

Science and Mathematics Education Centre

**Investigating the Effectiveness of an Online Course: Development of
the Comparative Learning Environment Questionnaire**

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**This thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University**

June 2011

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:

Acknowledgments

The successful completion of this study was made possible by committed help from many people. I want to express my heartfelt gratitude to all of them.

I want to begin by acknowledging the critically valuable guidance of my two supervisors, Associate Professor Jill Aldridge and Professor Barry J Fraser without whose help the completion of this project would have not been possible. Throughout the thesis work, I have never felt cut off from either of them despite the distance between Singapore and Perth. Their constant direction, feedback, guidance, prompt attention, empathy and understanding made this academic milestone achievable. They have gone out of their way to give me full support and guidance both face-to-face and from a distance.

Also, a big thank you to the administrative staff at the Curtin University of Technology, Science and Mathematics Education Centre – Petrina Beeton and Rosalie Wood without whose help the mundane yet essential administrative parts would have been tremendously difficult from a distant location.

My thanks go to my family, my husband, Sid, and my children, Madhu and Shyam, for their continuous support and to my sister and brothers for their encouragement.

Finally, this acknowledgement would not be complete without special mention of my parents. Thank you Mom and Dad!

Abstract

This study was undertaken with the purpose of evaluating a newly-developed online course. The study involved, firstly, designing, developing and validating two questionnaires that could be used to assess the relative effectiveness of the online course in terms of students' perceptions of the learning environment and attitudes. The development of the learning environment instrument drew on and extended the wide array of already validated instruments in the field of learning environments. The development used a multi-stage approach that included a review of pertinent literature, identifying salient scales and developing pertinent survey items. Both surveys were field tested and refinements were made on the basis of the findings. Its unique format allowed the comparison of the newly-developed online course with a parallel face-to-face course. The learning environment survey assesses the six scales of Task Orientation, Responsibility and Independence, Access, Computer Usage, Authentic Learning, Information Design and Appeal and the attitude instrument is comprised of three scales, namely, Student Enjoyment, Academic Efficacy and Anxiety.

The learning environment survey and attitude survey were administered to 1000 students, of whom 991 provided complete and usable responses. Analyses of the data obtained from 991 students were conducted to support the factorial validity and internal consistency reliability of both the learning environment and attitude instruments. For the learning environment instrument, principal axis factoring with varimax rotation (conducted separately for the online and face-to-face course) confirmed that, without exception, all items had a factor loading of at least 0.40 on

their *a priori* scale and no other scale. The scale reliability estimates were high for both versions of the learning environment instrument, ranging from 0.85 to 0.92 for the online course and from 0.85 to 0.91 for the face-to-face environment. The attitude instrument also was found to be reliable. Factor analysis confirmed the *a priori* structure of the student attitudes instrument for the online and face-to-face courses comprising 18 items in three scales. All items had a factor loading of at least 0.40 on their *a priori* scale and no other scale. The Cronbach alpha coefficient for the online and face-to-face course for each of the three attitude scales ranged from 0.91 to 0.95 for online course and from 0.91 to 0.96 for face-to-face course.

Qualitative information from focus-group interviews with 90 students were used to supplement and support the quantitative results. Interview data collected from 90 students who took part in the semi-structured interviews and focus-group discussions helped to confirm and provide reasons for the quantitative findings that students generally had more positive views of their online course than the face-to-face course.

Data collected using the learning environment and attitude surveys were used to compare students' scores for the online and face-to-face courses using MANOVA. The results indicated statistically significant ($p < 0.05$) differences for all six learning environment and three attitudes scales, with students' scoring higher for their online learning environment. For the six learning environment scales, had enjoyment and academic efficacy lower for anxiety when compared to the face-to-face course. In addition, the effect sizes (calculated to determine the magnitude of the differences in standard deviations) were found to be large (ranging from 0.39 to 1.00) for all of the

learning environment and attitude scales. The qualitative information supported these findings in all cases, and helped to explain the reasons why.

Associations were found between students' perceptions of the online learning environment and their attitudes (Enjoyment, Academic Efficacy and Anxiety). The multiple correlation were statistically significant for all three outcomes. The regression weights (β) indicated that five of the six learning environment scales were positively, significantly ($p < 0.05$) and independently related to Enjoyment and Academic Efficacy, and two of the six learning environment scales were negatively, significantly ($p < 0.05$) and independently related to Anxiety. These result suggest that, to increase the likelihood of students' enjoyment of the online course, the instructional design should incorporate material that is presented in manageable amounts with clear guidelines and instructions (Task Orientation), provide opportunities for students to proceed through the course at their own pace and to repeat components that have not been understood (Access), use authentic tasks to which students can relate (Authentic Learning) and use audio and visual materials, tables and graphics to assist students to understand the content (Information Design and Appeal). Two environment scales, Access and Information Design and Appeal, were statistically significantly ($p < 0.05$) related to Anxiety. with students studying the online course being less anxious if there was more Access and Information Design and Appeal.

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Chapter 1

INTRODUCTION AND RATIONALE

1.1 Introduction

Over the past two decades, rapid advances in technology have revolutionised the world, not only in the way that industrial, financial and business activities are carried out, but also in the way in which we communicate and conduct everyday chores such as banking. Computers and the internet have also impacted and changed the field of education by extending the boundaries of classroom learning beyond the walls and fences of learning institutions.

With the explosion of knowledge within the web-world and the increase in computer literacy, there are an increasing number of students seeking higher education. This, in addition to a worldwide crisis in institutional funding, has ensured that online learning has steadily but surely inched towards the central platform of higher education. As a result, online learning is being widely adopted in higher education institutions around the world (Allen & Seaman, 2008; Bonk & Graham, 2006; Mioduser & Nachmias, 2002; Moore & Kearsely, 2005; Penman & Lai, 2003). Large investments in instructional technologies are being outlaid by educational institutions on the assumption that this will lead to improved educational quality, as well as reduced costs through greater efficiency (Moonen, 2000).

Currently, a wide variety of online learning models and strategies are being implemented in diverse settings, including web-supported academic instruction that ranges from blended learning to fully-online models (Bramble & Panda, 2008). However, providing a framework for putting the syllabus online, such as including quizzes and linking discussion boards, does not necessarily translate into an effective learning environment. Asserting the pedagogical needs over the ‘glitz’ of technology and multimedia is crucial in providing an effective learning environment (Wijekumar, 2005). It is within this backdrop that the present study took place with the overarching aim being to examine the effectiveness of a fully-online course that takes into consideration a range of pedagogical factors and student outcomes.

This chapter provides a rationale and introduction for the present study under the following headings:

- Context of the study (Section 1.2);
- Objectives of the study (Section 1.3);
- Theoretical framework (Section 1.4);
- Significance of the study (Section 1.5);
- Limitations of the study (Section 1.6); and
- Overview of thesis (Section 1.7).

1.2 Context of the Study

The term ‘online learning’ could simply mean learning carried out using connected computers. However this definition does not reflect the full range and use of

connected computers in a learning situation. According to Chang and Fisher (2003), a web-based learning environment consists of digitally formatted content resources and communication devices that enable interaction. Zhu, McKnight and Edwards (2007), on the other hand, describe online instruction as any formal educational process in which the instruction occurs when the learner and the instructor are not in the same place and internet technology is used to provide a communication link between them. According to Siragusa (2005), online learning is involved when students use the internet to interact with content, other students and their tutors. The term online learning was used by Radford (1997) to denote material accessible via a computer using networks or telecommunications rather than material accessed from paper or other non-networked media. This range of definitions and interpretations of online learning is a reflection of the variety of ways in which educationalists, at all levels, use connected computers in learning. The definition used by Radford to define online learning was used in the present study. The next two sections describe the context of the study in terms of online learning in Singapore (Sections 1.2.1) and the research site (Section 1.2.2).

1.2.1 Online Learning in Singapore

E-learning and the use of technology, especially the internet, in teaching and learning have become widely accepted worldwide. Schools, universities, governments and companies around the world have realised the need to acquire and develop e-learning capabilities. According to *The Horizon Report* (The New Media Consortium, 2007), the environment of higher education is changing rapidly, costs are rising, budgets are shrinking and the demand for the new services is growing.

In Asia, e-learning has become even more pervasive since the Severe Acute Respiratory Syndrome (SARS) epidemic in 2003, which forced students to stay away from schools (Lim, 2009). The availability of a sound infrastructure, in addition to government incentives, has made Singapore an ideal platform for e-learning. The political vision for Singapore is to transform the country into the 'e-learning hub' of the region (Alex, 2004), providing further impetus to the growth of e-learning in the country.

In Singapore, education plays an important role in the economy, contributing roughly 2.2% to the Gross Domestic Product (GDP) and providing employment for approximately 52,000 people (Damien, 2004). The Singapore government is actively working with private sectors to encourage technology-based learning systems that will enhance learners' understanding of abstract concepts and increase their interest in learning to ensure a desire to continuously upgrade skills. Schools in Singapore are increasingly choosing to adopt technology-based learning in a bid to ensure efficient learning management.

To prepare the nation to meet the challenges of the knowledge economy, the Singapore government has invested heavily in resources within the tertiary education sector. Currently, there are three fully-fledged public universities in Singapore, all of which offer high-quality higher education backed by state-of-the-art technology. Alongside these universities, there are polytechnic institutes and offshore campuses of foreign universities that also offer higher education in Singapore (Bashar & Khan, 2007).

Given that there is a high potential for growth of the e-learning market in Singapore, it is likely that e-learning will be the next generation education tool in Singapore. To ensure that e-learning is successful, it is imperative that standard and quality are high and that technological and pedagogical innovation is balanced (Bashar & Khan, 2007).

1.2.2 The Research Site

The site for the research reported in this thesis was a leading Singapore Polytechnic School of Engineering in which there was an enrolment of around 5000 students. This Polytechnic is one of the five Government Polytechnics whose mission is to 'bring life to education and education to life'. In the first year (freshmen intake), there were around 1500 students all of whom were enrolled in a three-year diploma within the field of engineering, such as computer, electrical or aerospace engineering.

Students enrolled at this institution were all given instruction in technical communications using both a conventional face-to-face course and an online course. Students studied the online course completely online; that is, the purpose of the teacher's presence was merely 'social' and involved maintaining class discipline, ensuring that the students had access to the computers, and administering tests. During the present study, the online multimedia materials were made available via the school's learning management system (commonly abbreviated as LMS), from which students were able to access the course from anywhere and at all times. LMS

(BlackBoard, 2010) is a software application for the administration, documentation, tracking and reporting of training programs, classroom and online events, e-learning programs and training content. LMS is widely used in Singapore by educational institutions at all levels.

During the face-to-face course, students were taught using traditional face-to-face methods that were sensitive to current trends and theories in teaching and learning. Appendix C has an outline of one lesson each of both the online and face-to-face teaching materials. The teaching was primarily student-centred. In this study, I a) compared students' perceptions of the learning environment of their online course and face-to-face course and b) investigated the attitudes of students with respect to the two teaching/learning approaches.

1.3 Objectives of the Study

Research Objective #1

To develop and validate surveys to assess:

- a) Students' perceptions of the learning environment created in online and face-to-face courses.
- b) Students' attitudes towards their online and face-to-face courses (enjoyment, academic efficacy and anxiety).

Research Objective #2

To compare students in face-to-face and online courses in terms of:

- a) Perceptions of learning environment, and
- b) Attitudes (enjoyment, academic efficacy and anxiety).

Research Objective #3

To investigate whether associations exist between students' perceptions of the learning environment and students' attitudes of:

- a) Enjoyment,
- b) Academic efficacy, and
- c) Anxiety.

1.4 Theoretical Framework

Educational research is essentially concerned with exploring and understanding social phenomena pertaining to formalized and/or spontaneously occurring social, cultural, psychological processes which are educational in nature (Cohen, Manion & Morrison, 2000). In doing so, educational research involves the formation of questions and the selection of methods which enable satisfactory investigation of those questions (Dash, 1993). Because theoretical questions in education emerge from different conceptions and interpretations of social reality, different paradigms have evolved. Kuhn (1962), who originally coined the term, characterises a

paradigm as an integrated cluster of substantive concepts, variables and problems together with corresponding methodological approaches and tools.

Researchers in the social and behavioural sciences have engaged in what is known as paradigm wars (Johnson & Onwuegbuzie, 2004; Newman, Ridenour, Newman & DeMarco, 2003). In these wars, or debates, researchers of a positivist worldview (historically these are generally quantitative researchers) tend to criticize constructivists for being too subjective and unreliable (Guba & Lincoln, 1989, 1994; Tashakkori & Teddlie, 1998, 2003). Similarly those researchers with a constructivist worldview (historically these are generally qualitative researchers) tend to criticise empiricists for being too reductionist. These debates are essentially between purists (Johnson & Onwuegbuzie, 2004) and tend to focus on the differences rather than similarities between the two positions (Onwuegbuzie & Leech, 2005). In addition, these purists have argued that paradigms and research methodologies cannot be separated or mixed (Howe, 1988).

More recently, however, some researchers have argued that it is time to adopt a third paradigm, that of pragmatism (Morgan, 2007; Onwuegbuzie & Leech, 2005). Pragmatists argue for the importance of integrating methods when it is appropriate (Onwuegbuzie & Leech, 2005). Mixed-method research, according to Creswell and Plano Clark (2007), has philosophical assumptions as well as methods of inquiry. As a methodology, it involves the philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches during the research process. As a method, it focuses on collecting,

analysing and mixing both quantitative and qualitative data in a single study or series of studies.

