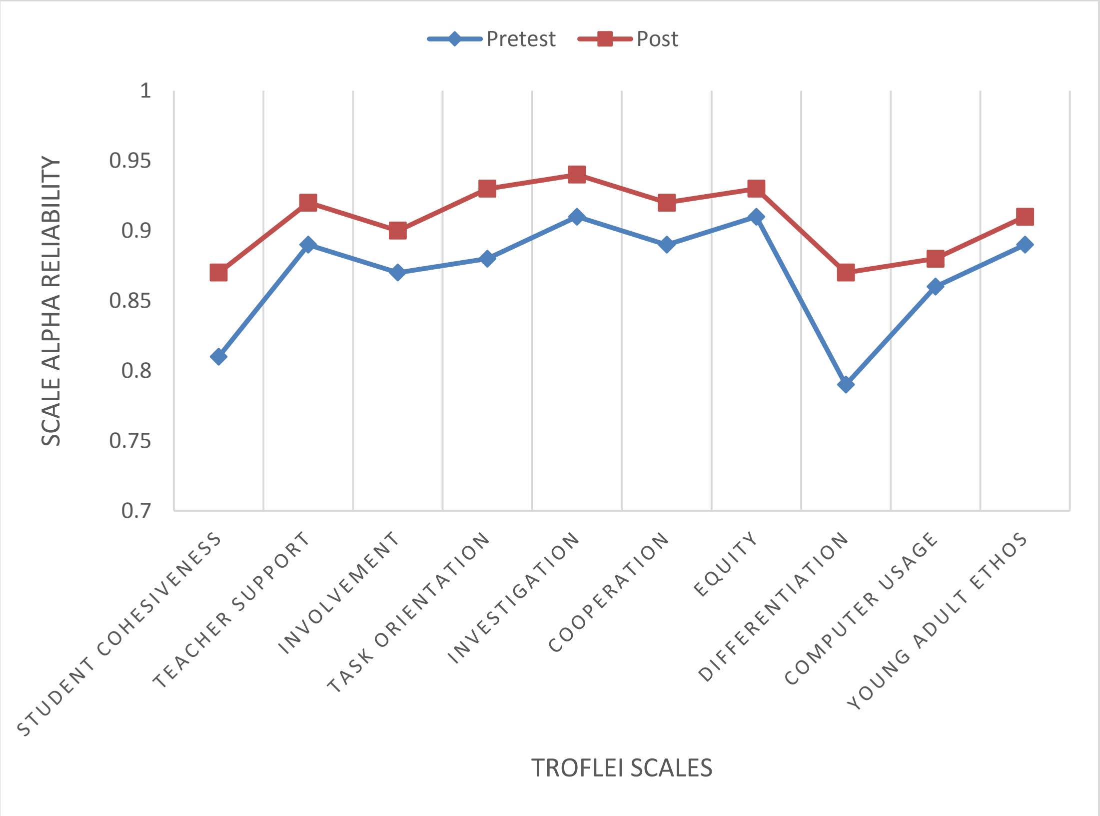

Figure 4.1: Scale Alpha Reliability for Pretest and Posttest for Each TROFLEI Scale

In comparison with other studies using the TROFLEI, Table 4.3 contrasts the internal consistency reliability (Cronbach alpha coefficient) for each TROFLEI scale in this study with past research. Section 4.2.3 discusses Table 4.3 in more detail.

All of the scales in the TROFLEI for both pretest and posttest administrations exhibited satisfactory factorial validity and internal consistency reliability.

4.2.3 Comparison with Past Research

This study replicates past research which supported the validity and reliability of the TROFLEI. When Dorman and Fraser (2009) used the TROFLEI with 4146 students in Australian secondary schools, analyses indicated good model fit to the data and confirmed the 10-scale structure of the TROFLEI. That study was one of the few reported attempts to employ confirmatory factor analysis, instead of the traditional exploratory factor analysis, to establish factor structure when validating a learning environments instrument. Evidence suggested that the TROFLRI was a structurally-sound instrument for use by researchers and teachers in classrooms that emphasize the use of technology and an outcomes focus. Confirmatory factor analysis indicated that loadings for the 80 paths from observed variables to the 10 TROFLEI scales that ranged from 0.39 to 0.92 (M = 0.80, SD = 0.11). For the paths between the 10 TROFLEI scale latent variables and the TROFLEI latent variable, loadings ranged from 0.21 to 0.76 (M =0.62, SD = 0.20). Reliability coefficients confirmed that all scales had very satisfactory internal consistency, with indices ranging from 0.82 for Differentiation to 0.95 for Equity, and that reliability coefficients compared favorably with those reported in previous learning environment research (Dorman, Adams & Ferguson, 2002; Koul & Fisher 2005).

Table 4.3 Internal Consistency Reliability (Cronbach Alpha Coefficient) for each TROFLEI Scale in Various Past Studies

Scale	Current Study			Aldridge, Dorman & Fraser (2004)			Gupta & Koul (2007)			Aldridge & Fraser (2008)			Dorman & Fraser (2009)		Koul, Fisher & Shaw (2011)			Welch, Cakir, Peterson & Ray (2012)					Earle (2014)		
	N	Alpha Reliability		N	Alpha Reliability		N	Alpha Reliability		N	Alpha Reliability		N	Alpha Reliability	N	Alpha Reliability		N	Alpha Reliability				N	Alpha Reliability	
		Pre	Post		Act.	Pref.		Act.	Pref.		Act.	Pref.		Act.		Act.	Pref.		Act. Turk	Pref. Turk	Act. USA	Pref. USA		Pre	Post
Student Cohesiveness	7	0.81	0.87	8	0.88	0.90	8	0.67	0.76	8	0.87	0.90	8	0.89	8	0.81	0.91	8	0.82	0.85	0.82	0.85	4	0.80	0.86
Teacher Support	8	0.89	0.92	8	0.92	0.92	8	0.79	0.75	8	0.92	0.92	8	0.93	8	0.91	0.91	8	0.92	0.93	0.92	0.90	7	0.90	0.90
Involvement	7	0.87	0.90	8	0.89	0.92	8	0.80	0.82	8	0.90	0.92	8	0.91	8	0.86	0.87	8	0.87	0.89	0.86	0.90	3	0.81	0.84
Task Orientation	8	0.88	0.93	8	0.93	0.95	8	0.78	0.83	8	0.88	0.94	8	0.89	8	0.88	0.92	8	0.87	0.91	0.91	0.94	8	0.91	0.92
Investigation	8	0.91	0.94	8	0.88	0.94	8	0.82	0.84	8	0.92	0.95	8	0.94	8	0.90	0.95	8	0.86	0.92	0.82	0.81	8	0.86	0.90
Cooperation	8	0.89	0.92	8	0.91	0.94	8	0.82	0.82	8	0.91	0.93	8	0.92	8	0.88	0.91	8	0.89	0.91	0.87	0.88	8	0.87	0.87
Equity	8	0.91	0.93	8	0.94	0.95	8	0.85	0.84	8	0.94	0.95	8	0.95	8	0.93	0.95	8	0.92	0.93	0.90	0.89	8	0.91	0.93
Differentiation	6	0.79	0.87	8	0.77	0.84	8	0.68	0.70	8	0.85	0.86	8	0.82	8	0.75	0.86	8	0.81	0.84	0.78	0.81	5	0.76	0.83
Computer Usage	8	0.86	0.88	8	0.88	0.90	-	-	-	8	0.88	0.90	8	0.88	8	0.84	0.88	8	0.84	0.88	0.86	0.90	7	0.84	0.89
Young Adult Ethos	8	0.89	0.91	8	0.94	0.94	-	-	-	8	0.93	0.94	8	0.94	8	0.90	0.92	8	0.89	0.90	0.91	0.89	8	0.86	0.90