The present study involved a mixed-method approach in which the data were collected sequentially in two stages. During the first stage, a questionnaire, designed to compare students' perceptions of a face-to-face learning environment with an online learning environment, was administered to provide quantitative data. This stage of the study employed a more positivistic framework, favouring an objectivist view. The second stage involved the collection of qualitative data and employed an interpretative framework drawing on elements of constructivism (Schwandt, 1994; Tobin, 1993) and critical theory (Denzin & Lincoln, 2000). In this stage, the focus was on understanding and interpreting phenomena and making meaning out of the quantitative data. Thus embracing a mixed-method approach for this study opened the door for different worldviews, forms of data collection and analyses (Creswell & Plano Clarke, 2007). The methods of data collection and data analysis are discussed in detail in Chapter 3.

The present study drew on and extends the theory, methods and research conducted in the field of learning environments. In essence, a learning environment is the interaction that occurs between individuals, groups and the setting within which they operate. Research on learning environments is consistent with the Lewinian formula, $B=f(P,E)$ where behaviour (B) is considered to be a function (f) of the person (P) and the environment (E) (Lewin, 1936). The formula recognizes that "both the environment and its interaction with personal characteristics of the individual are potent determinants of human behaviour" (Fraser, 1998a, p. 529). Following Lewin's

work, Murray (1938) proposed a needs-press model in which situational variables found in the environment account for a degree of behavioural variance. In Stern's (1970) person-environment congruence theory, based on Murray's needs-press model, more congruence between personal needs and environmental press leads to enhanced outcomes.

Because the learning environment is a place where learners and educators congregate for extended periods of time to participate in learning, the environment created (also referred to as climate, atmosphere, tone, ethos or ambience) is regarded as an important component in the learning process (Fraser, 2007). Over the past 40 years, much progress has been made in terms of conceptualising, describing and assessing the learning environment (Fraser, 2007, 2012). Numerous valid and reliable instruments have been developed and used in countries around the world, in different courses and at different educational levels (Fraser, 2007). By examining the classroom environment from the viewpoint of students and teachers, educators and researchers are able to assess the climate of classrooms and to implement changes that are likely to improve the environment (Aldridge, Fraser, Bell & Dorman, in press). Past research indicates that students with different abilities, genders and ethnic backgrounds can perceive the same classroom differently (Fraser, 1998a). Numerous questionnaires have been developed to assess students' perceptions of their classroom learning environments for a range of purposes and different settings (Fraser, 1990; Fraser, Giddings & McRobbie, 1995; Taylor, Fraser & Fisher, 1997). For example, the Science Laboratory Learning Environment Instrument (SLEI; Fraser, Giddings & McRobbie, 1995) was developed to assess students' perceptions of the unique environment created in a science laboratory. Chapter 2 provides a

review of historically-important and contemporary questionnaires in the field of learning environments.

Furthermore, when new teaching methods are introduced, often the learning environment will also change (Fraser, 2001). For example, when constructivist-orientated pedagogies are implemented, there can be a shift from teacher-centred to learner-centred learning environments. To examine this shift, the Constructivist Learning Environment Survey was developed by Taylor, Fraser and Fisher (1997).

Research carried out with tens of thousands of students has shown that classroom environment strongly influences student outcomes (Fraser, 1998a). The question, then, is whether innovative efforts that extend education beyond the walls of classrooms provide a positive learning environment that can lead to improved student outcomes (cognitive and affective). It is with this in mind that the present study was initiated to evaluate the effectiveness of an online course in terms of the learning environment created.

Chapter 2 provides a review of pertinent research related to the field of learning environment and student attitudes, particularly as they relate to online learning.

1.5 Significance of the Study

It is anticipated that this study will have theoretical, methodological and practical implications for the field of classroom learning environments and for teaching on line. As such, it is hoped that the results of this study will benefit researchers,

curriculum developers, and teachers and educators at the institution where this research took place.

Theoretically the present study brought together, for the first time, the areas of online learning environments, anxiety towards learning in an online environment and academic efficacy in an online learning course. It is anticipated that the results of this study will provide a starting point from which future studies can build.

The present study provides methodological implications to the field of learning environments through its contribution to the wide range of distinctive and useful learning environment instruments. The development and validation of an instrument that can be used to assess students' perceptions of both their online and face-to-face learning environments makes available a practical, economical and reliable questionnaire that can be used by teachers to improve their online learning environments in ways that are conducive to effective teaching and learning.

Practically, the results of the present study have the potential to provide insights to a variety of stakeholders, including those who design online courses and curriculum developers and who want to integrate online learning with face-to-face learning environments.

The outcomes of the present study are likely to provide insights into associations between students' affective outcomes and their perceptions of their online learning environments, thereby helping developers of online learning to understand how they

can modify the e-learning environment in ways that will enhance student attitudes and, subsequently, student learning.

The results of this study could provide important information to the technical institution in which the study took place. Because the online course that was evaluated in this study is the first to be introduced at the institution, this investigation of the effectiveness of the online course can be used to assist in the development of future online courses.

Chapter 5 further expands on the significance of the research, particularly in terms of practical implications of the results for the design of online courses.

1.6 Limitations of the Study

This section provides a brief overview of the limitations of the present study, which are discussed more fully in Chapter 5. In designing the research, attempts were made to ensure that limitations of the study were minimised. It is noted, however, that the sample size was relatively small and was drawn from only one polytechnic in Singapore. It is unclear, therefore, whether the findings of this study would apply to other polytechnics in Singapore. It is acknowledged, also, that a larger sample size could have permitted more powerful statistical analyses. To reduce this limitation, however, in-depth qualitative data were collected to enrich the quantitative findings.

A further possible limitation of the study is that, while there is a wide range of variables (cognitive and affective) that could have been included in the study to

provide information about the impact of the learning environment on student outcomes, my study focused on only three student attitudes, namely, enjoyment, self-efficacy and anxiety.

Chapter 5 explores in more detail the limitations and constraints related to the study and how these were reduced or overcome.

1.7 Overview of the Thesis

This chapter has introduced the thesis, providing a context for the study and an overview of the aims of the research. The chapter also has provided a theoretical framework for the study and a brief introduction to the field of learning environment. The chapter introduced the significance and possible limitations of the present study.

Chapter 2 reviews literature pertinent to the present study, including the sound development of online courses and the pedagogical practices that are important. The chapter then reviews literature related to past learning environment research, a brief history of the field of learning environments, assessment instruments and past studies related to online learning environments. Finally, this chapter reviews literature related to students' attitudes and the role of attitudes in student learning.

Chapter 3 details the research methods used in the present study, including the design and development of the new learning environment and attitude questionnaires for assessing and comparing an online course with a face-to-face course. The chapter describes the three stages used in the development and validation of the learning

environment survey instrument, the sample and the analyses used to answer each of the research questions.

Chapter 4 presents the findings and results of the present study. The chapter reports the reliability and validity of the new instruments, associations between the learning environment and student attitudes and, finally, a comparison of the online and face-to-face courses in terms of the learning environment and student attitudes.

Chapter 5 summarises the thesis and the findings and outlines the conclusions of the research. The chapter provides information about limitations of the study, implications of the research and recommendations for future research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Whereas the last chapter provided a context for the study and identified the specific research objectives, this chapter provides a review of literature pertinent to the three major areas relevant to the present study:

- Online education and learning (section 2.2);
- Psychosocial learning environments (section 2.3);
- Roles of attitudes in learning (section 2.4).

2.2 Online Education and Learning

The overarching aim of the present study was to evaluate the effectiveness of an online programme developed for use at the polytechnic level in Singapore. It is important, therefore, to review literature related to online education. This section examines: the definition and types of online learning (Section 2.2.1); and learning theories and their implications for the development of online programmes (Section 2.2.2).

2.2.1 Online Learning

As discussed in chapter 1, flexible teaching has evolved to meet the changing needs of learners. In the context of higher education, online learning, as a form of flexible teaching and learning, seeks to provide greater access to learning for all students. Flexible teaching, therefore, is concerned with the provision of a suitable learning environment that provides a variety of access opportunities as well as a variety of learning modes. Flexible teaching can include conventional teaching practices and learning modes as well as alternatives and options provided by various media including, but not exclusive to, the recent developments in communications and information technology.

There is a multitude of terms used to describe online education, including, ‘e-learning’, ‘distributed learning’, ‘online learning’, ‘web based learning’ and ‘distance learning’ (Halawi, McCarthy & Pires, 2009). According to Schreiber and Berge (1998), online learning includes any technology-based learning with links to a computer. As such, online learning can extend from a basic online learning programme that includes text and graphics, exercises, testing and record keeping (such as test scores and book marks) to a sophisticated online learning programme. The National Center for Supercomputing Application (NCSA) e-learning group (Gallaher & Wentling, 2004) defines e-learning as the acquisition and use of knowledge distributed and facilitated primarily by electronic means. According to the NCSA e-learning group, e-learning can take the form of courses as well as modules and smaller learning objects. In addition, e-learning can incorporate synchronous or asynchronous access and can be distributed geographically with

varied limits of time. For the purpose of the study described in this thesis, the definition of the NCSA e-learning group is used.

According to Dantas and Kemm (2008), online learning, or e-learning, is largely practised in three modes: the web-supplemented mode; the web-dependent mode; and the fully online mode. The web-supplemented mode provides enrolled students with the option to access information, via the web, in the form of a study module which usually provides supplementary material in addition to the basic course material. The web-dependent mode relies on students having access to course materials via the web to successfully complete the study module. The fully online mode takes place when all interactions with staff and students, education content, learning activities, assessment and support services are integrated and delivered online. Within each of these modes, there is a variety of models that are used to create an effective learning environment for any given set of students. In addition, Boettcher and Conrad (1999) suggest that there are three types of online courses, namely, those in which there is little or no interaction, hybrid courses in which there is a blend of online and face-to-face interaction, and interactive courses which are exclusively online but require interactions between the participants.

2.2.2 Learning Theories and Implications for the Design of Online Learning Environments

Past studies that have compared traditional classroom-based instruction with technology-supported instruction have found no significant differences on educational variables such as learning outcomes and student satisfaction (Clarke,

1999; Johnson, Aragon, Shaik, & Palma-Rivas, 2000; Navarro & Shoemaker, 1999; Smeaton & Keogh, 1999). It would appear, therefore, that the quality of learning is affected more by instructional strategy and an appropriate blend of learning theories (Phipps & Merisotis, 1999; Tan, Aris & Abu, 2006) than the technology itself (Bonk & Graham, 2006). Given the importance of incorporating sound theoretical support to create an effective online environment, it was considered prudent to review literature related to learning theories and how they apply to online learning. This section provides a brief description of four historically important theories of learning that can be incorporated into online design to increase their effectiveness, these being, Vygotskian thought, behaviourism, constructivism and cognitive load theory. Finally this section examines how instructional design might incorporate an eclectic theory of learning.

2.2.2.1 Vygotskian Thought

Vygotsky (1978) proposed three important theories of learning, namely, the convergence of thought and language, the zone of proximal development, and the concept of scaffolding. The zone of proximal development refers to a range of optimal learning with upper and lower boundaries that are a function of the learner's expertise and the content difficulty. Scaffolding refers to the method of reducing instructional guidance as a learner progresses through materials (Mostyn, 2009). This theory implies that, for effective learning to take place, students should be weaned away from dependence towards independence and autonomy.

Vygotskian thought has design implications for e-learning, including the 'situatedness' of the learning, in which the learner is able to construct meaning

because the task is clear and meaningful (Brown & Duguid, 2000). According to Vygotskian thought, then, to increase the effectiveness of e-learning environments, the learner would need to have an understanding of the importance of the tasks at hand and consideration should be given to the importance of grouping learning activities into manageable sizes (Hung & Chen, 2001).

2.2.2.2 Behaviourism

In the 40s and 50s, B. F. Skinner (1947, 1953) proposed behaviourism which highlights the efficacy of reinforcement of desired behaviour as a key element to learning. With this in mind, the design of e-learning should consider the elements of small steps, immediate feedback, self-paced learning and the nature of motivational reinforcement. In addition, because students working online are expected to manage their own time, a clear understanding of what is required and clear deadlines for the assessments are important considerations (Bocchi, Eastman & Swift, 2004).

2.2.2.3 Constructivism

Constructivist learning theory, a theoretical frame work for the subsequent development of active learning, views the instructor as an enabler or helper who gives minimum guidance (Kirschner, Sweller & Clark, 2006; Mayer 2004). E-learning environments that incorporate a more constructivist approach might involve elements of active learning, such as learning by doing (problem solving), social and motivational aspects of learning and the learning styles of individual students. Creating time for and encouraging self-reflection on the learning process are identified as other crucial features by constructivists (Allen, 2005). The design of e-

learning environments that is more constructivist-oriented also requires consideration of the use of authentic tasks (Allen, 2005; Nix & Fraser, 2011).

2.2.2.4 Cognitive Load Theory

According to Cognitive Load Theory (CLT), for learning to occur, two kinds of memory are required, namely, the working memory and the long-term memory. According to Sweller and Chandler (1991), the working memory is characterised by its ability to retain five to nine small pieces of information simultaneously for short periods of time and to temporarily store, manipulate and analyse this information. The long-term memory, on the other hand, retains seemingly unlimited amounts of information for long periods of time but cannot perform the functions of a working memory. Learning occurs as a result of an alteration to long-term memory.

The cognitive load, or mental effort that a learning task or analytical task places upon working memory, is directly related to instructional design. There are three types of cognitive load, namely, intrinsic load, extraneous load and germane load (Sweller & Chandler, 1994). The intrinsic load is the inherent difficulty of a task relative to a student's level of expertise existing in the long-term memory. Learning is impeded if the intrinsic load is either too high or too low. Extraneous load is the unnecessary load created by the use of incorrect instructional design, application or inappropriate content or learning material – all of which fill the working memory with distracting elements. The germane load is the working memory resource needed to create schema from individual elements for long-term memory acquisitions. Germane load is crucial because it not only creates schema but it also activates the schema. In instructional design, to maximise efficiency and understanding, it is necessary to

optimise the intrinsic load relative to the learner while minimising the extraneous load (Kalyuga, Chandler & Sweller, 1998; McNamara, Kintsch, Songer, & Kintsch, 1996; Sweller, van Merriënboer & Paas, 1998).

Although CLT involves new ideas, it also retains important elements of earlier theories such as feedback, grouping and zone of proximal development, and it is consistent with the application of other elements such as the social nature of learning and the effects of learner control in the learning process (Paas, van Gog & Sweller, 2010; Sweller, 2010; Sweller & Chandler, 1991). In the light of this theory, consideration of the cognitive load in online learning can be given. The delivery of an online course intrinsically creates a higher cognitive load, particularly for novice learners (Clark, 2003; Stefano & le Fevre, 2007; Tyler-Smith, 2006) and, therefore, requires mitigating instructional strategies. One such strategy is not to overload the working memory with unnecessary guidance, as this can increase cognitive load (Kalyuga et al., 1998). Also, the online instruction should be consistent with course objectives and provide a degree of learner control to enable movement to different levels of difficulty. Minimising extraneous load is another important consideration and this can be achieved by providing illustrations, models, tables and audio-visual support aimed at reducing the cognitive load that can be created by the use of unending paragraphs of written instructions and content (Halabi, Tuovinen & Farley, 2005).

2.2.2.5 Instructional Design Involving an Eclectic Theory of Learning

The behaviourist, cognitivist and constructivist schools of thought provide many overlaps in terms of ideas and principles that can be used in instructional design

(Ertmer and Newby, 1993). According to Ertmer and Newby (1993), behaviourist strategies can be used to teach the “what” (facts), cognitive strategies can be used to teach the “how” (processes and principles) and constructivist strategies can be used to teach the “why” (higher-level thinking that promotes personal meaning and situated and contextual learning). High-quality online learning environments, therefore, should include elements of behavioural learning theory (e.g., positive reinforcement and repetition), cognitive learning theory (e.g., address multiple senses, present new information in motivating ways, limit the amount of information presented, and connect new information to prior knowledge), and social learning theory (e.g., encourage group interaction, peer assessment and personal feedback). In this way, an eclectic theory of learning can be achieved by integrating the most positive and powerful aspects of each individual learning theory into an online learning environment (Johnson, 1997; Johnson & Aragon, 2002).

2.3 Psychosocial Learning Environments

The psychosocial learning environment refers to the tone, ambience or atmosphere created in a classroom. With respect to the learning environment, Moos (1979, p. vii) coined the terms “social climate” and “personality of the environment”, to describe the learning environment. This section reviews literature related to the theories that have influenced the field of psychosocial learning environments and how this has led educational researchers to study the learning environment as an alterable educational variable which can directly influence students’ cognitive and affective outcomes.

2.3.1 History of the Field of Learning Environments

As discussed in chapter 1, the notion of a learning environment existed as early as 1936 when Lewin proposed that personal behaviour is a result of the interaction between the individual and his/her environment. To this end, he developed the formula $B=f(P,E)$ in which behaviour (B) is a result of the interaction between the person (P) and environmental factors (E). Building on Lewin's theory, Murray (1938) proposed his Needs-Press theory in which an individual's behaviour is affected internally by characteristics of personality (needs) and externally by the environment itself (press). Press, according to Murray (1938) has a directional tendency with properties not obtainable by the sum of the parts of the environment or situation.

Stern, Stein and Bloom (1956) further proposed that the same environment can be perceived differently by different entities, namely, individuals, groups and external observers of the environment. Independent of this thread of research, Stern, Stein and Bloom (1956) also pointed to measurements of educational environments as decisive components for prediction and successful learning manipulation. Hunt (1975), Stern (1970) and Fraser and Fisher (1983) proposed person-environment fit in which an individual is more likely to achieve better outcomes (cognitive and affective) if the environment is more closely matched to the environment that they would prefer.

In 1981, Walberg proposed a nine-factor model of educational productivity in which student outcomes are co-determined by such variables as the quantity and quality of instruction, the psychosocial environments of the school/class, the home, the peer

group and the mass media (Fraser, Walberg, Welch & Hattie, 1987; Walberg, 1981). In their research, carried out to examine whether correlations exist between student outcomes and the various factors proposed in the nine factor model, Fraser, Walberg, Welch and Hattie (1987) found that the psychosocial environment was a strong predictor of both achievement and attitudes even when a comprehensive set of other factors were held constant.

Moos (1991) proposed that the different characteristics of all human environments can be classified into the three broad dimensions of Relationship Dimension, Personal Development Dimension and the System Maintenance and System Change Dimension. The Relationship Dimension assesses “the extent to which people are involved in the setting, the extent to which they support and help each other, and the extent to which they express themselves freely and openly” (Moos, 1979, p. 14). The Personal Development Dimension assesses “the basic directions along which personal growth and self enhancement tend to occur in the particular environment” (Moos, 1976, p. 331). Finally, the System Maintenance and System Change Dimension assess the “extent to which the environment is orderly and clear in its expectations, maintains control and responds to change” (Moos, 1979, p. 16). These dimensions co-exist in all human environments and have been used extensively by researchers in the construction of learning environment instruments (Fraser, 1998a, 1998b, 2007; Walker, 2005) and the classification of individual scales.

In the 1960s, the first two psychosocial learning environment instruments were developed independently of each other: the Learning Environment Inventory (Walberg & Anderson, 1968); and the Classroom Environment Scale (Moos &

Trickett, 1987). Since this time, much work has been done to conceptualise the learning environment and to assess students' perceptions of their educational environments (Fraser, 2007, 2012). The development of an International Journal dedicated to this field of study, *Learning Environments Research* (Fraser, 1998a), as well as books such as *Studies in Educational Learning Environments* (Goh & Khine, 2002) and *Outcomes-Focused Learning Environments* (Aldridge & Fraser, 2008), among others, have helped to inform the worldwide educational community of the importance of this area of research.

The following two sections review literature related to the development of instruments to assess the learning environment (Section 2.3.2) and the types of past research that have been conducted within the field of learning environments (section 2.3.3).

2.3.2 Instruments for Assessing Classroom Environment

Over the past 40 years numerous, valid and reliable instruments have been developed to enable teachers and researchers to assess students' perceptions of the learning environment. These questionnaires have been used at different educational levels and been translated and used in different countries. This section provides a brief description of nine historically-significant and contemporary instruments:

- Learning Environments Inventory (LEI);
- Classroom Environment Scale (CES);
- Individualised Classroom Environment Questionnaire (ICEQ);

- My Class Inventory (MCI);
- College and University Classroom Environment Inventory (CUCEI);
- Questionnaire on Teacher Interaction (QTI);
- Science Laboratory Environment Inventory (SLEI);
- Constructivist Learning Environment Survey (CLES); and
- What is Happening In this Class? (WIHIC) questionnaire.

2.3.2.1 Learning Environments Inventory (LEI)

The Learning Environment Inventory was developed and validated as part of the evaluation and research related to Harvard Project Physics (Walberg & Anderson, 1968). The final version of the inventory consisted of 105 statements, descriptive of typical school classes, in 15 scales. The scales included Cohesiveness, Friction, Favouritism, Cliqueness, Satisfaction, Apathy, Speed, Difficulty, Competitiveness, Diversity, Formality, Material Environment, Goal Description, Disorganisation and Democracy. The items are presented in a cyclic order and the response scale involved the four alternatives of Strongly Disagree, Disagree, Agree or Strongly Agree. Typical statements include ‘All students know each other very well’ (Cohesiveness) and ‘The pace of the class is rushed’ (Speed).

2.3.2.2 Classroom Environment Scale (CES)

This scale was developed by Rudolf Moos at Stanford University (Moos & Trickett, 1974, 1987) as a result of extensive research that involved perceptual measures of a variety of human environments, including, psychiatric hospitals, prisons, university residences and work milieus (Moos, 1974). The final published version of the CES includes nine scales, namely, Involvement, Affiliation, Teacher Support, Task

Orientation, Competition, Order and Organisation, Rule Clarity, Teacher Control and Innovation. There are 10 items in each scale with a True-False response format. Two typical items are ‘The teacher takes a personal interest in the students’ (Teacher Support) and ‘There is a clear set of rules for students to follow’ (Rule Clarity).

2.3.2.3 Individualised Classroom Environment Questionnaire (ICEQ)

The Individualised Classroom Environment Questionnaire (ICEQ) assesses dimensions which distinguish individualised classrooms from traditional ones. The published version of the ICEQ (Fraser, 1990; Rentoul & Fraser, 1979) has 50 items with 10 items in each of 5 scales, namely, Personalisation, Participation, Independence, Investigation and Differentiation. Each item is responded to using a five-point frequency scale of Almost Never, Seldom, Sometimes, Often and Very Often. Typical items include ‘The teacher considers students’ feelings’ (Personalisation) and ‘Different students use different books, equipment and materials’ (Differentiation).

2.3.2.4 My Class Inventory (MCI)

The My Class Inventory (MCI) is a simplified version of the LEI, developed for use with children aged 8–12 (Fraser, Anderson & Walberg, 1982; Fisher & Fraser, 1981; Fraser & O’Brien, 1985). Although initially developed for use with primary school students, the MCI has been found to also be useful for research involving secondary school students who experience reading difficulty. To make the instrument more manageable for younger children, the items were simplified to make it easier to read, the number of items and scales were reduced and the response format was simplified to a Yes–No format. Goh, Young and Fraser (1995) subsequently used a three-point

response format of Seldom, Sometimes and Most of the Time to provide a more meaningful response format. The final version has 35 items within five scales, namely, Cohesiveness, Friction, Satisfaction, Difficulty and Competitiveness. Typical items include: 'Children are always fighting with each other' (Friction) and 'Children seem to like the class' (Satisfaction).

The MCI has been used successfully in a number of countries, including, Brunei Darussalam (Majeed, Fraser & Aldridge, 2002), the US (Scott Houston, Fraser & Ledbetter, 2008; Sink & Spencer, 2005) and Singapore (Goh, Young & Fraser, 1995). In Brunei Darussalam, the MCI was used among 1565 lower secondary mathematics students, and was found to have satisfactory factorial validity (Majeed, Fraser & Aldridge, 2002). In the US, two independent studies, one involving a sample of 2835 students in grades 4 to 6 (Sink & Spencer, 2005), one involving 588 grade 3 to 5 students (Scott Houston, Fraser & Ledbetter, 2008) both found the MCI to have a satisfactory psychometric properties.

2.3.2.5 College and University Classroom Environment Inventory (CUCEI)

To fill the void of research in the area of classroom environment research at the higher education level the College and University Classroom Environment Inventory (CUCEI) was developed (Fraser & Treagust, 1986; Fraser, Treagust & Dennis, 1986). The CUCEI was developed for use in tutorial classes (up to 30 students) and includes the seven scales of Personalisation, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation and Individualisation. The response format involves a four-point rating scale of Strongly Agree, Agree, Disagree and Strongly Disagree. Typical items include 'Activities in this class are clearly and carefully

planned' (Task Orientation) and 'Teaching approaches allow students to proceed at their own pace' (Individualisation).

2.3.2.6 Questionnaire on Teacher Interaction (QTI)

Past research has shown that the interactions of the teacher can influence student outcomes. Although there is generally no direct teacher interaction within an online subject, its role in creating an effective face-to-face learning environment is important. As one of the nine historically important questionnaires (Fraser, 2007), the QTI was examined. The Questionnaire on Teacher Interaction (QTI) was developed in the Netherlands by Wubbels, Creton and Hooymayers (1992) to evaluate students' and teachers' perception of interpersonal teacher behaviour. The QTI was based on Leary's (1957) work of Interpersonal Diagnosis of Personality. The theoretical model maps interpersonal behaviour using an *influence* dimension (Dominance – Submission) and a *proximity* dimension (Cooperation – Opposition) (Wubbels & Brekelmans, 2005; Wubbels & Levy, 1993). These dimensions are represented in a coordinate system divided into eight equal sectors which are Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing, and Strict behaviour (Wubbels et al., 1992). The response format involves a five-point rating scale that ranges from Never to Always.

The QTI has been translated into different languages including Standard Malay, Korean and Indonesian and cross-validated at different grade levels in the USA (Wubbels & Levy, 1993), Australia (Fisher, Henderson & Fraser, 1995; Henderson, Fisher & Fraser, 2000), Singapore (Goh & Fraser, 1998; Quek, Wong & Fraser,

2005), Korea (Kim, Fisher & Fraser, 2000; Lee, Fraser & Fisher, 2003), Brunei (Scott & Fisher, 2004) and Indonesia (Fraser, Aldridge & Soerjaningsih, 2010).

2.3.2.7 Science Laboratory Environment Inventory (SLEI)

The Science Laboratory Environment Inventory (SLEI) was developed by Fraser, Giddings and McRobbie (1995) to assess the unique setting of science laboratory classes. The SLEI has seven items in each of five scales, namely, Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment (Fraser et al., 1995; Fraser & McRobbie, 1995; Fraser, McRobbie & Giddings, 1993). The response format involves a five-point frequency scale consisting of Almost Never, Seldom, Sometimes, Often and Very Often. Typical items are 'I use the theory from my regular science class sessions during laboratory activities' (Integration) and 'We know the results that we are supposed to get before we commence a laboratory activity' (Open-Endedness).

The SLEI has been used in studies around the world. When the SLEI was originally field tested, the sample involved 5447 students from six different countries, these being, the USA, Canada, England, Israel, Australia and Nigeria. In the US, Lightburn and Fraser (2007) used the SLEI with a sample of 761 high school biology students to examine the effectiveness of using anthropometry activities. The study reported the validity of the SLEI as well as the positive influence of anthropometry activities on the learning environment. In Korea, the SLEI was translated and used to examine whether perception differences in the learning environment existed for three science streams (Fraser & Lee, 2009). The study involved 439 high school science students and reported the factorial validity of the Korean version of the SLEI. The study also

reported that students in different science streams perceived the learning environment differently.