Another study by Aldridge, Dorman and Fraser (2004) used multitrait–multimethod modelling with a subsample of 1249 students, of whom 772 were from Western Australia and 477 were from Tasmania. All scales of the actual and preferred forms of the TROFLEI had good internal consistency reliability, with Cronbach coefficient alpha values ranging from 0.77 for the actual form of the Differentiation scale to 0.95 for the preferred form of the Task Orientation and Equity scales. Discriminant validity (using the mean correlation of a scale with the remaining nine scales as an index) ranged from 0.16 for the actual form of the Computer Usage scale to 0.47 for the preferred form of the Cooperation scale. Using the actual and preferred forms of the TROFLEI, a principal components analysis with varimax rotation yielded 10 factors for both the actual and preferred forms of the TROFLEI. These factors accounted for 62.8% and 69.3% of variance in scores, respectively, for the actual and preferred forms. All items had loadings of at least 0.41 with the factor corresponding to their *a priori* scale and below 0.35 with other factors.

Another study using a large sample of 2317 students from 166 grade 11 and 12 classes from Western Australia and Tasmania reported strong factorial validity and internal consistency reliability for both the actual and preferred forms of the TROFLEI (Aldridge & Fraser, 2008). As well, the actual form of each scale was capable of differentiating between the perceptions of students in different classrooms. In that study, except for three items, items had a factor loading of at least 0.40 on their *a priori* scale and no other scale for both the actual and preferred versions. For the actual version, the percentage of variance varied from 3.75% to 6.99% for different scales, with the total variance accounted for being 58.03%. For the preferred version, the percentage of variance ranged from 4.03% to 7.96% for difference scales, with the total variance accounted for being 64.97%. The internal consistency reliability for the refined 77-item version of the TROFLEI was established using Cronbach alpha reliability coefficient for two units of analysis, with scale reliability ranging from 0.85 to 0.94 for the actual form and from 0.86 to 0.95 for the preferred from. These internal consistency indices are comparable to those in past studies that have used the WIHIC (Aldridge & Fraser, 2000; Chionh & Fraser, 2009; Wolf & Fraser, 2008).

A slightly-modified version of the TROFLEI (nine scales instead of ten scales) was used with a sample of 705 students in 15 technology-supported classrooms in India (Gupta & Koul, 2007). The results were analyzed to determine the reliability and validity of the TROFLEI questionnaire for use in Indian settings. When the Cronbach alpha reliability coefficient was used as an index of scale internal consistency, reliability estimates for the different scales of the TROFLEI using the individual student as the unit of analysis ranged from 0.67 for the Student Cohesiveness scale to 0.85 for the Equity scale for the actual form and from 0.70 for the Differentiation scale to 0.86 for the Technology Teaching (an added scale in this modified version of the TROFLEI) scale for the preferred form. These indices of reliability are comparable to those in past studies that have used the WIHIC (Aldridge & Fraser, 2000; Chionh & Fraser, 2009) and the TROFLEI (Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser, 2008; Kerr et al., 2006). In order to further validate the modified TROFLEI questionnaire in the Indian setting, factor analysis was carried out using the data collected. Principal components factor analysis followed by varimax rotation confirmed a refined structure for the actual and preferred forms of the TROFLEI comprising 72 items in nine scales. Nearly all of the 72 items had a loading of at least 0.35 on their *a priori* scale for the actual version. Four scales did not load at 0.35 or above on their own or any other scale; therefore, they were omitted. The cumulative percentage variance extracted for all factors was 44.18%. The overall loadings confirmed the factor structure of the TROFLEI. The results are similar to the previous cross-validations with the TROFLEI in Australia (Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser 2008).

The above validity and internal consistency reliability results are consistent with another study using scales from the TROFLEI in both Turkey with approximately 980 students and in the USA with 130 students in grades 9–12 (Welch, Cakir, Peterson, & Ray, 2012). Scale reliability analyses and confirmatory factor analysis (CFA) were performed separately for Turkish and US participants for both actual and preferred responses to each scale to confirm the structure of the TROFLEI across two distinct samples. Cronbach's alpha reliability coefficients ranged from 0.82 to 0.93 for Turkish participants and from 0.78 to 0.94 for US participants. Confirmatory factor analyses supported adequate model fit across both samples for both actual and preferred response, with the root mean square of approximation ranging from 0.052 to 0.057 and the comparative fit index ranging from 0.920 to 0.982. These results supported sound validity and internal consistency when the TROFLEI was used with both Turkish and US students in grades 9–12.

In another study in New Zealand, Koul, Fisher and Shaw (2011) used the TROFLEI with a sample of 1027 high-school students from 30 classes. Principal components factor analysis followed by varimax rotation confirmed a refined structure of the actual and preferred forms of the instrument that consisted of all 80 items with a loading of at least 0.30 on their priori scales. Cronbach's alpha reliability coefficients, using the student as the unit of analysis, ranged from 0.75 to 0.93 for the actual form and from 0.82 to 0.95 for the preferred from. Generally reliability estimates were even higher with the class mean as the unit of analysis. As well as cross-validating the TROFLEI for assessing students' perceptions of their classroom learning environments in technology-rich, outcomes-focused settings, this study revealed sex and grade-level differences in perceptions, as well as associations between students' attitudes and their classroom environment perceptions.

A study in the USA used the TROFLEI with a sample of 949 students in grades 6–8 in 49 classrooms to evaluate the effectiveness of online mathematics software (Earle, 2014). The alpha reliability coefficient for the 10 different TROFLEI scales with the individual unit of analysis ranged from 0.76 to 0.97 for the pretest and from 0.83 to 0.93 for the posttest. With the class mean unit of analysis, alpha coefficients ranged from 0.83 to 0.97 for the pretest and from 0.90 to 0.97 for the posttest. These values indicate a high degree of internal consistency reliability. Principal axis factoring with varimax rotation and Kaiser normalization, and applying the criteria for retention that an item must have a factor loading of at least 0.40 on its own scale and less than 0.40 on each of the other nine TROFLEI scales, led to the removal of 14 items, leaving the 66 items. The proportion of variance accounted for ranged from 2.18% to 7.36% for pretest responses to different TROFLEI scales, with the total variance accounted for by all 10 pretest scales being 50.94%. For the posttest, the percentage of variance accounted for by different scales ranged from 1.39% to 8.03%, with the total variance being 57.14%. Eigenvalues for different TROFLEI scales ranged from 1.44 to 5.30 for the pretest and from 2.10 to 4.86 for the posttest. This study provided additional validation data for the Technology-Rich Outcomes-Focused Learning Environment

Inventory (TROFLEI) and provided the largest sample size to date for research using the TROFLEI in the United States.

Table 4.3 contrasts the internal reliability (Cronbach alpha coefficient) for each TROFLEI scale in this study with results from the past research discussed in this section. In every study listed, the scale of Differentiation had the lowest or almost lowest alpha reliability, which is consistent with my finding of a reliability of 0.79 for the pretest and 0.87 for the posttest for Differentiation. Additionally, most of the studies show the scale of Equity as having the highest or one of the highest alpha reliabilities with a mean of 0.92, which is comparable to my study's values of 0.91 for the pretest and 0.93 for the posttest. The study in USA with a sample of 949 students in grades 6–8 in 49 classrooms (Earle, 2014) reported very similar alpha reliability values as in my study. Overall, the various studies listed in Table 4.3 reported reliability coefficients for TROFLEI scales that were quite similar to those found in my study.

4.3 Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scales

To answer the second research question of this study (*Is the integration of instructional technology across the core curriculum effective in terms of students' perceptions of the classroom learning environment?),* descriptive statistics, inferential statistics and effect sizes were used. Only students completing both pretests and posttests (N=605) were used to investigate pre–post changes in TROFLEI scores.

Descriptive statistics, including the average item mean and average item standard deviation for both the pre- and post-administrations, are provided in Table 4.4 for each scale. Figure 4.2 graphically compares the average item mean (scale mean divided by the number of items in that scale) for the pre- and post-administration of the TROFLEI scales. The average item mean ranged from 3.15 to 4.38 for the pretest and from 3.36 to 4.29 for the posttest. The results indicate a pattern of very small differences between the pre- and post-administration in TROFLEI scales as well as inconsistency in the direction of changes for different scales.

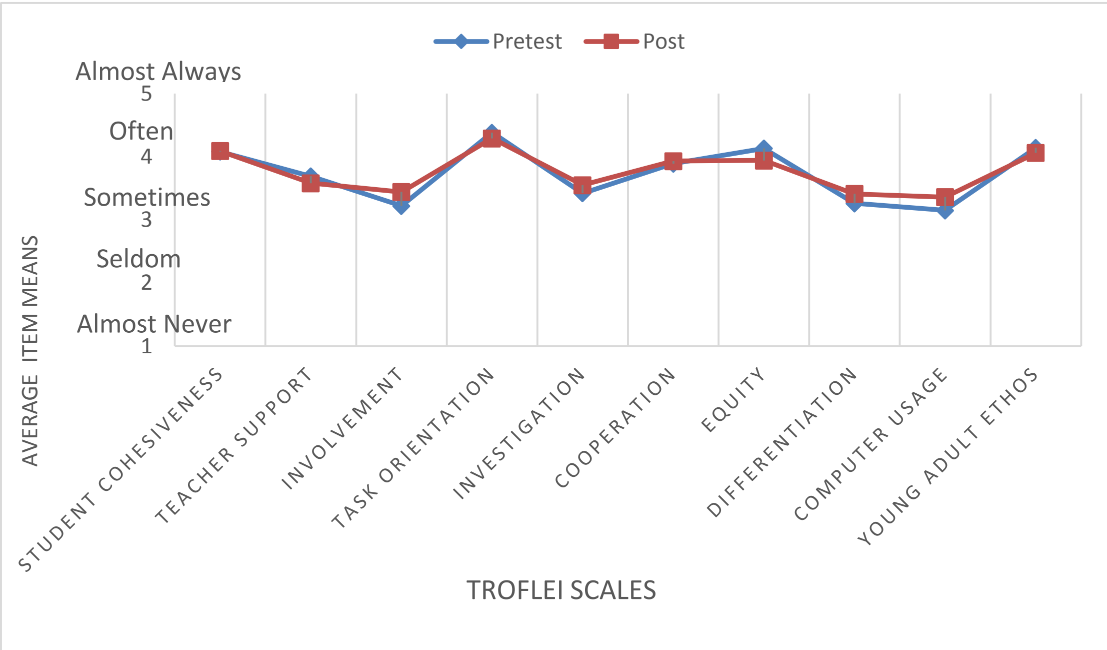

Figure 4.2: Average Item Mean for Pretest and Posttest for Each TROFLEI Scale

Inferential statistics involving one-way multivariate analysis of variance (MANOVA), using the individual student as the unit of analysis, were used to investigate the statistical significance of differences between the pretest and posttest for each TROFLEI scale. Because the multivariate test yielded statistically significant differences for the whole set of dependent variables using Wilks' lamda criterion, the univariate ANOVA result was interpreted separately for each TROFLEI scale. The ANOVA results recorded in the (*F*) column of Table 4.4 indicate that differences between students' scores for the pretest and posttest were statistically significant ($p<0.05$) for 8 of the 10 learning environment scales. Over the time when instructional technology was being integrated across the core curriculum, students perceived significantly more in the scales of Involvement, Investigation, Differentiation and Computer Usage, but significantly less Teacher Support, Task Orientation, Equity and Young Adult Ethos.

This analysis of pre–post differences provides insights into the specific areas in which students' perceptions of the classroom environment changed significantly but slightly over the seven-month period during which instructional technology was being integrated into the core curriculum classes. A review of some of the items included in these scales offers credibility to the reasonableness of the statistically significant results. Scales for which there was a significant increase in scores between pretest and posttest included items such as "Students discuss with me how to go about solving problems" (Involvement), "I carry out investigations to answer questions that puzzle me" (Investigation), "I work at my own speed" (Differentiation), and "I use the computer to type my assignments" (Computer Usage). Sample items from the scales for which there was a significant decrease in scores between pretest and posttest include "The teacher helps me when I have trouble with my work" (Teacher Support), "I know how much work I have to do" (Task Orientation), "I am treated the same as other students in this class" (Equity) and "I am given responsibility" (Young Adult Ethos). Nevertheless, despite the statistical significance of the pre–post differences for some scales, it is important also to consider the effect sizes or magnitudes of any differences, which are listed in Table 4.4 and discussed below.

Table 4.4 MANOVA/ANOVA Results for Pre–Post Differences in TROFLEI Scale Scores

Scale	Mean		SD		*F*	Effect Size *d*
	Pre	Post	Pre	Post		
Student Cohesiveness	4.08	4.09	0.71	0.78	0.49	0.02
Teacher Support	3.69	3.58	0.88	0.98	2.75**	-0.12
Involvement	3.22	3.44	0.96	1.01	4.95***	0.22
Task Orientation	4.38	4.29	0.68	0.76	2.64**	-0.12
Investigation	3.42	3.55	0.95	1.02	2.74**	0.13
Cooperation	3.89	3.93	0.84	0.90	0.92	0.05
Equity	4.13	3.94	0.87	0.95	4.54***	-0.21
Differentiation	3.26	3.41	0.92	1.03	3.20**	0.15
Computer Usage	3.15	3.36	0.98	1.00	4.44***	0.21
Young Adult Ethos	4.14	4.06	0.82	0.87	1.95*	-0.09

* $p<0.05$, **$p<0.01$, ***$p<0.001$, $N= 605$ students
(Only students completing pretest and posttests were used for these analyses.)
The effect size is computed by dividing the difference between the means of the two groups by the pooled standard deviation. Effect size can be interpreted as small (≤0.2), medium (0.5) or large (≥0.8) (Cohen, 1988).

The effect size for each scale is shown to portray the magnitude of pre–post differences. The effect size is computed by dividing the difference between the means of the two groups by the pooled standard deviation. Effect sizes can be interpreted as small (≤0.2), medium (0.5) or large (≥0.8) (Cohen, 1988). Table 4.4 indicates that effect size (*d*) range in magnitude from 0.02 to 0.22 standard deviations, and therefore can be interpreted as small (≤0.2) (Cohen, 1988) for all of the ten scales.