2.3.2.8 Constructivist Learning Environment Survey (CLES)

The Constructivist Learning Environment Survey (CLES) was developed to assess the extent to which a particular classroom's environment is consistent with the constructivist epistemology and to help teachers to reflect on their epistemological assumptions and to reshape their teaching practice (Taylor, Dawson & Fraser, 1995; Taylor, Fraser & Fisher, 1997). To the constructivist, meaningful learning is an active process of constructing rather than acquiring knowledge, and instruction is a 'process of supporting that construction rather than communicating knowledge' (Duffy & Cunningham 1996, p. 171). The CLES has six items in each of five scales, these being, Personal Relevance, Uncertainty, Critical Voice, Shared Control and Student Negotiation. The response format involves a five-point frequency scale of Almost Never, Seldom, Sometimes, Often and Almost Always. The CLES was the first learning environment instrument to order the items in scales rather than cyclically to provide students with contextual cues, thereby improving the reliability of the instrument (Taylor, Fraser & Fisher, 1997). Two typical items are 'I learn that Science has changed over time' (Uncertainty) and 'It's okay for me to express my opinions' (Critical Voice).

The reliability and usefulness of the CLES has been reported in numerous studies. The CLES was used in a cross-national study involving Taiwan and Australia (Aldridge, Fraser, Taylor & Chen, 2000), in which the CLES was administered to 1081 students in 50 classes in Australia and a mandarin version of the CLES was

administered to 1879 students in 50 classes in Taiwan. The study reported sound psychometric properties of the CLES when used in both countries. In addition, the results indicated that Australian students perceived a more constructivist learning environment than their Taiwanese counterparts.

The CLES has been used in several studies in the US. Peiro and Fraser (2009) modified and translated the CLES into Spanish and administered Spanish and English versions to 739 K-3 science students. Analysis of the data supported the validity of this modified version when used with young children. Johnson and McClure (2004) validated a 20-item version of the CLES. Nix, Fraser and Ledbetter (2005; 2009) used this 20-item version of the CLES with 1079 students in 59 science classes and reported sound psychometric properties for the revised version.

In South Africa, Aldridge, Fraser and Sebela (2004) used the CLES with 1864 grade 4 to 6 mathematics students. The results reported the sound factorial validity and internal consistency of the CLES when used with this group of students.

2.3.2.9 What Is Happening In this Class? (WIHIC) Questionnaire

The What Is Happening In this Class? (WIHIC) questionnaire was developed by Fraser, Fisher and McRobbie (1996) to address contemporary educational concerns. The WIHIC combines modified versions of salient scales from different questionnaires with scales that address concerns such as equity and constructivism. The WIHIC is available in two versions, namely, a class form (which assesses a student's perceptions of the class as a whole) and a personal form (which assesses a student's personal perceptions of his her role in a classroom). The original 90-item

version was later refined to include 56 items in seven scales, these being Student Cohesiveness, Teacher Support, Involvement, Investigation, Task orientation, Cooperation and Equity (Aldridge, Fraser & Huang, 1999; Dorman, 2003). Two typical items include 'I give my opinions during class discussions' (Involvement) and 'I receive the same encouragement from the teacher as other students do' (Equity).

The WIHIC is perhaps the most widely used of all of the learning environment questionnaires. It has been translated into numerous languages and used in many countries. Aldridge, Fraser and Huang (1999) cross validated the WIHIC with a sample of 1879 high school students in 50 classes in Taiwan and 1081 high school students in 50 classes in Australia (Aldridge, Fraser & Huang, 1999).

The WIHIC has also been validated in independent studies in Singapore (Chionh & Fraser, 2009; Khoo & Fraser, 2008), India (Koul & Fisher, 2005), South Africa (Aldridge, Fraser & Ntuli, 2009), Indonesia (Fraser, Aldridge & Adolphe, 2010; Wahyudi & Treagust, 2000), Korea (Kim, Fisher & Fraser, 2000), the US (Allen & Fraser, 2007; Ogbeuhi & Fraser, 2007; Wolf & Fraser, 2008), the United Arab Emirates (Afari, Aldridge, Fraser & Khine, in press; MacLeod & Fraser, 2010), Canada (Zandvliet & Fraser, 2004, 2005) and Australia, Canada and the UK (Dorman, 2003).

Perhaps the most comprehensive validation of the WIHIC was by Dorman (2003) who used a sample of 3980 high school students from Australia, Canada and the UK.

His analysis of the data utilised a confirmatory factor analysis that supported the seven scale *a priori* factor structure.

Whilst this section has described some of the historically important and contemporary instruments in the field of learning environments, the following section reviews instruments developed to investigate online learning environments.

2.3.3 Instruments Used to Assess Online Learning Environments

Over the past two decades there has been an increasing focus on developing instruments to assess the learning environments created online, including the use of computers, network technologies and software technologies such as internet browsers. In this section, instruments that have been used to investigate the learning environment created by the use of computers or the World Wide Web are examined.

- Computer Laboratory Environment Inventory (CLEI)
- Constructivist On-line Learning Environment Survey (COLLES)
- Web-Based Learning Environment Inventory (WEBLEI)
- Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)
- Online Learning Environment Survey (OLES)
- Distance Education Learning Environments Survey (DELES)
- On-Line Learning Environment Survey (OLLES)
- Constructivist Multimedia Learning Environment Survey (CMLES)

2.3.3.1 Computer Laboratory Environment Inventory (CLEI)

To assess the learning environment of a computer laboratory, Newby and Fisher (1997) developed the Computer Laboratory Environment Inventory (CLEI). The scales of the Computer Laboratory Environment Inventory were modified from the Science Laboratory Environment Inventory. The Computer Laboratory Environment Inventory (CLEI) has five seven-item scales, namely, Student Cohesiveness, Open-Endedness, Integration, Technology Adequacy and Material Environment. The CLEI was developed for use at the tertiary level and used with a sample of 50 business students. Although each scale was found to have adequate reliability, it was concluded by Newby and Fisher (1997) that the instrument should be refined and developed to suit the context of future research.

2.3.3.2 Constructivist On-line Learning Environment Survey (COLLES)

The Constructivist On-line Learning Environment Survey (COLLES) was developed by Taylor and Maor (2000) to assess students' and tutors' perceptions of online learning from a social constructivist perspective. The COLLES was developed to support the use of the on-line environment for delivering postgraduate professional development programs to teachers of science, mathematics and technology.

The COLLES comprises 24 items, grouped into six scales, namely, Emancipatory Activities, Co-participatory Activities, Qualia and Information Structure and Design Activities. According to Taylor and Maor (2000), the COLLES is a reliable and useful tool for assessing the educational benefits of online education. There are three forms of the COLLES: a preferred form; an actual form; and a combined actual and

preferred form. The COLLES has a five-point frequency response scale consisting of Almost Never, Seldom, Sometimes, Often, Almost Always.

2.3.3.3 Web-Based Learning Environment Inventory (WEBLEI)

Chang and Fisher (2001) developed the Web-Based Learning Environment Inventory (WEBLEI) to assess the effectiveness of web-based learning environments. This instrument was utilised with a cohort of undergraduate and graduate students. The instrument includes six scales, namely, Professional Relevance, Reflective Thinking, Interactivity, Cognitive Demand, Affective Support, and Interpretation of Meaning. This instrument uses a five-point frequency scale with the response options of Almost Never, Seldom, Sometimes, Often, and Almost Always.

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

The Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) (Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser, 2008, 2011) is based largely on the What Is Happening In this Class? (WIHIC) questionnaire. The TROFLEI was developed to investigate students' perceptions of their outcomes-focused, technology-rich setting. The TROFLEI has 77 items in 10 scales, namely, Student Cohesiveness, Teacher support, Involvement, Task Orientation, Investigation, Cooperation, Equity, Differentiation, Computer Usage, and Young Adult Ethos. All items have a positive scoring direction and, to provide a more economical format, the TROFLEI pioneered the inclusion of two adjacent response scales on one sheet where the responses were for both their perception of their actual class and what they would prefer in their class. This instrument uses a five-point

frequency scale with the response options of Almost Never, Seldom, Sometimes, Often, and Almost Always.

The TROFLEI has been used at the high-school level across a number of different courses and learning areas. Using data collected from 2317 students in 166 classes, support the 10-scale *a priori* factor structure, internal consistency, discriminant validity and ability to differentiate between classes were strongly supported (Aldridge & Fraser, 2008).

The TROFLEI was also used in monitoring the success of educational programs over four years in promoting outcomes-focused learning environments at an innovative new senior high school. The sample consisted of 449 students in 2001, 626 students in 2002, 471 students in 2003 and 372 students in 2004. There were statistically significant differences in students' perceptions of classroom environment over the years from 2001 to 2004 for seven of the ten TROFLEI scales (Aldridge & Fraser, 2011).

2.3.3.5 Online Learning Environment Survey (OLES)

Scales relevant to online learning environment were selected from various learning environment surveys and inventories to create the Online Learning Environment Survey (OLES) (Trinidad, Aldridge & Fraser, 2005). The OLES has 62 items in 8 scales, namely, Computer Usage, Technical Support, Student Interaction and Collaboration, Personal Relevance, Authentic Learning, Student Autonomy, Equity, and Asynchronicity. The OLES includes two separate response forms, one allowing students to indicate how often they perceive a classroom practice as actually

happening, and the other to indicate how often they would prefer that practice to happen. In each case, students responded on a five-point frequency scale of Almost Always, Often, Sometimes, Seldom and Almost Never.

When the OLES was administered to a sample of 325 high school students, analysis of the data supported the *a priori* factor structure and internal consistency reliability (Trinidad, Aldridge & Fraser, 2005). The results indicated that the OLES could be used with confidence to examine ways in which educators can make improvements in e-learning environments. Although the survey is detailed and suitable for online learning environments, the aim of the current research was to study the comparative nature of the two learning environments (i.e. the face-to-face course and the learning environment of the online course).

2.3.3.6 *Distance Education Learning Environments Survey (DELES)*

Walker and Fraser (2005) developed the Distance Education Learning Environments Survey to assess students' perceptions of learning in distributed environments and dispersed locations. It is a six-scale, 34-item Web-based learning environment instrument suitable for use in asynchronous post-secondary distance education environments. The new instrument, the Distance Education Learning Environment Survey (DELES) assesses Instructor Support, Student Interaction and Collaboration, Personal Relevance, Authentic Learning, Active Learning, and Student Autonomy. Analyses of data obtained from 680 university students supported the factorial validity and internal consistency reliability. The results also indicated statistically significant associations between the distance education learning environment and student enjoyment of distance education.

2.3.3.7 On-Line Learning Environment Survey (OLLES)

The On-line Learning Environment Survey (OLLES) was developed by Clayton (2004) to assess students' perceptions of the online learning environment at higher educational institutions. The OLLES includes eight scales, namely, Computer Competency, Material Environment, Student Collaboration, Tutor support, Active Learning, Order and Organisation, Information Design and Appeal, and Reflective Thinking.

The instrument was validated (factorial validity and internal consistency reliability) with a sample of 104 tertiary-level students to demonstrate the feasibility of developing a perceptual measure that could be used to examine the learning environments created when using connected computers and the World Wide Web.

2.3.3.8 Constructivist Multimedia Learning Environment Survey (CMLES)

The Constructivist Multimedia Learning Environment Survey (CMLES) was developed by Maor and Fraser (2005) to assess the learning environment of students interacting with science multimedia programs. The CMLES was designed to examine the degree to which students and teachers perceive that their classroom environment involves students in negotiations, inquiry learning and reflective thinking. The first part of the questionnaire measures students' perceptions of the process of learning with a multimedia program and contains three scales: Student Negotiation, Inquiry Learning and Reflective Thinking. The second part of the CMLES measures students' reactions to the interactive multimedia program and contains three new scales, Authenticity, Complexity and Challenge. There are 30 items in the CMLES, with five items in each scale.

A study involving 221 students in 12 high school (grade 10 and 11) classrooms was used to validate the questionnaire. For this sample, the CMLES scales demonstrated a high degree of internal consistency reliability and satisfactory factorial validity and discriminant validity.

Although each of these questionnaires is worthy of note, no single instrument was able to capture the unique setting at the polytechnic in which the study took place. Therefore, this study involved developing a new questionnaire which drew on salient scales within these existing instruments.

2.3.4 Types of Research within the Field of Learning Environments

As discussed in the previous sections, numerous questionnaires have been developed to assess students' perceptions of their classroom learning environments (Fraser, 2007). The present research drew on this huge array of questionnaires (developed for both online and face-to-face classrooms) described in the previous sections to assist in evaluating the effectiveness of a newly-developed online course. These questionnaires have the potential to provide a range of information about factors such as: whether a class is learner-centred or teacher-centred; whether there is active participation or passive reception in class; whether students are undertaking collaborative work; whether the teacher is approachable and supportive; whether students have a say in the choice of teaching and assessment methods; and whether differences in students' interests and pace of working are taken into consideration by the teacher (Fraser, 2007, 2012).

Past research within the field of learning environments provides many research models and methods that were of relevance to the present study. Reviews of classroom environment work (Fraser, 2007, 2012) have delineated at least 10 areas of classroom environment research, including: identifying differences in perceptions of the classroom environment between students and their teachers (Fisher & Fraser, 1983); identifying exemplary teachers (Waldrup, Fisher & Dorman, 2009); and guiding teacher's decisions about implementing strategies to change their classroom environments (Aldridge, Fraser, Bell & Dorman, in press; Aldridge, Fraser & Sebela, 2004; Waldrup, Reene, Fisher & Dorman, 2008). Determinants of the classroom environment have also been identified, including: cultural differences involving the race of the teacher in Brunei (Khine, 2002); the socio-cultural beliefs of students (Jegade, Fraser & Okebukola, 1994); in Korea, whether students were science or humanities orientated (Lee, Fraser & Fisher, 2003); and gender difference across several countries (Chionh & Fraser, 2009; Quek, Wong & Fraser, 2005). Large cross-national studies have also been carried out for the purpose of gaining new insights into areas such as teaching methods and student attitudes that might be overlooked within one culture (Aldridge, Fraser & Huang, 1999; Aldridge, Fraser, Taylor & Chen, 2000; Fraser, Aldridge & Adolphe, 2010).