Overall scores on six scales (Student Cohesiveness, Involvement, Investigation, Cooperation, Differentiation and Computer Usage) increased while scores on four scales (Teacher Support, Task Orientation, Equity and Young Adult Ethos) decreased between pretest and posttest. With the integration of technology into the core curriculum classes, one would anticipate that scores on Involvement and Computer Usage would increase slightly between pretest and posttest. The decrease in Teacher Support could be attributed to an increase in the students' technical abilities and the time allowed/required for technology usage and teacher interaction.

Overall, integrating instructional technology into the core curriculum was neither advantageous nor disadvantageous in terms of classroom learning environment. These mixed results, which are inconsistent in direction and small in size, seem consistent with the 'no significant difference phenomenon' (Russell, 1999) associated with integrating technology into classroom instruction as discussed in Chapter 2, Section 2.6. During the last century, research on various technological educational innovations – including loudspeakers, phonographic recordings, instructional radio/television, interactive whiteboards, e-reader/tablet devices, video simulations, and other computer-assisted content delivery software programs – has revealed no significant differences. Chapter 5 discusses my study further and its consistency with this pattern of results suggesting that the integration of technology alone might not improve education in terms of classroom learning environments.

4.4 Summary of Analyses and Results

This chapter reported analyses and results for the two research questions of the present study:

1) Is the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) valid and reliable when used among middle-school students in Texas?

2) Is the integration of instructional technology across the core curriculum effective in terms of students' perceptions of the classroom learning environment?

Quantitative data were collected from a sample of 966 students for the pretest and 860 students for the posttest in Grades 6, 7, and 8 core curriculum classes at Texas Middle School in Texarkana, Texas, USA. Data were derived from the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI).

Section 4.2 provided the results of factor analysis for the TROFLEI (Section 4.2.1) and internal consistency reliability (Section 4.2.2). To validate the TROFLEI, data were analyzed using principal axis factor analysis (to examine whether each scale assesses a unique construct) with varimax rotation and Kaiser normalization. Factor analysis was conducted separately for the TROFLEI for the pre- and post-administrations. Applying two criteria for retention of any item (that it must have a factor loading of at least 0.30 on its own scale and less than 0.30 on each of the other nine TROFLEI scales) led to the removal of four items, leaving 76 items. The proportion of variance accounted for ranged from 1.68% to 28.47% for pretest responses to different TROFLEI scales, with the total variance accounted for by all 10 pretest scales being 57.20%. For the posttest, the percentage of variance accounted for by different scales ranged from 1.36% to 38.04%, with the total variance being 64.80%. Table 4.1 showed the factor analysis results for 76 items of the TROFLEI.

The internal consistency reliability (a measure of the extent to which items contribute to the same underlying construct) of each scale in the TROFLEI was assessed using Cronbach's alpha coefficient. Table 4.2 shows the internal consistency reliability for the TROFLEI. Cronbach's alpha coefficient, used as an index of the internal consistency reliability, was high (≥0.79) for all TROFLEI scales, which supported the strong internal consistency of all scales in both the pre- and post-administrations.

The results of the factor analyses and internal consistency reliability provided strong evidence supporting the validity and reliability. Section 4.2.3 provide a comparison of the validity and reliability results in my study to those in past research using the TROFLEI. Overall the results reported in Tables 4.1–4.3 support the factorial validity and internal consistency reliability of the TROFLEI. These results with my sample of 966 students who completed the survey as a pretest and for the 860 students who completed the survey as a posttest in Grades 6, 7, and 8 in core curriculum classes in Texas replicate the findings of the limited number of prior validation studies with the TROFLEI reviewed in Section 2.3.10. These previous validations involved samples of 1249 Australian students (Aldridge, Dorman & Fraser, 2004), 2137 Australian students (Aldridge & Fraser, 2008), 4146 Australian students (Dorman & Fraser, 2009), 1027 students in New Zealand (Koul, Fisher & Shaw, 2011), 980 students in Turkey and 130 students in the USA (Welch, Cakir, Peterson & Ray, 2012), 705 students in India (Gupta & Koul, 2007) and 949 students in Florida, USA (Earle, 2014).

To evaluate the impact of integrating technology, in Section 4.3 – Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scales – the statistical significance of differences between the pre and post scores were investigated using MANOVA with the ten TROFLEI scales. Statistically significant differences were found for eight of the ten TROFLEI scales. Furthermore, the effect size (Cohen, 1988) was used to provide evidence for the magnitude of the pre–post difference for each TROFLEI scale expressed in standard deviation units. For the scales for which pre–post differences were statistically significant, effect sizes ranged from only 0.09 to 0.22 standard deviations, which are all small according to Cohen (1988). Also, the direction of the pre–post changes was inconsistent across scales.

Generally, the findings point to neither an advantage nor a disadvantage for integrating instructional technology into the core curriculum in terms of classroom learning environment. These results seem consistent with the ‘no significant difference phenomenon’ (Russell, 1999) which is discussed further in Chapter 5 in relation to this study’s contribution to that pattern of results.

The following chapter summarizes the thesis and conclusions of this study by discussing the educational significance of the contributions made by this study, the implications of the research, the limitations of the study and suggestions for future research.

Chapter 5

DISCUSSIONS AND CONCLUSIONS

According to Albert Szent-Gyorgyi, "Research is to see what everybody else has seen, and to think what nobody else has thought" (Harper & Yesilada, 2008. p. xvii).

5.1 Introduction to Discussions and Conclusions

Digital technologies such as computers, video games, digital music players, video cams, cell phones and other digital tools are incorporated in the students' daily lives (Green & Hannon, 2007; Prensky, 2005). Technology facilitates student learning styles (Oblinger & Oblinger, 2005) and provides new forms of communication for reinforcing learning (Saltman, 2011). The classroom environment could be enhanced with a combination of the teacher's pedagogical intent and the utilization of technology tools (Zandvliet, 2006). As our society becomes increasingly technological, research suggests that students, too, benefit from technology-rich learning environments (Aldridge & Fraser, 2008).

This study was first conceptualized based upon the researcher's anecdotal observation that the elementary students within the same school district appeared more engaged seemed to have greater retention and understanding with increased task completion in technology-integrated classrooms. Therefore, the researcher was motivated to test this initial observation methodically to determine if technology integration was indeed effective in improving students' perceptions of the classroom.

Because the aim of the current study was to evaluate the effectiveness of integrating technology across the curriculum in the core classes among middle-school students in Texas in terms of students' perceptions of their classroom environment, the field of learning environments was the foundation for the current study.

Previous chapters included the rationale for this study in Chapter 1, a literature review that provided the context for this study in Chapter 2, the research methods used to implement the study in Chapter 3, and the results for answering the research questions that guided this study in Chapter 4.

This chapter begins with a summary of the thesis and the research questions which guided the present study in Section 5.2. A discussion of the major findings from the data analyses are provided in Section 5.3, while Section 5.4 identifies the limitations and constraints of this study. Recommendations for future research follow in Section 5.5. Section 5.6 draws together the contributions of my study, including its significance and implications. Finally, concluding remarks are provided in Section 5.7. The content of this chapter is outlined below:

5.2 Summary of Chapters 1–3 of Thesis

5.3 Major Findings of the Study

- 5.3.1 Validity and Reliability of TROFLEI
- 5.3.2 Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scale Scores

5.4 Limitations and Constraints

5.5 Recommendations for Future Research

5.6 Implications, Significance and Contributions

5.7 Concluding Remarks.

5.2 Summary of Chapters 1–3 of Thesis

The purpose of this exploratory study was to investigate whether integrating technology across the core curriculum affects the classroom learning environment perceptions of middle-school students in the Texarkana, Texas. My specific research objectives were:

1. To validate the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) among middle-school students in Texas
2. To evaluate the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment.

Chapter 1 provided an introduction and overview of the thesis. The background, purposes and research questions for the present study were identified in this initial chapter. The significance of the study was also stated, as well as an overview of the thesis being provided.

Chapter 2 was devoted to a review of literature on the learning environments, together with a framework for assessing students' perceptions of the effectiveness of the integration of instructional technology across the core curriculum in terms of classroom learning environments. This literature review attests to the validity of the instruments used in diverse past educational research in many different countries.

Section 2.2 entitled Historical Background of Learning Environment Field defined for the term ‘learning environment’ and provided an overview of the history and development of research on classroom learning environments. Beginning with Lewin's (1936) studies, Walberg and Anderson's pioneering evaluation of Harvard Project Physics program and Moos' scheme of classifying human environment in the USA, the focus of learning environments research shifted to Australia and the Netherlands.

Eleven noteworthy questionnaires that were developed, validated and used in research over the past 40 years were described in Section 2.3 – Classroom Learning Environments Instruments: Learning Environment Inventory (LEI), Classroom Environment Scale (CES), Individualized Classroom Environment Questionnaire (ICEQ), My Class Inventory (MCI), College and University Classroom Environment Inventory (CUCEI), Questionnaire on Teacher Interaction (QTI), Science Laboratory Inventory (SLEI), Constructivist Learning Environment Survey (CLES), What Is Happening In this Class? (WIHIC), Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) and Constructivist-Oriented Learning Environment Survey (COLES). The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) was given special emphasis because it is the instrument that was used in this study. The section also focused on the development and characteristics of the TROFLEI and past validation studies involving the TROFLEI.

Section 2.4 entitled Past Studies of Learning Environments provided an overview of past lines of learning environments research, with an emphasis on investigations of outcome–environment associations and determinants of classroom environments, as well as the evaluation of innovative educational programs, including the use of technology in the classroom, innovative curricula, and innovative approaches for teacher education.

Section 2.5 – Technology Integration/Instructional Technology – reviewed literature on technology integration and instructional technology in order to lay a framework for the educational innovation that was evaluated in my study. Section 2.6 entitled The Critics: No Significant Difference Phenomenon Regarding Educational Technology reviewed a pattern in past research in which evaluations of the use of educational technology have revealed no significant differences. This section is provided to alert readers that findings of no significant differences associated with the use of educational technology have been common in past research.

Chapter 3 described the methods of the present study including the context, data sources, instrument, procedures, and data-analysis methods for assessing the effectiveness of the integration of instructional technology across the core curriculum. The study's research questions were identified as validating the TROFLEI among middle-school students in Texas and evaluating the effectiveness of the integration of instructional technology across the core curriculum in terms of students' perceptions of the classroom learning environment in Section 3.2. Section 3.3 provided background information about the school district, its location and community (Section 3.3.1), the school's demographics (Section 3.3.2) and the school's core curriculum courses (Section 3.3.3). Section 3.4 described the sample as consisting of those 605 students who had provided complete pretest responses and complete posttest responses in Grades 6, 7, and 8. The sample was described so that others can gauge the applicability of my findings to other settings. Section 3.5 described the TROFLEI, which was used to assess the effectiveness of integration of instructional technology in terms of the classroom learning environment, whereas the data-collection procedures were the focus of in Section 3.6.

Section 3.7 described the methods of data analysis used to answer my two research questions. TROFLEI data were subjected to factor analysis and reliability analysis to determine the validity and reliability of the questionnaire when used with middle-school students in Texas. Inferential statistics (MANOVA and ANOVA) were used to determine the effectiveness of the integration of instructional technology in terms of changes in students' perceptions of the classroom learning environment. To portray the magnitude of differences between pretest and posttest for each TROFLEI scale, effect sizes were calculated to express differences in standard deviation units.

5.3 Major Findings of the Study

Chapter 4 reported the results from each statistical analysis to answer the research questions investigated in this present study. Quantitative data form the TROFLEI were collected from a sample of 966 students for the pretest and 860 for the posttest in Grades 6, 7, and 8 core curriculum classes at Texas Middle School in Texarkana, Texas, USA. My two research questions focused on the validity and reliability of the TROFLEI (Section 5.3.1) and evaluating the effectiveness of technology integration (Section 5.3.2).

5.3.1 Validity and Reliability of TROFLEI

To validate the TROFLEI, student responses for the pretest (*N*=996*)* and posttest (*N*=860*)* were analyzed separately using principal axis factor analysis with varimax rotation and Kaiser normalization in order to examine whether each scale assesses a unique construct (see Section 4.2.1 and Table 4.1). The use of two criteria for the retention of any item (that is must have a factor loading of at least 0.30 on its own scale and less than 0.30 on each of the other nine TROFLEI scales) led to the removal of only four items, leaving 76 items. The proportion of variance accounted for ranged from 1.68% to 28.47% for pretest responses to different TROFLEI scales, with the total variance accounted for by all 10 pretest scales being 57.20%. For the posttest, the percentage of variance accounted for by different scales ranged from 1.36% to 38.04%, with the total variance being 64.80%. Eigenvalues for the pretest ranged from 1.35 to 22.78 and for the posttest ranged from 1.09 to 30.43 for the 10 TROFLEI scales.

Each TROFLEI scale's internal consistency reliability (a measure of the extent to which the items in a scale contribute to the same underlying construct) was assessed using Cronbach's alpha coefficient. Table 4.2 shows that the internal consistency reliability was 0.79 or higher for every TROFLEI scales for both the pretest and posttest. Overall, the results of the factor analysis and for internal consistency reliability provided strong support for the validity and reliability of the TROFLEI when used with my sample.
Section 4.2.3 compared the validity and reliability results in my study with those in past research using the TROFLEI. The results with my sample of 966 students for the pretest and 860 students for the posttest in Grades 6, 7, and 8 in core curriculum classes in Texas replicated the findings of the limited number of prior validation studies with the TROFLEI involving 1249 students in Australia (Aldridge, Dorman & Fraser, 2004), 2137 students in Australia (Aldridge & Fraser, 2008), 4146 students in Australia

(Dorman & Fraser, 2009), 1027 students in New Zealand (Koul, Fisher & Shaw, 2011), 980 students in Turkey and 130 students in the USA (Welch, Cakir, Peterson & Ray, 2012), 705 students in India (Gupta & Koul, 2007) and 949 students in Florida (Earle, 2014). Table 4.3 provided a comparison of alpha coefficients for TROFLEI scales in my research with those in past research.

5.3.2 Evaluating Technology Integration in Terms of Pre–Post Changes in TROFLEI Scale Scores

To evaluate the impact of integrating technology, the statistical significance of differences between the pretest and posttest scores were investigated using MANOVA with the ten TROFLEI scales as dependent variables. When MANOVA revealed statistically significant differences for the set of all TROFLEI scales, the ANOVA results were interpreted separately for each scale. Statistically significant differences were found for eight of the ten TROFLEI scales. For scales for which pre–post differences were statistically significant, effect sizes were used to provide evidence about the magnitude of differences in standard deviation units. Effect sizes ranged from only 0.09 to 0.22 standard deviations, which are all small according to Cohen (1988). Also, the direction of changes between pretest and posttest was inconsistent across scales.