Of particular relevance to the present study was past research related to (1) associations between the learning environment and student outcomes and (2) the evaluation of educational innovations. Each of these areas of past research is reviewed below. The present study drew on and extended this research.

2.3.4.1 Associations between the Learning Environment and Student Outcomes

Over the past 40 years there have been numerous classroom environment studies conducted around the world with a variety of purposes (Fisher & Khine, 2006; Fraser, 2007, 2012). One of the strongest themes in past classroom learning environment research has involved investigations into associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their classroom environments (Fraser & Fisher, 1982; Haertel, Walberg & Haertel, 1981; McRobbie & Fraser, 1993). Numerous studies have shown that students' perceptions of their classroom environments, relative to students' background characteristics, are closely associated with their learning outcomes – that is, the more favourable that students' perceptions of the learning environment are, the better they learn (Dorman & Fraser, 2009; Fraser & Fisher, 1982; Wang, Haertel, & Walberg, 1993; Waxman & Huang, 1998). According to Fraser (2001), those teachers and lecturers wishing to improve the effectiveness of schools and universities should not ignore the strong influence of the learning environment.

Learning environments research has consistently demonstrated that, across nations, languages, cultures, subject matter and educational levels, there are associations between classroom environment perceptions and student outcomes (Fraser, 1998a, 1998b, 2007). For example, in Singapore, several studies have been conducted. Wong and Fraser (1996) established links between students' attitudes and scores on SLEI scales for a sample of 1592 Grade 10 chemistry students in 56 classes. Goh and Fraser (1998, 2000) used the MCI and the QTI with 1512 primary mathematics students in 39 classes to establish associations between the classroom environment and mathematics achievement and attitudes. Chionh and Fraser (2009) reported

associations between WIHIC scales and three student outcomes (examination results, attitudes and self-esteem) among a sample of 2310 mathematics and geography students in 75 classes. Using both the SLEI and the QTI, Quek, Fraser and Wong, (2005) recorded links with student attitudes for a sample of 497 gifted and non-gifted secondary school chemistry students. Khoo and Fraser (2008) established links between student satisfaction and dimensions of the WIHIC for a sample of 250 adults attending 23 computing classes. Using an instrument suited for computer-assisted instruction classrooms, Teh and Fraser (1995a, 1995b) found associations between classroom environment, achievement and attitudes among a sample of 671 high school geography students in 24 classes in Singapore. Finally, Waldrup and Wong (1996) reported attitude-environment associations when they used the SLEI in both Singapore and Papua New Guinea.

In a more recent study, Dorman and Fraser (2009) found positive relationships between students' perceptions of the learning environment and attitudinal outcomes. This research has been replicated: in India, where Koul and Fisher (2005) found positive associations between scales of the WIHIC and students' attitude to science; in Turkey, where Telli, Cakiroglu and den Brok (2006) found positive associations between the learning environment and attitudes towards biology; and, in Cyprus, where Kyriakides (2006) found positive associations between perceptions of the teacher's interactions with students and affective outcomes. These strong links between dimensions of the learning environment and student outcomes have been replicated in other countries including Brunei Darussalam (Majeed, Fraser & Aldridge, 2002; Scott & Fisher, 2001, 2004), Korea (Lee, Fraser & Fisher, 2003; Fraser & Lee, 2009; Kim, Fisher & Fraser, 1999), Taiwan (Aldridge, Fraser &

Huang, 1999; Aldridge & Fraser, 2000), Indonesia (Fraser, Aldridge & Adolphe, 2010; Fraser, Aldridge & Soerjaningsih, 2010; Margianti, Aldridge & Fraser, 2004).

Research investigating associations between the learning environment and student outcomes has been carried out across a range of subjects and educational levels for a range of different outcomes. For example, in New York, Wolf and Fraser (2008) investigated the relationship between perceptions of the learning environment, attitudes and achievement, in Australia, Dorman (2001) investigated associations between the learning environment and academic efficacy and, in Texas, Walker and Fraser (2005) examined relationships between the learning environment and student enjoyment.

Two studies in Singapore compared the results from multiple regression analysis with those from an analysis involving the hierarchical linear model, which acknowledges the hierarchical nature of classroom settings (Goh, Young & Fraser, 1995; Goh & Fraser, 1998; Wong, Young & Fraser, 1997). In all cases, most of the statistically significant results from the multiple regression analyses were replicated in the HLM analyses, as well as being consistent in direction. Generally, these studies confirmed that the classroom environment accounted for variance in student outcome measures.

2.3.4.2 Evaluating Educational Innovations

Another important application of learning questionnaires in past research has been as a source of process criteria of effectiveness in curriculum evaluation. Past research has indicated that student responses to learning environment instruments have

allowed researchers to differentiate revealingly between alternative curricula even when student outcome measures have shown little sensitivity (Fraser, Williamson & Tobin, 1987).

An evaluation of the Australian Science Education Project study (Fraser, 1979) revealed that, when compared with a control group, students perceived their classrooms as being more satisfying and individualised and as having a better material environment. This research is significant because it demonstrated that learning environment criteria were able to differentiate between curricula, even when various outcome measures showed negligible differences (Fraser, 2007). One of the objectives of the present study was to evaluate and compare an online course with a face-to-face course in terms of the learning environment created in each.

In Singapore, classroom environment instruments have been used to evaluate educational innovations including computer-assisted learning (Teh & Fraser, 1994a, 1994b) and computer courses for adults (Khoo & Fraser, 2008). In other countries, such as Australia, classroom environment instruments have been used for the evaluation of an outcomes-focused, technology-rich school (Aldridge & Fraser, 2008). The use of learning environment criteria has illuminated the impact of a wide range of new educational programs or approaches including computer-assisted learning in Australia (Maor & Fraser, 1996, 2005) and Canada (Raaflaub & Fraser, 2002); innovations involving anthropology activities in science education in the US (Lightburn & Fraser, 2007); Year 11 earth science in Korea (Cho, Yager, Park & Seo, 2004); inquiry-based science instruction for middle-school students (Wolf & Fraser, 2008); an innovative science course for prospective elementary students

(Martin-Dunlop & Fraser, 2008); and the effectiveness of the Science and Mathematics Integrated with Literary Experiences (SMILE) project carried out with fifth grade students in the United States (Mink & Fraser, 2005). Three of these studies are described in more detail below.

Lightburn and Fraser (2007) used the Science Laboratory Environment Inventory (SLEI) to evaluate the effectiveness of using anthropology activities in science education. Their study involved a sample of 761 high school students in South Florida and the results indicated that, relative to a comparison group, students' perceptions were more positive on some scales of the SLEI.

Martin-Dunlop and Fraser (2008) used scales from the SLEI and the WIHIC in their evaluation of the effectiveness of an innovative science course for prospective teachers. Using a pre-post design, with a sample involving 525 university students in 27 classes in California, students reported statistically significant improvements on all seven scales assessing the laboratory learning environment and attitudes towards science. The largest gains were observed for Open-Endedness and Material Environment (with effect sizes of 6.74 and 3.82 standard deviations, respectively).

Nix, Fraser and Ledbetter (2005) evaluated an innovative science teacher professional development programme that was based on the Integrated Science Learning Environment Model. They used the Constructivist Learning Environment Survey (CLES), with a unique side-by-side format, to examine 445 students' perceptions of the learning environments created by the teachers who had attended the professional development opportunity and to compare them with the classes of

other teachers who had not. Students perceived the classes of teachers who had attended the teacher development course to have higher levels of Personal Relevance and Uncertainty (as assessed by the CLES) than the comparison classes.

The present study drew on and extended research in the field of learning environments by using a learning environment instrument (developed for the purpose of this study) to help to assess the effectiveness of a newly-developed online course.

2.4 Roles of Attitudes in Learning

Although past studies have examined associations between student attitudinal outcomes and student perceptions of the learning environment in science classes (Fraser, 1998a), my study is distinctive in that it is the first that specifically focused on students in an online learning environment and compared their attitudes to their face-to-face learning environment, with particular reference to enjoyment, academic efficacy and anxiety.

Paying attention to the role of attitudes in learning is important because of the psychological differences between perception of the learning environment and the attitudes to Learning environment. While perception is the process by which people interpret and organize sensation to produce a meaningful experience of the world (Lindsay & Norman, 1977), an attitude is defined as a positive or negative evaluation of people, objects, events, activities, ideas, or just about anything in that environment (Zimbardo & Leippe, 1991). According to Bartlett (1932), information processing is an active process that is guided and shaped by people's generic beliefs about the

world (i.e. schematic thinking: see also Brewer & Nakamura, 1984; Neisser, 1976; Schank & Abelson, 1977). As such, rather than responding to the world as it genuinely is, people's inferences and memories are embellished by schematic forces that guide information-processing and its associated products in an expectancy-consistent manner. Consistent with the object appraisal function that attitudes presumably serve (Katz, 1960; Smith, Bruner & White, 1956) and with the constructive nature of perception, individuals' attitudes may guide such perceptions.

In the past, research involving science students' outcomes focused primarily on educational objectives in the cognitive domain (Weinburgh, 1995) but, in more recent times, it has been acknowledged that stimulating students' motivation to learn is one of the greatest challenges for teachers (Theobald, 2006). Research has revealed that students' attitudes are an important affective component because they play a central role in their conceptual change processes, critical thinking, learning strategies and achievement (Kuyper, van der Werf & Lubbers, 2000; Shulman & Tamir, 1972).

Reid's (2006) definition of attitudes involves three components, namely, cognitive (knowledge of the object, belief or ideas), affective (feelings regarding the object, such as like or dislike) and behavioural (the tendency towards an action or objective). Other researchers have tended to view these three components more independently and as the basis of 'evaluative judgements', such as when we judge something emotively such as good or bad, like or dislike (Crano & Prislin, 2006). Such a definition enables researchers to distinguish attitudes from emotions or behaviours. Kind, Jones and Barmby (2007, p. 873) provide a definition based on these

components of attitudes as “the feelings that a person has about an object [evaluative attitudes are always towards something often called an attitude object] based on their beliefs about that object”. This definition of attitudes is very similar to what was used in my study.

Culpan (1995) stated that, no matter how sophisticated and how capable the technologies, its effective implementation depends upon users having a positive attitude towards it. Although the concept of attitude towards computers has gained recognition as a critical determinant in the use and acceptance of information technology, there is no single, universally-accepted definition of the computer attitude construct. Brock and Sulsky (1994) indicated that attitudes toward computers are composed of two distinct factors: the belief that computers are a beneficial tool; and the belief that computers are autonomous entities.

Learners form views about their own competence and learning characteristics. These have considerable impact on the way in which they set goals, the strategies that they use and their achievement (Zimmerman, 2008). Two ways of defining these beliefs are: in terms of how well students think that they can handle even difficult tasks – self efficacy (Bandura, 1994); and in terms of their belief in their own abilities – self-concept (Marsh, 1993a, 1993b). These two constructs are closely associated with one another, but nonetheless are distinct.

Attitude has been viewed as having many components or facets. Some researchers (Fazio & Zanna, 1981; Insko & Schopler, 1972) view attitude as unidimensional. According to Cotterall (1995, p. 195), a student’s attitude to learning can influence

his or her learning behaviour and learning outcomes. When the use of the term is restricted to only the affective dimension, attitude is regarded as a unidimensional construct. Some researchers have emphasised that attitudes also involve both cognitive and affective aspects (Bagozzi & Burnkrant, 1979; Mohsin, 1990; Oppenheim, 1992; Hilgard, 1980; Triandis, 1971). Researchers have also indicated that attitudes involve three components: cognition, affect, and conation (the behavioural component). They suggested that feelings toward an attitude object and beliefs about the characteristics of the attitude object impact on behaviour.

My study explored relationships between an online learning environment and three student affective outcomes – enjoyment, academic efficacy and anxiety – which are discussed in turn below.

2.4.1 Enjoyment of Courses

A review of literature suggests that affective factors remain, for the most part, without much notice in discussions concerning learning. However, if the apparently irreversible move toward learner-centredness is to become more highly refined and responsive, then there is a need to tackle, head-on, the highly problematic issue of enjoyment in education (Bigum, Fitzclarence & Kenway, 1993). While there is an obviousness to a statement from Daningburg and Schmid (1988 p.185) that “learning and enjoyment are not mutually exclusive”, it nonetheless seems necessary to re-state this truism. According to Goldfayl (1995), there is an entertainment-education continuum which, at one extreme, involves strictly cognition-orientated materials with dry and un-engaging content for the learner and, at the other, involves materials

which seem driven by high-technology aimed at the middle-brow and of low educational value.

To assess students' enjoyment of their online course or face-to-face course, my study made use of an enjoyment scale that originated from Fraser's (1981) Test of Science-Related Attitudes (TOSRA). The TOSRA was selected for use in this study because it overcomes most of the problems addressed associated with past questionnaires developed to assess students' attitudes (Kind, Jones and Barmby, 2007). The scales of the original TOSRA are based on Klopfer's (1971) classification of students' attitudinal aims: attitude to science and scientists, attitude to inquiry, adoption of scientific attitudes, enjoyment of science learning experiences, interest in science, and interest in a career in science. For the purpose of this study, one scale, called Enjoyment of Science Lessons, was selected. This scale has been modified and used in numerous past studies. This scale was selected for its usefulness in terms of assessing students' enjoyment of a course. In addition, the TOSRA has been modified and used successfully in a variety of settings and for different courses. The version selected for use in the current study was adapted by Aldridge, Fraser and Huang (1999) was been found to be reliable in past studies (Aldridge & Fraser, 2008; Aldridge, Fraser & Huang, 1999).

2.4.2 Academic Efficacy

An individual's academic-efficacy refers to the subjective assessment of his or her own ability to learn a subject. An individual's level of self-efficacy is thought to relate to the individual's choice of activities, effort in those activities, and

perseverance in the activities (Bandura, 1977). Research has shown that self-efficacy is related to performance across a variety of behaviours (e.g., Hackett & Betz, 1989; Lopez & Lent, 1992; Pajares & Miller, 1994). Bandura (1977, 1997) argued that researchers would find the most utility from self-efficacy by focusing on a specific context and activity domain, highlighting the fact that measurements of self-efficacies should be task-specific or context-specific and not global in nature.

Perceived academic efficacy refers to students' judgements of their ability to master the academic tasks that they are given in their classrooms. Past research into academic efficacy includes a study by Taylor (2004) which made use of a modified version of a seven-item scale using items developed by Midgely and Urdan (1995, 1996). When Dorman (2001) investigated associations between students' perceptions of their classroom psychosocial environment and academic efficacy, the classroom environment perceived by students was statistically significantly associated with their academic efficacy. Aldridge and Fraser (2008, 2011) modified the Morgan Jinks Efficacy Scale (Jinks & Morgan, 1999) for use with students in senior high schools. In a study involving 2317 students, the revised self-efficacy scale was found to have high internal consistency reliability (Aldridge & Fraser, 2008). In addition, environment perceptions were found to be related to self-efficacy (Aldridge & Fraser, 2008).

Because of its applicability and reliability across a number of subjects and learning areas, I adapted Aldridge and Fraser's (2008) self-efficacy scale to assess the academic efficacy of students enrolled in the online and face-to-face courses.

2.4.3 Student Anxiety

Anxiety is a "transitory emotional state or condition characterised by feelings of tension and apprehension and heightened autonomic nervous system activity" (Spielberger, 1972, p. 24), a state which can have both negative and positive effects, which can either motivate and facilitate or disrupt and inhibit cognitive actions such as learning. Izard (1972) defines three types of anxiety (trait anxiety, state anxiety, and situation-specific anxiety) identifying reactions of fear, distress, anger and shame (including shyness and guilt) on the negative side, and interest and excitement on the positive side. Williams and Burden (1997, p. 92), in their work with language anxiety, point out that anxiety is "highly situation specific and itself affected by a number of other factors". According to Hembree (1988), anxiety can inhibit productive cognitive processes by reducing the availability of working memory, thereby creating difficulties in the learning process. Anxiety can also influence learning and the acquisition of knowledge, which then leads to lower performance (Tobias, 1985). To this end, some more recent studies have reported associations between student anxiety and student outcomes (Dane, 2005; Daniels et al., 2009).

Anxiety has also been shown to lower levels of motivation in highly evaluative learning environments and to impact learning strategies (Daniels et al, 2008, 2009; Hancock, 2001). The cumulative effect of anxiety, given its pervasiveness, can ultimately be detrimental to a student's overall learning (Manning, 2007). In 2001, a study by Ashcraft and Kirk (2001) indicated that students with high levels of mathematics anxiety had lower performance on cognitive tasks, both mathematical

and non-mathematical, that required a working memory. Their research suggests that anxiety associated with one specific area can have effects on unrelated areas.

From the online learning perspective, investigating anxiety can help to develop methods to suitably modify the learning environment to make it less stressful and more conducive for learning. According to Ropp's (1999) review of the literature, most research concludes that the less experience that people have with computers, the more computer anxiety that they exhibit.

The results of past research that has investigated associations between the learning environment and anxiety suggest that the learning environment can be modified to make it less stressful and more conducive for learning (Taylor, 2005). Taylor used a revised version of Plake and Parker's (1982) 24-item Mathematics anxiety Rating Scale (MARS) to assess two conceptually distinct dimensions of mathematics anxiety, namely, Learning Mathematics Anxiety and Mathematics Evaluation Anxiety. Past studies, including Taylor's (2005) study found the scales to have strong psychometric properties (Capraro, Capraro & Henson, 2001; Hannafin, 1985; Kazelskis, 1988). Using Taylor's modified version of the MARS, I developed a new scale to assess students' underlying levels of anxiety when undertaking online and face-to-face courses.

2.5 Chapter Summary

This chapter has provided a review of literature pertinent to this research including: online education and learning, psychosocial learning environment; and the role of attitudes in learning.

The impact of Information and Computer Technology (ICT) has given place to technology-rich classrooms and provided a means of flexible teaching that hitherto has been unheard of. These emerging technologies have impacted learning and the learning environments created online. There are numerous terms used to describe online learning (such as e-learning or web-based learning), different definitions of what constitutes online learning and a range of modes, or combinations of online learning and face-to-face learning. Online learning can extend from basic programmes that include text and graphics through to sophisticated programmes. For the purpose of this research, Gallaher and Wentling's (2004) definition of online learning as the acquisition and use of knowledge distributed and facilitated primarily by electronic means was used.

Research has provided conclusive evidence that it is not the technology itself but, rather, the quality of the instructional strategies and appropriate blend of learning theory that will affect learning. Therefore, as with traditional classroom teaching, the effective design of online instruction needs to take into consideration the ideas and principles that apply to a range of theories of learning. Learning theories from which instructional design in an online setting can draw include Vygotskian thought (e.g. Brown & Duguid, 2000), behaviourist theory of learning (e.g. Bocchi, Eastman &

Swift, 2004), constructivist learning theory (eg. Allen, 2005) and cognitive load theory (e.g. Paas, van Gog & Sweller, 2010). To create an effective online learning environment, then, one must consider a range of factors. Behaviourist, cognitivist and constructivist schools of thought provide a degree of overlap in terms of principles and ideas that can be used in instructional design. Therefore, in the development of an online course, it is possible to draw from different schools of thought to prove an eclectic theory of learning.

The present study drew on and extended the field of learning environments. The field provides numerous models that were used to assist in the evaluation of the effectiveness of the newly-developed online course. Over the past 40 years, numerous reliable and robust instruments have been developed for specific learning environments. This chapter reviewed surveys to assess students' perceptions of a range of traditional and contemporary face-to-face classroom settings (such as the Constructivist Learning Environment Survey and What Is Happening In this Class? questionnaire) as well as a number of surveys that have been developed to assess students' perceptions of a range of technology-rich, web-based and online learning environments (for example, the Online Learning Environment Survey and the Web Learning Environment Inventory). These instruments were to provide a rich starting point for the development of a learning environment instrument that could be used to compare two parallel courses, one presented online and the other taught face-to-face, in my study.

Perceptual measures have been successfully used to assess students' perceptions of the learning environment in a range of educational settings for over 40 years. The

most dependable sources or an ‘insider view’ of the learning environment comes from the perceptions of students who undertake the study of the course that is being evaluated. The data thus obtained can inform and guide changes in some of the existing teaching and learning activities.

Past research evidence consistently has demonstrated associations between perceptions of the learning environment and student outcomes. These studies have involved a range of cognitive (e.g. student achievement) and affective (e.g. student attitudes and self-efficacy) outcomes. Although the majority of these studies were conducted in classrooms that involved face-to-face teaching, there is growing research evidence, from the field of learning environments, that there are strong and consistent links between online learning environments and student outcomes.

Important to the present study was the use of learning environment instruments in evaluating the effectiveness of an educational innovation. Past studies have revealed that learning environment criteria were able to differentiate between alternative curricula even when other outcomes (such as achievement scores) did not. Past research that has used students’ perceptions of the learning environment to evaluate educational innovations has involved a wide range of educational programmes (for example, computer-assisted learning and inquiry-based science instruction).

It has been recognised that a major factor affecting the effectiveness of an online programme is the attitudes that students hold about it. Therefore, although the evaluation of educational programmes in the past has focused primarily on student achievement, my research focused on the impact of a newly-developed online course

on student affective outcomes. A review of literature indicates that attitudes, although important, are difficult to define. Reid's (2006) definition of attitudes involving three components (cognitive, affective and behavioural) was drawn on for the present research. To examine the affective outcomes of students, the three aspects that were considered were enjoyment of the course (in terms of whether the online tasks can hold the students' interest), academic efficacy (the students' belief in how well they can handle the tasks) and anxiety (the extent to which the online course is designed to reduce stress and not inhibit productive cognitive processes).

Given that my research focused on the effectiveness of an online course environment in terms of students' perceptions of the learning environment and their attitudes, I have relied heavily on past learning environments research and incorporated many of the principles, ideas and scales from this field. The development of a perceptual questionnaire, identification of potential scales and items, and administration of the questionnaire are captured in the next chapter.

Chapter 3

RESEARCH METHODS

3.1 Introduction

Whereas Chapter 2 provided a review of pertinent literature, this chapter details the research methods used in the present study. The overarching aim of the study was to examine the effectiveness of a newly-developed online course. As a first step, two questionnaires were developed and validated, one to assess the learning environment of the new online programme that was running at a polytechnic college in Singapore and the other to assess students' attitudes towards the online course. Data collected using the new questionnaires were then used to compare the new online course with a face-to-face course as an indication of its effectiveness and later to investigate associations between students' perceptions of the learning environment and their attitudes.

This chapter is organised under the following headings:

- Research design (Section 3.2);
- Research objectives(Section 3.3);
- Development of the new questionnaires (Section 3.4);
- Description of sample (Section 3.5);
- Data collection (Section 3.6); and
- Analysis of the data (Section 3.7).

3.2 Research Design

The present study involved the development, validation and use of two questionnaires through primarily using quantitative methods. However, important qualitative information was also gathered at two crucial points in the study, namely, during the pilot study and after the main administration of the questionnaire. In both cases, qualitative and quantitative data were collected in a sequential manner (Creswell & Plano Clark, 2007), with qualitative data being collected to help to explain and provide insights into findings derived from the quantitative data. During a pilot study, the two surveys were administered to students, whom were asked afterwards a range of questions related to the questionnaire to ensure its suitability (as described further in Section 3.6). Once the questionnaire had been administered to the main sample, students were again interviewed to provide insights into their attitudes and views of the learning environment created during their interaction with the online course.

Students' perceptions of the online learning environment were employed in the present study because there is much merit in engaging students in reporting as milieu inhabitants. The advantages, according to Fraser (2007), include: economy (in terms of time and finance); more accurate representations as "perceptual measures are based on students' experiences over many lessons..." (Fraser, 1994, p. 494) when compared to a small number of lesson observations by an outside observer; collective representation of the members of the class as opposed to that from a single outside observer.

As mentioned in Chapter 1, the focus of the present study was the evaluation of an online course. The next sections elaborate the research questions, the general procedures for the present study and the selection of students for the study.

3.3 Research Objectives

In Chapter 1, the research objectives were stated and are repeated below:

1. To develop and validate surveys to assess:
 - a) Students' perceptions of the learning environment created in online and face-to-face courses.
 - b) Students' attitudes towards their online and face-to-face courses (enjoyment, academic efficacy and anxiety).

2. To compare students in face-to-face and online courses in terms of:
 - a) Perceptions of learning environment; and
 - b) Attitudes (enjoyment, academic efficacy and anxiety).

3. To investigate whether associations exist between students' perceptions of the learning environment and students' attitudes of:
 - a) Enjoyment;
 - b) Academic efficacy; and
 - c) Anxiety.

3.4 Developing the Learning Environment and Attitude Questionnaires

An important aspect of the present study was the development of a new learning environment questionnaire and an attitude instrument that could be used to compare students enrolled in online and face-to-face classes in terms of the perceived learning environment and attitudes. Development of the two new questionnaires (the new learning environment instrument and attitude instrument) involved a four-stage approach used by Fraser (1986) and Jegede, Fraser, and Fisher (1995): (1) identifying and developing salient scales (Section 3.4.1); (2) writing and modifying individual items, bearing in mind the unique nature and characteristics of e-learning environments (Section 3.4.2); (3) making decisions related to the response format, organisation and layout of the questionnaires (Section 3.4.3); (4) and the last stage involved seeking advice from experts and field testing the newly-created instruments (Section 3.4.4).

3.4.1 Stage 1: Identification and Development of Salient Scales

The first stage, identifying and developing salient scales, involved three steps. The first step involved reviewing literature related to psychosocial learning environments in e-learning in order to identify the key components of the online learning environment that can be considered to be important for effective learning. Important research and theoretical insights were sought and, from these, dimensions important in the e-learning situation were identified. Chapter 4 provides a description of the scales included in the learning environment instrument.

The next step involved reviewing previously-developed learning environment instruments (as recommended by Fraser, 1986, 1998a, 1998b). There are many precedents for adapting and modifying existing scales from previously-validated instruments (Aldridge, Dorman & Fraser, 2004; Fraser, McRobbie & Fisher, 1996; Maor, 1999; Teh & Fraser, 1994a; Trinidad, Aldridge & Fraser, 2005), as well as for creating new scales that are suitable for a specific type of environment. Various learning environment instruments, including the What Is Happening In this Class? (WIHIC; Fraser, Fisher & McRobbie, 1996), Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, Aldridge & Fraser, 2008, 2011), Web-Based Learning Environment Inventory (WEBLEI, Chang & Fisher, 2003), Constructivist Learning Environment Survey (CLES, Taylor, Fraser and Fisher, 1997) and Online Learning Environment Survey (OLLES, Clayton, 2009) were considered in detail. Preliminary scales were then selected from existing and validated learning environments instruments. During this stage, close attention was paid to the unique nature of online learning environments. The justification for the selection of scales and their modification are discussed in detail in Chapter 4.