Overall, my findings suggest neither an advantage nor a disadvantage for integrating instructional technology into the core curriculum in terms of classroom learning environment. These results seem consistent with the ‘no significant difference phenomenon’ (Russell, 1999), reviewed in Section 2.6, in which innovations in educational technology often have failed to fulfil their promise.

5.4 Limitations and Constraints

All diligence was maintained while conducting this study to ensure that the processes of inquiry, such as research design, data collection, data analysis and interpretation, were free from errors. As is true with all studies, certain inherent limitations and constraints could still affect the findings of this investigation, especially because it involved human beings (Brutus et al., 2013). There are several limitations and constraints that should be mentioned.

The size and the composition of the sample gave rise to a methodological limitation. Limitations in sample size can reduce the statistical power of analyses and a restriction in sample representativeness can reduce the generalizability of the findings. With the support of the district's superintendent, the entire student body of 1464 students were available for the study, but the final number of students with complete responses to the TROFLEI for data analysis dropped to 966 students who completed the pretest and 860 students who completed the posttest. The students who completed both the pretest and posttest administrations reduced the sample further to 605 for investigating changes in learning environment scores. The sample in this study was relatively large in comparison with other learning environment studies (Fraser, 2012) and, indeed, was the largest possible size available at the school because no students were left out of the sample.

Moreover, the sample in my study was not a true random sample because only those students who had parental consent were used in the study. A true random sample is always an ideal in data collection, but realistically this is impossible in nearly all educational research studies because of the obligation of ethical conduct, such as parental consent.

While the questionnaire for this study was convenient, economical, and written in language designed for school children, responding to a questionnaire containing 80 items was potentially taxing for my sample of middle-school students aged 11–14 years. To ensure consistency and understanding in the data-collection process, a short video with the instructions and directions for responding to the instrument was provided. The video of instructions also informed students that the teacher would provide clarification or reading assistance if needed. The students were also assured that their opinions were valued and would be used for school improvement, as well as being encouraged to take their time and complete the survey at their convenience. However, even with taking these precautions, there was potential for students not to respond seriously to questionnaire items. Additionally, students within the sample could have misinterpreted the intention of some items or provided distorted responses based upon their own expectations. Extraneous variables such as students’ mood, fatigue or stress levels could affect the completion the questionnaires with regard to students' honesty, seriousness, and interest in the research even when provided with clear explanations of the purposes, procedures, voluntary participation and confidentiality associated with the research.

The questionnaire used in this study involved only closed-choice items and did not include open-ended response items. While this instrument assured the manageability of the collected data, this quantitative research method with standardized measures provided a limited number of predetermined response categories and only an overview of the learning environment (Patton, 2015). Inability to further probe and investigate students' interpretations and understandings, qualify students' answers or explain their opinions was a constraint in this study. Overall, the lack of qualitative data-collection methods to augment my quantitative data-collection was a limitation in my study (Tobin & Fraser, 1998).

Because the most common line of past classroom environment research involves outcome–environment associations (see Section 2.4.1), my study could have benefitted from including an investigation of associations between students' perceptions of the classroom environment and some student outcome variables.

Another possible limitation of the present study was that only learning environment dimensions were used as criteria of effectiveness. It could have provided additional insights if some student outcomes (such as achievement and attitudes) also had been included.

My pretest–posttest design involving one group of students who experienced the integration of technology across the curriculum yielded useful insights. However, a research design that also incorporated a comparison group of students as a control group perhaps would have provided even more illuminating findings about the effectiveness of integrating technology across the curriculum. In addition, controlling for the exposure to instructional technology outside the core curriculum setting, which is an extraneous variable, was not possible.

Although the methods of statistical analysis were quite adequate for my study, perhaps some more sophisticated methods of analysis might have been used. For example, in addition to exploratory factor analysis, confirmatory factor analysis also might have been used. The use of MANOVA in my study possibly could have been complemented by performing multilevel analysis.

5.5 Recommendations for Future Research

The limitations discussed in Section 5.4 naturally lead to suggestions for future research. Future studies in this area could involve larger samples from a wider geographic area and multiple schools to increase the statistical power of analyses and the generalizability of results and statistical analyses. The larger sample involving additional schools would allow greater confidence in the findings of this study.

To minimize validity threats during data gathering, adding a single administrator or researcher who supervises the administration of the TROFLEI questionnaire to clarify understandings, control external variables and reduce students' concerns is likely to lead to more honest and serious responses.

Additionally, adding a qualitative component to probe the reasons for small pre–post differences would be a suggestion for future research. Including the use of qualitative research methods, such as observations, interviews and narrative stories, to augment questionnaire data and to provide insights into patterns that emerged from the quantitative data, could add meaning and enhance credibility to a study. A mixed-methods approach is recommended and the benefits are discussed by Tobin and Fraser (1998).

This research into the effectiveness of integrating technology into the core curriculum could be replicated with improvements to the methodology and with an enhanced design. For example, as noted in Section 5.4, it would be desirable in future research to include some student outcomes (e.g. achievement, attitudes) in addition to classroom environment as criteria of effectiveness. Also, the inclusion of a comparison group of students, who did not experience technology integration, would be likely to provide enhanced understanding in future studies.

Additionally, future research could focus on one subject area, such as mathematics or science instead of investigating all classes in the school. Another recommendation would be to consider the pedagogical practices in conjunction with technology integration.

Another suggestion for future research would be to make use of both actual and preferred forms of the TROFLEI. In contrast to my study that investigated the changes between pretest and posttest administration of the TROFLEI, future research also could focus on differences between actual and preferred classroom environments.

Another suggestion for future research involving the use of learning environment scales in classrooms where technology is integrated into the curriculum is to pursue some of the common lines of past research identified by Fraser (2012), such as associations between student outcomes and the nature of the classroom environment, differences between students' and teachers' perceptions, whether students achieve better in their preferred environment, links between environments (e.g. home, peer-group and school environments), and teachers' attempts to improve their classroom environments.

In future research with a larger sample, methods of statistical analysis could be more sophisticated than those used in my study. For example, confirmatory factor analysis could be used as well as exploratory factor analysis. The class mean could be used as the unit of analysis in addition to the student. Multilevel analysis could be used in addition to MANOVA.

5.6 Implications, Significance and Contributions

A contribution of the study was the cross-validation of the TROFLEI. Although research has been conducted in the learning environments field for over 40 years (Fraser, 2012), there have been only a few past studies using the TROFLEI. Dorman and Fraser (2009) validated the TROFLEI in Australian secondary schools, whereas Peterson, Welch, Cakir and Ketterling (2011) cross-validated the TROFLEI with high-school students in the US and Turkey. My study adds to the validity and reliability information available for this instrument, therefore increasing confidence in its future use as an economical questionnaire to use among the middle school population.

A practical implication of this study is a cautionary note before assuming that technology necessarily will be beneficial (i.e. improvement in students' perceptions of their learning environment in this case). In my research, some TROFLEI scales showed a small positive pre–post improvement while other TROFLEI scales showed a small negative trend.

This study's finding of quite small differences between pretest and posttest scores for the TROFLEI scales when evaluating technology integration into the core curriculum is just as important as finding large differences. In trying to adapt content to instructional media, the content and its delivery are reviewed, and this reviewing itself is advantageous for improving instruction and education (Russell, 1999). These findings suggest that technological integrations into the core curriculum might not necessarily offer any direct educational advantages in traditional school environments, but also that it is not detrimental to students' learning experiences.