The third step was to classify the scales using Moos' (1974) scheme, developed to enable the classification of dimensions of any human environment to ensure appropriate coverage of these dimensions. Moos identified three social organization dimensions, namely, the Relationship Dimension, Personal Development Dimension and System Maintenance and Change Dimension. At this point, an important decision was made in relation to coverage of these dimensions as discussed in Chapter 4.

In addition to the learning environment scales, a three-scale attitude survey was developed. Two of the scales were selected and modified from existing instruments, namely, the Enjoyment of Subject scale and the Academic Efficacy scale. The Enjoyment of Subject scale was adapted from the Test of Science-Related Attitudes (TOSRA, Fraser, 1981) and the Academic Efficacy scale was modified from the Morgan Jinks Efficacy Scale originally developed by Jinks and Morgan (1999). The third scale was developed for the purpose of the present study to assess students' level of anxiety related to the course. The selection, modification and development of the scales are discussed further in Chapter 4.

3.4.2 Stage 2: Selecting, Modifying and Writing Individual Items

The second stage, selecting, modifying and writing individual items, involved three steps. In the first step, existing items were closely scrutinised to ensure clarity, face validity, readability and freedom from ambiguity (Fraser, 1986). Where necessary, individual items were reworded or the number of items was reduced to ensure that the questionnaires were economical in terms of administration time. Particular attention was paid to negatively-worded items. For example, the What Is Happening In this Class? (WIHIC) questionnaire used scales and items selected from different survey instruments, but care was taken not to include any reverse-scored items as these can be confusing to students (Aldridge, Fraser & Huang, 1999; Fraser, 2002). In addition, reverse-scored items cannot be considered to be direct opposites of their positively-worded counterparts (Barnette, 2000) and are likely to lower the response accuracy (Chamberlain & Cummings, 1984).

In some cases, it was necessary to add individual items or, in the case of the attitude survey, to add an entire scale. When writing individual items, care was taken to ensure that, within a given scale, items measured only the scale that they purport to assess, and none of the other scales, and that each item is conceptually similar to each other as recommended by Fraser (1986).

3.4.3 Stage 3: Response Format, Organisation and Layout of the Questionnaires

At this stage of the development of the questionnaire, important decisions were made with respect to the response format. In the past, research in the field of learning environments has involved a range of different response formats. In more recent research, numerous surveys have used a five-point frequency scale (e.g. Aldridge, Fraser & Huang, 1999; Aldridge, Fraser, Taylor & Chen, 2000; Fraser, 2007, 2012). Past literature related to the usability and reliability of these response formats was used to inform the researcher's decision. In addition, decisions about the ordering of the items in the questionnaires were made. In past research, particularly in the field of psychology, it has been traditional to arrange items in a random manner. In some recent questionnaires in the field of learning environment, however, it has been found to be useful to group items belonging to the same scale together in blocks (e.g. Taylor, Fraser & Fisher, 1997; Aldridge, Fraser & Huang, 1999; Aldridge & Fraser, 2008, 2011). In grouping items together in this way, it is likely that the student will respond to items in a way that is less confusing and, therefore, more reliable. Details related to the response format, layout and organisation of the two questionnaires are described in detail in Chapter 4.

3.4.4 Stage 4: Pilot Testing the Questionnaires

To minimise measurement errors, resulting from a poorly-worded items or poor instrument layout, the new instruments were pilot tested to:

- Check the readability of the questionnaires.
- Try out the administration process, in terms of the length of time to respond to the questionnaire and whether students were able to understand the items and directions for answering.
- Identify any items that were problematic using interviews with students.

3.5 Description of Sample

This section describes the sample and its selection for the pilot study (Section 3.5.1) and for the main study (Section 3.5.2).

3.5.1 Sample for the Pilot Study

The pilot study involved a quantitative and a qualitative component. For the quantitative component, 117 students were randomly selected from the same courses from which the main study's sample was to be drawn. All of the students were studying both the online course and the face-to-face course simultaneously. Students were all studying in the first semester of their first year at the polytechnic. For the qualitative component, 17 of the 117 students were randomly identified and asked to be involved in focus-group interviews (Patton, 2002) made up of 6 to 8 students. These focus-group interviews involved a semi-structured format that enabled the

researcher to ask questions related to individual items in the surveys to ensure clarity, readability and freedom from ambiguity.

3.5.2 Sample for the Main Study

This section describes the sample for the main study's two phases. In the first phase, the newly-developed instruments were administered to students to provide data about the validity of the instruments and to provide descriptive data related to students' perceptions of and attitudes towards the course. In the second phase, qualitative data were gathered to provide explanations for students' responses to the questionnaires. The sample for each of these phases is described below.

Almost 80% of the students enrolled in the online course and the parallel face-to-face course were selected. Although the original sample for the main study included 1000 students, only 991 of these students provided complete and usable responses. The students were in their first year of a three-year engineering diploma course. The cohort was divided into 50 tutorial groups and each tutorial group had an average of 20–24 students aged between 17 and 21 years. The entry level of these students is generally the General Certificate of Secondary Examination 'O' Level of the British Educational system or 'O' Level equivalent (which in Australia would be equivalent of the leaving examinations at the end of year 10). The sample included both Singaporeans and international students who came mainly from China, India, Malaysia, Sri Lanka, Myanmar and other ASEAN countries.

The data collected using the new questionnaires provided a parsimonious and economical view of students' attitudes and perceptions of the learning environments in the online and face-to-face courses. The subsequent collection of qualitative data was used to provide more in-depth information to help to explain results obtained from the quantitative information. From the 991 students who responded to the questionnaire, the researcher randomly selected 90 students based on their willingness to be involved. Semi-structured interviews were held with these students in focus-groups (Patton, 2002) made up of nine students in each. The 90 students were drawn from across the 50 classes that were surveyed.

3.6 Data Collection

Both the pilot study and the main study involved the collection of quantitative and qualitative data as recommended by Tobin and Fraser (1998) and Creswell and Plano Clark (2007). This section details the data collection methods used during the two stages of the study: the pilot study (Section 3.6.1) and the main study (Section 3.6.2).

3.6.1 Data Collection for the Pilot Study

The pilot study involved the collection of quantitative and qualitative data. As stated previously (Section 3.5.1), the newly-developed instruments were field tested with 117 students. Subsequently, focus-groups interviews with students were conducted with 17 of the 117 students. The decision to use focus groups was made to provide a setting in which students felt comfortable and, therefore, expressed their opinions about the questionnaire with confidence (Patton, 2002). Feedback helped the

researcher to obtain information related to the readability of the individual items and whether students were able to understand and to respond to the items appropriately. The interviews also helped to ascertain whether the questionnaire format (including the response scale) was user friendly. The results of the pilot study are presented in Chapter 4.

3.6.2 Data Collection for Main Study

Data collection for the main study involved two phases. In the first phase, the two newly-developed questionnaires were administered to the 991 students across 50 classes (see Section 3.5.2). The questionnaires were administered during the online classes by the supervisor of that class. Students were provided with information about the research and were informed that their participation was voluntary. The teachers supervising the online class emphasised to the students that the information that they provide would remain confidential and that any feedback provided would be in the form of aggregated scores.

The questionnaires were administered in the middle of the semester to provide adequate time for a stable learning environment to be established in both courses and to enable students to give a well-informed opinion on the basis of their experiences of the two learning environments. All of the questionnaires were administered in the same week to all of the 991 students.

In the second phase, 90 students were interviewed in focus groups to provide more in-depth information. The interview process was explained to the participants before

proceeding. The students were assured of confidentiality and anonymity. Interviews were recorded in the form of notes that were taken during the discussions (as recommended by Lincoln & Guba, 1985 and Lofland & Lofland, 1984).

Semi-structured interviews were used with each of these focus groups to further enhance understanding of issues that could have been partially evident in terms of the survey questionnaire. Semi-structured interviews were used to provide a structure that would ensure consistency across the groups but allow a degree of flexibility within which students could follow lines of interest (Hitchcock & Hughes, 1989). As such, semi structured interviews allowed me to design a set of key questions that would be raised before the interview takes place, and also to allow for additional topics that emerged in the course of the interview. The researcher later analysed the responses of students based on thematic categories (Strauss & Corbin, 1990). In addition, some students elected to write their reflections down on paper as they felt that they could convey their ideas better in this way. A sample of the interview schedule and session notes can be found in Appendix D.

3.7 Analysis of Data

Quantitative and qualitative data were analysed in various ways to answer each of the respective research questions as described below.

3.7.1 *Research Question #1*

To examine the reliability and validity of the new instruments developed to assess students' perceptions of their learning environment and student attitudes towards the online and face-to-face courses, data for the sample of 991 students described above were analysed in various ways.

Exploratory factor analysis was conducted separately for the newly-developed learning environment questionnaire and attitude scales. Varimax rotation was utilised in the principal axis factor analysis of the items to ensure the extraction of succinct sets of factors. Factor loadings indicated how strongly each item was related to each factor, eigenvalues showed the relative importance of each factor, and the cumulative variance was used to check whether a sufficient number of factors have been retained (Field, 2009). The Cronbach alpha coefficient was calculated for each factor to provide an indication of its internal consistency reliability. Finally, an estimate of the discriminant validity of each scale was derived, using the mean magnitude of the correlation of a scale with the other scales in the same instrument as a convenient index. A scale that possesses discriminant validity measures a unique dimension not measured by any other scale in the questionnaire.

3.7.2 *Research Question #2*

To examine the effectiveness of the online course, relative to the face-to-face course, the two courses were compared in terms of students' perceptions of the learning environment and students' attitudes of enjoyment of the course, academic efficacy

and anxiety. As a first step, testing of preliminary assumption was conducted to check for violations of normality, linearity and homogeneity of variance-covariance matrices. Once these conditions all were satisfied, a one-way multivariate analysis of variance (MANOVA) was performed to investigate differences in perceptions of the learning environment and students' attitudes to the courses (online and face-to-face). Wilks' Lambda was checked to ensure that there was a statistically significant difference between the online and face-to-face course in terms of the whole set of learning environment or attitude scales, prior to interpreting the one-way ANOVA for between-group differences for each individual scale. In addition, effect sizes were used to indicate the magnitude of the differences between the two courses expressed in terms of the number of standard deviations (as recommended by Thompson, 2001).

To analyse the qualitative data, 'open coding' (Strauss & Corbin, 1990) was used to create descriptive multidimensional categories which formed a preliminary framework for analysis. The themes that emerged from the interviews and discussions were thus categorized to provide conclusions about the sample. Triangulation of the data were then used to capture a more complete, holistic and contextual portrayal of students' perceptions of the two learning environments and their attitudes towards the two different courses (Bogdan & Biklen, 1982; Patton, 1990).

3.7.3 Research Question #3

To examine whether associations exist between students' perceptions of the learning environment and student attitudes of enjoyment, academic efficacy and anxiety, simple correlation and multiple regression analysis were used. Simple correlations were used to examine the bivariate relationship between each student attitude outcome with each environment scale. Multiple regression analysis were carried out to investigate the joint influence of the whole set of environment scales on each attitude outcome, as well as which environment scales contribute most to variance in students' attitudes when other environment scales are mutually controlled.

3.8 Chapter Summary

A major aim of the present study was the development of two new questionnaires. First, a learning environment instrument was developed to assess students' perceptions of either an online learning environment or a face-to-face learning environment. The second questionnaire was developed to assess students' attitudes to their online and face-to-face courses. The method used to develop the two questionnaires involved a multi-stage approach (Fraser, 1986; Jegede, Fraser, and Fisher, 1995) that included the identification of salient scales, modifying items from existing learning environments instruments and developing appropriate items for newly-developed scales according to the needs of the context. Finally, the instruments were pilot tested to ensure their suitability when used in both the online and face-to-face courses.

For the pilot study, the sample included students from five randomly-selected classes, providing a total of 117 students. The questionnaires were administered to the students and, after completion, 17 students were randomly selected for semi-structured focus-group interviews. These were undertaken to find out whether the students were comfortable with the format of the questionnaire, whether they understood the items and whether the administration procedure was user-friendly.

The main study involved the administration of the two new questionnaires to 991 students in 50 classes. Focus-group interviews were conducted with 90 of the students (randomly selected from the group of 991 students). Interview data were recorded manually during the discussions.

To examine whether the two new questionnaires were valid and reliable, students' responses were analysed to furnish evidence regarding the scales' factor structure, internal consistency reliability and discriminant validity. To examine whether differences exist between the online and face-to-face courses in terms of students' perceptions of the classroom environment and attitudes, data were analysed using one-way MANOVA and effect sizes. In addition, qualitative data collected during interviews were used to provide clarification and further depth to the qualitative data. The analysis of the qualitative data included inductive analysis to identify common themes and categories. To investigate associations between student outcomes and the nature of the learning environment, simple correlation and multiple regression analyses were conducted.

Chapter 4 describes the analyses of the quantitative data and qualitative data including reports of the major findings for each research objective.

Chapter 4

ANALYSES AND RESULTS

4.1 Introduction

The overarching purpose of the present study was to assess the effectiveness of a recently-introduced online course in a polytechnic in Singapore. Whilst Chapter 3 described the research methods used in the present study, including the steps taken to develop and pilot test the two new instruments, this chapter is devoted to describing the analyses and results of the present study. After careful development and pilot testing of both instruments, they were administered to 991 students in 50 classes in a polytechnic in Singapore. The data collected during this administration were analysed to address the research objectives outlined in Chapters 1 and 3. The findings are reported in this chapter using the following headings:

- Development of the questionnaires (Section 4.2)
- Pilot test (Section 4.3)
- Validity and reliability of the questionnaires (Section 4.4)
- Comparing online and face-to-face courses in terms of learning environment and student attitudes (Section 4.5)
- Associations between the learning environment and attitudes with regard to online courses (Section 4.6).