Lastly, my study adds to the body of educational research on learning environments as a source of process criteria of effectiveness in evaluating educational innovations. The outcomes of this study have the potential to inform policy-makers who call for technological advancements in education and for educators implementing these tools in their classrooms. Innovations that transform the dynamics of the traditional classroom, such has the integration of technology, have been touted as leading to increased student engagement and being essential for a paradigm shift in defining the optimal learning environment. However, the results of my study suggest that incorporating technology into the core curriculum did not offer any direct educational advantages relative to traditional school environments, but also that using technology was not detrimental. These technological innovations seem to be comparable to many other instructional innovations or methods in their effectiveness. While technological interventions in the classroom are often predicted to provide be more useful than studies have shown

(Russell, 1999), they are not generally detrimental to students' learning and they are therefore considered to provide effective alternatives for specific educational experiences.

5.7 Concluding Remarks

The quantitative data, collected using the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) in this study, supported the validity and reliability of all scales. The a priori factor structure was replicated with nearly all of the items loadings on their own factor and no other factor. Internal consistency reliability was found to be satisfactory. Overall, this study provided strong support for the validity and reliability of the TROFLEI when used among middle-school students.

My pre–post design revealed that students' perceptions of the learning environment changed only slightly over the seven-month period during which instructional technology was being integrated into the core curriculum classes. To explore these findings in more depth, I suggest the use of a multi-method approach in future research which involves the use of qualitative research methods, such as observations, interviews and narrative stories, to supplement the questionnaire data and to provide triangulation and deeper interpretations and insights.

The results of this study do not suggest the abandonment of using educational technology, but rather that impartial research and judicious assessment of effectiveness in education are essential to balance the efforts invested in promoting and embellishing these innovations (Oser, 2013). Because economic interests and sensationalized media naturally drive the publication and dissemination of studies showing positive, significant differences (Russell, 1999), a balance in publication is necessary.

Finally, along with many other studies in the field of learning environments, my research suggests that more attention should be focused on the subtle concept of classroom learning environment instead of assuming that technology will directly benefit students (Fraser, 2001).

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APPENDIX A

Technology-Rich Outcomes-Focused

Learning Environment Inventory (TROFLEI)

Items 1–80 in this appendix are based on the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) developed by Aldridge and Fraser (2008). The TROFLEI is discussed in Sections 2.3.10 and 3.5. This questionaire was used in my study and is included in this thesis with the permission of the authors.

Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)

Directions for Students

This questionnaire contains statements about practices that take place in your class. You will be asked how often each practice takes place. The column to the right of the question is to be used to describe how often each practice actually takes place in your

There are no 'right' or 'wrong' answers. Your opinion is what is wanted and valued. Your responses will be confidential.

This survey is used to measure how you feel about your core curriculum classes. By using the following scale, answer how you feel today regarding these items provided: I **almost never** feel this way in my core curriculum classes. I **seldom** feel this way in my core curriculum classes. I **sometimes** feel this way in my core curriculum classes. I **often** feel this way in my core curriculum classes. I **very often** feel this way in my core curriculum classes.						
Student Cohesiveness		Almost Never	Seldom	Some times	Often	Almost Always
1	I make friends among students in this class.	1	2	3	4	5
2	I know other students in this class.	1	2	3	4	5
3	I am friendly to members of this class.	1	2	3	4	5
4	Members of the class are my friends.	1	2	3	4	5
5	I work well with other class members.	1	2	3	4	5
6	I help other class members who are having trouble with their work.	1	2	3	4	5
7	Students in this class like me.	1	2	3	4	5
8	In this class, I get help from other students.	1	2	3	4	5
Teacher Support		Almost Never	Seldom	Some times	Often	Almost Always

9	The teacher takes a personal interest in me.	1	2	3	4	5
10	The teacher goes out of his/her way to help me.	1	2	3	4	5
11	The teacher considers my feelings.	1	2	3	4	5
12	The teacher helps me when I have trouble with my work.	1	2	3	4	5
13	The teacher talks with me.	1	2	3	4	5
14	The teacher is interested in my problems.	1	2	3	4	5
15	The teacher moves about the class to talk with me.	1	2	3	4	5
16	The teacher's questions help me to understand.	1	2	3	4	5
Involvement		Almost Never	Seldom	Some times	Often	Almost Always
17	I discuss ideas in this class.	1	2	3	4	5
18	I give my opinions during class discussions.	1	2	3	4	5
19	The teacher asks me questions.	1	2	3	4	5
20	My ideas and suggestions are used during classroom discussions.	1	2	3	4	5
21	I ask the teacher questions.	1	2	3	4	5
22	I explain my ideas to other students.	1	2	3	4	5
23	Students discuss with me how to go about solving problems.	1	2	3	4	5
24	I am asked to explain how I solve problems.	1	2	3	4	5

Task Orientation	Almost Never	Seldom	Some times	Often	Almost Always
25 Getting a certain amount of work done is important to me.	1	2	3	4	5
26 I do as much as I set out to do.	1	2	3	4	5
27 I know the goals for this class.	1	2	3	4	5
28 I am ready to start class on time.	1	2	3	4	5
29 I know what I am trying to accomplish in this class.	1	2	3	4	5
30 I pay attention during this class.	1	2	3	4	5
31 I try to understand the work in this class.	1	2	3	4	5
32 I know how much work I have to do.	1	2	3	4	5
Task Orientation	Almost Never	Seldom	Some times	Often	Almost Always
33 I carry out investigations to test my ideas.	1	2	3	4	5
34 I am asked to think about the evidence for my statements.	1	2	3	4	5
35 I carry out investigations to answer questions coming from discussions.	1	2	3	4	5
36 I explain the meaning of statements, diagrams, and graphs.	1	2	3	4	5
37 I carry out investigations to answer questions that puzzle me.	1	2	3	4	5
38 I carry out answers to questions by doing investigations.	1	2	3	4	5
39 I find out answers to questions by doing investigations.	1	2	3	4	5
40 I solve problems by using information obtained from my own investigations.	1	2	3	4	5

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

Differentiation		Almost Never	Seldom	Some times	Often	Almost Always
57	I work at my own speed.	1	2	3	4	5
58	Students who work faster than me move on to the next topic.	1	2	3	4	5
59	I am given a choice of topics.	1	2	3	4	5
60	I am set tasks that are different from other students' tasks.	1	2	3	4	5
61	I am given work that suits my ability.	1	2	3	4	5
62	I use different materials from those used by other students.	1	2	3	4	5
63	I use different assessment methods from other students.	1	2	3	4	5
64	I do work that is different from other students' work.	1	2	3	4	5
Computer Usage		**Almost Never**	**Seldom**	**Some times**	**Often**	**Almost Always**
65	I use the computer to type my assignments.	1	2	3	4	5
66	I use the computer to email assignments to my teacher.	1	2	3	4	5
67	I use the computer to ask the teacher questions.	1	2	3	4	5
68	I use the computer to find out information about the course.	1	2	3	4	5
69	I use the computer to read lesson notes prepared by the teacher.	1	2	3	4	5
70	I use the computer to find out information about how my work will be assessed.	1	2	3	4	5
71	I use the computer to take part in online discussions with other students.	1	2	3	4	5
72	I use the computer to obtain information from the Internet.	1	2	3	4	5

Young Adult Ethos		Almost Never	Seldom	Some times	Often	Almost Always
73	I am treated like a young adult.	1	2	3	4	5
74	I am given responsibility	1	2	3	4	5
75	I am expected to think for myself.	1	2	3	4	5
76	I am dealt with as a grown up.	1	2	3	4	5
77	I am regarded as reliable.	1	2	3	4	5
78	I am considered mature.	1	2	3	4	5
79	I am given the opportunity to be independent.	1	2	3	4	5
80	I am encouraged to take control of my own learning.	1	2	3	4	5

APPENDIX B

Parent/GuardianConsentForm

Donna McDaniel, M.Ed.
Research Investigator

Curtin University
Science and Mathematics Education Centre

Parent/Guardian Consent Form

Dear Parent/Guardian:

Permission is requested for ____ to participate in a student-based research study. The purpose of the research is to investigate the effectiveness of integrating technology across the core curriculum in terms of the classroom learning environment among middle school students in Texas. Participants will be asked to be involved in the completion of two surveys. The entire process will take approximately 35 minutes.

The contact will be non-intrusive and will not disrupt classroom lessons. **The student samples will not be identifiable and confidentiality of all participants will be maintained.**

Participation in this study will be beneficial in investigating the classroom environment amongst middle schoolers in Texas.

Please indicate on the second page whether you give permission for the above named student to participate in this valuable research study. Forms should be returned to the students' teacher.

I will be the individual responsible for this research. Should you have any questions, feel free to contact me at (903) 701-0312 or via e-mail at donna.mcdaniel@txkisd.net.

Sincerely,

Donna C. McDaniel, M.Ed.
Research Investigator, Curtin University
Principal, Texarkana Independent School District
Texas Middle School
2100 College Drive
Texarkana, Texas 75503
T 903.793.5631 | F 903.792.2935

____YES, permission is GRANTED to participate.
____No, permission is DENIED to participate.

______________________________	______________________________
Parent/Guardian Name (Signature)	Parent/Guardian Name (Signature)
______________________________	______________________________
Parent/Guardian Name (Printed Name)	Parent/Guardian Name (Printed Name)
______________________________	______________________________
Date	Date

APPENDIX C

Parent/Guardian Information Sheet

Donna McDaniel, M.Ed.
Research Investigator

Curtin University
Science and Mathematics Education Centre

Parent/Guardian Information Sheet

My name is Donna C. McDaniel and I am currently completing a piece of research for my degree of Doctor of Philosophy at Curtin University in Perth, Western Australia.

Purpose of Research
I am investigating the effectiveness of the integration of instructional technology across the core curriculum in terms of the student's perceptions of the classroom learning environment among middle school students in Texas.

Your Child's Role
I am interested in comparing data obtained from both a pre and post test with the purpose of assessing students' classroom environment amongst middle schoolers. Your child will be asked to complete two surveys that will be administered during one of his/her normal class periods. This entire process will take approximately 35 minutes.

Consent to Participate
Your child's involvement in this research is entirely voluntary. He/she has the right to withdraw at any stage without it affecting his/her rights or my responsibilities. Once you and your child have signed the consent forms, I will assume that you have agreed to allow your child to participate in this study and that I have your permission to use the data in this research.

Confidentiality
The information your child provides will be kept separate from his/her personal details, and only my supervisor and I will have access to the completed questionnaires. These questionnaires will be kept in a locked cabinet for five (5) years at which point they will be destroyed.

Further Information
This research has been reviewed and given approval by the Curtin University Human Research Ethics Committee. If you would like further information about this study, please feel free to contact me at mcdanield@txkisd.net or (903) 701-0312. Alternatively, you may contact my supervisor, Professor Barry J. Fraser, at B.Fraser@curtin.edu.au.

Should you wish to make a complaint on ethical grounds, please contact the Human Research Ethics Committee Secretary at hrec@curtin.edu.au or via post at Office of Research Development, Curtin University, GPO Box U1987, Perth, Western Australia 6845.

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

APPENDIX D

Student Participant Consent Form

Donna McDaniel, M.Ed.
Research Investigator

Curtin University

Curtin University
Science and Mathematics Education Centre

Student Participant Consent Form

- I understand the purpose and procedures of the study.
- I have been provided with a *Student Participant Information Sheet*.
- I understand that the study itself may not benefit me.
- I understand that my involvement is voluntary and that I can withdraw from participating at any time without penalty or problems.
- I understand that no personal identifying information, such as my name and address, will be used in any published materials.
- I understand that all information related to this study, including completed questionnaires, will be securely stored for a period of five (5) after which 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 (Print)

____
Signature

____
Date

____
Student ID Number

____
Grade

APPENDIX E

Student Participant Information Sheet

Donna McDaniel, M.Ed.
Research Investigator

Curtin University
Science and Mathematics Education Centre

Student Participant Information Sheet

My name is Donna McDaniel and I am currently completing research for my degree of Doctor of Philosophy at Curtin University in Perth, Western Australia.

Purpose of Research
I am investigating the effectiveness of integrating technology across the core curriculum in terms of the classroom learning environment of middle school students in Texas.

Your Role
I am interested in comparing data obtained from both a pre and post survey with the purpose of assessing students' perceptions of their classroom environment among middle school students. You will be asked to be complete two surveys that will be administered during one of your normal class periods. This entire process will take approximately 35 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. Once 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.

Confidentiality
The information you provide will be kept separate from your personal details, and only my supervisor and I will have access to the questionnaires you complete. These questionnaires will be kept in a locked cabinet for five (5) years at which point they will be destroyed.

Further Information
This research has been reviewed and given approval by the Curtin University Human Research Ethics Committee (Approval Number SMEC 25-12). If you would like further information about this study, please feel free to contact me at dmcdaniel@txkisd.net or (903) 701-0312. Alternatively, you may contact my supervisor, Professor Barry J. Fraser, at B.Fraser@curtin.edu.au.

Should participants wish to make a complaint on ethical grounds, please contact the Human Research Ethics Committee Secretary at hrec@curtin.edu.au or via post at Office of Research Development, Curtin University, GPO Box U1987, Perth, Western Australia 6845.

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

APPENDIX F

Superintendent Permission Letter

Donna McDaniel, M.Ed.
Research Investigator

Curtin University

Curtin University
Science and Mathematics Education Centre

Letter of Inquiry: School Superintendent

My name is Donna McDaniel and I am currently working on my doctoral degree with Curtin University in Perth, Western Australia. I wish to request permission for students in Grades 6, 7, and 8 in your school to participate in a student-based research study. The purpose of the research is to investigate the effectiveness of integrating technology across the core curriculum in terms of the classroom learning environment within the Texarkana Independent School District.

I would like to administer classroom environment and attitudinal surveys during the months of October 2009 and May 2010.

Student participants will be asked to be involved in the completion of two surveys. The entire process will take approximately 35 minutes. The contact will be non-intrusive and will not disrupt classroom lessons. The student samples will not be identifiable and confidentiality of all participants will be maintained.

Participation in this study will be beneficial in investigating the classroom environment among middle school students in Texas.

Included in this correspondence are copies of my approval letters from Curtin University's Human Research Ethics Committee (Approval Number SMEC-25-12).

I will be the individual responsible for this research. Should you have any questions, feel free to contact me at (903) 701-0312 or via e-mail at mcdanield@txkisd.net. Alternatively, you may contact my supervisor, Professor Barry J. Fraser, at B.Fraser@curtin.edu.au.

Best regards,

Donna C. McDaniel

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