4.2 Development of the Questionnaires

Following the steps described in Chapter 3, two questionnaires were developed for use in the present study. The first was a learning environment instrument suitable for assessing students' perceptions of both an online and a face-to-face course (described in Section 4.2.1) and the second was developed to assess three affective outcomes relevant to both an online and a face-to-face course (described in Section 4.2.2). Finally, the response format and layout of the final version of the two questionnaires are described in Section 4.2.3.

4.2.1 Development of the Comparative Learning Environment Questionnaire

As discussed in Chapter 2, Moos has conveniently delineated three general dimensions which characterise any human environment. The Personal Development Dimension maps the opportunities that the learning environment provides for individual growth and self enhancement. The Relationship Dimension maps the nature and strength of personal relationships. Finally, the System Maintenance and Change Dimension maps the degree of the control, orderliness, clarity in expectations, and responsiveness to change within the environment (Moos, 1974). Because the nature of the online environment was such that personal relationships were not built (except perhaps through discussion boards and emails), the new learning environment questionnaire focused on scales and items that give a comprehensive coverage of the Personal Development Dimension and System Maintenance and Change Dimension.

The first stage of the development of this new learning environment questionnaire (suitable for assessing students' perceptions of either an online or a face-to-face learning environment) involved a review of literature and the identification of salient scales. At this stage, a total of seven learning environment scales were identified, namely: Task Orientation; Responsibility and Independence; Access; Active Learning; Computer Usage; Authentic Learning; and Information Design and Appeal. Table 4.1 provides information about the origin of each scale, in addition to a description, a sample item and Moos (1974) category for each of the seven scales. Below, the scales and their importance to learning are discussed.

4.2.1.1 Task Orientation

The Task Orientation scale assesses the extent to which activities are clear and well organised. It is widely acknowledged that students need to have goals, both short-term and long-term, to provide them with motivation and purpose (Killen 2001; Spady, 1994). According to Vygotskian and behaviourist learning theories, if the goals and expectations of a course or lesson are clear, then students are more likely to be engaged in their learning (Bocchi, Eastman & Swift, 2004; Brown & Duguid, 2000; Hung & Chen, 2001). To assess the extent to which students perceive that it is important to complete activities and understand the goals of online or face-to-face courses, the Task Orientation scale was selected from the What Is Happening In this Class? questionnaire (Aldridge, Fraser & Huang, 1999) described in Section 2.3.2.9. A sample item in this scale is 'I know how much work I have to do'.

Table 4.1: Origin, Description, Sample Item and Moos Classification for each Learning Environment Scale of the newly developed instrument

Scale	Origin of Scale	Description	Sample Item	Moos Dimension
<i>The extent to which</i>				
Task Orientation	What Is Happening In this Class? (Fraser, Fisher & McRobbie, 1996)	... activities are clear and well organised.	I know how much work I have to do.	System Maintenance and Change
Responsibility and Independence	Young Adult Ethos scale of Technology-Rich-Outcomes Focused Learning Environment Inventory (Aldridge & Fraser, 2008; 2011)	... students are given opportunities to be responsible and independent.	I make decisions about my learning.	Personal Development
Access	Web-Based Learning Environment Inventory (WEBLEI, Chang & Fisher, 2001, 2003)	... the learning environment is convenient and efficient for the students.	I access the learning activities at times convenient to me.	System Maintenance and Change
Active Learning	Modified from Investigation scale of What Is Happening In this Class? (Fraser, Fisher & McRobbie, 1996)	... students have the opportunity to take an active role in their learning.	I find out answers to questions by doing investigations.	Personal Development
Computer Usage	Technology-Rich Outcomes-Focused Learning Environment Inventory (Aldridge & Fraser, 2008; 2011)	... students use their computer as a tool for communication with others and to access information.	I use a computer to obtain information from the internet.	System Maintenance and System Change
Authentic Learning	Constructivist Learning Environment Survey (Taylor, Fraser & Fisher, 1997)	... students have the opportunity to solve authentic, real-world problems.	I can connect my studies to my activities outside.	Personal Development
Information Design and Appeal	On-Line Learning Environment Survey (Clayton, 2004)	... the choice of design makes the text clear.	The choice of design makes the text clear.	System Maintenance and System Change

4.2.1.2 Responsibility and Independence

It was considered important to assess the extent to which students are given the opportunity to take control of their own learning and become independent. First,

Vygotsky's theories of learning and constructivist theory of learning stress the importance of involving the concept of scaffolding so that students can be weaned away from dependence and provide opportunities for independence in their learning (Allen, 2005; Mayer, 2004; Mostyn, 2009). To assess the extent to which students perceive that they are given the opportunity to be independent, the Responsibility and Independence scale was modified from the Young Adult Ethos scale, developed by Aldridge and Fraser (2008) as part of the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI, described in Section 2.3.3.4). Modification to the scale was made to ensure its suitability for students enrolled in online courses at the polytechnic level. A sample item in this scale is 'I am given the opportunity to be independent'.

4.2.1.3 Access

The Access scale was developed to measure the extent to which the online activities are available to the students to enable them to work at their own pace and to work at times that are convenient to them. The scale was modified from the Emancipatory Scale, developed by Chang and Fisher (2001, 2003) as part of the Web-Based Learning Environment Instrument (WEBLEI) described in Section 2.3.3.3. The original Emancipatory scale had a total of eight items but was modified to form a six-item scale in the current questionnaire. A sample item in this scale is 'I work at my own pace to achieve learning objectives'.

4.2.1.4 Active Learning

The Active Learning scale assesses the extent to which students investigate problems and find their own strategies and solutions. It assumes that, in order for learning to be

meaningful, teachers should create appropriate conditions to facilitate students' active engagement in their learning (Allen, 2005; Spady, 1994). The six-item scale included in my questionnaire was modified from the Investigation scale of the WIHIC (Fraser, McRobbie & Fisher, 1996) to assess the extent to which students perceive that they find their own strategies for identifying and solving problems. A sample item in this scale is 'I solve my own problems'.

4.2.1.5 Authentic Learning

A central feature of the constructivist approach is the inclusion of authentic learning tasks in which students are engaged in active learning (Kirschner, Sweller & Clark, 2006). Authentic Learning was derived from a scale within the Constructivist Learning Environment Survey (CLES; Taylor, Fraser & Fisher, 1997) to assess the extent to which students make use of their everyday experience as a meaningful context for developing their knowledge. According to Honebein (1996, p. 20), the learning environment should "stimulate learners so that their thinking is related to actual practice". The seven-item Personal Relevance scale, originating from the CLES (see Section 2.3.2.8), was adapted to a six-item Authentic Learning scale in the current questionnaire to assess the extent to which students relate their study to real-life experiences. A typical item in this scale is 'I work on assignments that deal with real world information'.

4.2.1.6 Computer Usage

To assess the extent to which the online course was designed in a way that enabled students to make use of technology in a variety of ways (e.g., as a tool to communicate with others or to access information), the Computer Usage scale,

designed by Aldridge and Fraser (2008, 2011) as part of the TROFLEI, was selected. This scale was adapted for use in the present study to assess the extent to which students use their computers to retrieve information and complete various tasks. A typical item in this scale is 'I use a computer to find information related to the course'.

4.2.1.7 Information Design and Appeal

Cognitive load theory stresses the importance of minimising extraneous load. By providing support (such as models, audiovisual material, etc.) a students' extraneous load can be reduced (Halabi, Tuovinen & Farley, 2003). The Information Design and Appeal scale originated from the On-Line Learning Environment Survey (OLLES; Clayton, 2004) described in Section 2.3.3.7. It was adapted to a six-item scale for inclusion in the new questionnaire. This scale assesses the extent to which students feel that the visual materials help them to understand concepts. A sample item in this scale is 'I find the photographs and tables help me to understand concepts'.

4.2.2 Development of the Attitude Instrument

In addition to the learning environment scales described above, three scales were used to assess the student affective outcomes of Enjoyment of Subject, Academic Efficacy and Anxiety. Each of the scales in the attitude questionnaire has six items.

A number of instruments have been designed to assess students' attitudes towards a course (Fraser, 1981; Mackay, 1971; Walker, 2005). In the present research, however, three scales were adapted from existing instruments: the Enjoyment of Subject scale, adapted from Test of Science-Related Attitudes (TOSRA, Fraser,

1981); the Academic efficacy scale adapted by Aldridge and Fraser (2008) from the Morgan Jinks Efficacy Scale (Jinks & Morgan, 1999); and an Anxiety scale, developed for use in the current research based on the work of Taylor (2004) and Gillis (1995). Table 4.2 provides a description of each scale and a sample item. The following sections provide information related to the development and origin of each scale.

Table 4.2: Description and Sample Item for each Attitude Scale

Scale	Description	Sample Item
	<i>The extent to which</i>	
Enjoyment	... the subject lends itself to enjoyment.	I enjoy activities that we do in this subject.
Academic Efficacy	... students' feel confident in their own ability.	I am good at this subject.
Anxiety	... students are anxious about this subject.	I feel anxious when I think about this subject.

4.2.2.1 *Enjoyment of Course*

To assess students' enjoyment of the online and face-to-face courses, a modified version of a scale from Fraser's (1981) *Test of Science Related Attitudes* (TOSRA) was used. The original scale comprises eight items to assess the extent to which students enjoy, are interested in and look forward to science lessons. An example of an item is 'I enjoy science classes'. For this study, the wording of the items was changed so that it was not related to only science, but rather applicable across all subjects. For example, the item 'I look forward to lessons in science' was changed to 'I look forward to lessons in this subject'. Also, in the original version, Items 3, 4 and 7 were negatively worded and, therefore, scored in reverse. Given that negatively-worded items can reduce the reliability of a questionnaire (Chamberlain

& Cummings, 1984), the wording for these three items was changed to ensure that there were no negatively-worded items.

Fraser's original version of the TOSRA, employed a Likert-type response format was used (Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree). This format was changed, however, so that the same response format could be used for both the attitude instrument and the newly-developed learning environment questionnaire. Each item was checked to ensure that the response made sense for every item. As a result, both instruments used the five-point frequency response scale of Almost Always, Often, Sometimes, Seldom and Almost Never.

4.2.2.2 Academic Efficacy

Students' beliefs about their capabilities is a potent influence on their behaviour (Bandura, 1977). Self-efficacy is defined as the beliefs in ones' capability to achieve a specified goal or outcome. According to Bandura's (1986) social cognitive theory, students are more likely to have an incentive to learn and to persist in tasks, even if they are difficult, if they believe that they will succeed. It was considered important, therefore, that a measure of students' academic efficacy, a judgement of what they can do with their skills and the extent to which they are confident in their own ability (Bandura, 1986), was included in the present study. This scale was based on an academic efficacy scale that was originally developed by Jinks and Morgan (1999) and later adapted by Aldridge and Fraser (2008). In the current research, Aldridge and Fraser's (2008) 8-item scale was reduced to 6 items. The items were responded to using a five point frequency scale of Almost Always, Often, Sometimes, Seldom

and Almost Never. The Academic Efficacy scale assesses students' beliefs in their ability to succeed in the face-to-face course and the online course.

4.2.2.3 Anxiety

In the general study of the psychology of anxiety, Spielberger (1972, p. 24) states that "anxiety is a condition characterised by feelings of tension and apprehension". The level of anxiety experienced by a person can have both negative and positive effects in that it can either motivate or disrupt learning. Recent studies have reported associations between student outcomes and student anxiety (Dane, 2005; Daniels et al., 2005). The development of the anxiety scale used in the present study drew on and modified items from the Beck Anxiety Inventory (Gillis, 1995) and a scale developed by Taylor (2004). The scale used in the present study included 6 items that were developed to assess students' levels of anxiety regarding learning the subject and their performance in the subject. As with the learning environment and other attitude scales used in my study, the wording of all items allowed respondents to use a five-point frequency scale of Almost Always, Often, Sometimes, Seldom and Almost Never.

4.2.3 Response Scale and Layout of the Questionnaires

Past studies have indicated that personalising assessment items (i.e., asking each student to provide responses related to personal perceptions in his/her role in the classroom) yields feedback from participants that can be useful for assessing the perceptions of different groups of students (e.g. males and females) (Aldridge, Fraser

& Huang, 1999; Fraser, Fisher & McRobbie, 1996). It was considered prudent, therefore, to personalise the wording of all items on each scale.

It was decided that, because of the comparative nature of my study (designed to compare an online learning environment with a face-to-face learning environment), it was appropriate to use two response blocks placed side-by-side in the questionnaire. In one block, students were requested to respond to items with respect to their views about the online course and, in the other block, students responded to items with respect to their views about the face-to-face course. Nix, Fraser and Ledbetter (2000) used a similar response format in their research involving a comparison of classes that used a constructivist approach and those that did not. The two blocks were presented in a side-by-side format as illustrated below.

Access	On-line Course					Face-to-Face Course				
	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>In this course:</i>										
13. I access the learning activities at times convenient to me.	1	2	3	4	5	1	2	3	4	5
14. I work at my own pace to achieve learning objectives.	1	2	3	4	5	1	2	3	4	5

All items in both the learning environment questionnaire and attitude scales were responded to using a five-point frequency response scale (i.e. Almost never, Seldom, Sometimes, Often, Almost always).

The learning environment scales and attitude scales were integrated into a single questionnaire sheet with common directions and response scales to provide a more economical format. The final version of each questionnaire can be found in Appendix A (COMPLEQ) and Appendix B (Attitude Survey).

4.3 Pilot Test

As discussed in Chapter 3, the newly-developed instruments were pilot tested with 117 students. The initial questionnaire was administered to a random selection of classes. The aim of the pilot test was to:

- 1) Check the readability of the questionnaire
- 2) Try out the administration process, in terms of the length of time needed to complete the questionnaire and whether students were able to understand the response format and directions.
- 3) Use item analysis to provide an indication of whether any of the items were problematic.

The questionnaire data were entered into an Excel spreadsheet in a case-wise format in the data analysis software application SPSS Version 17. Cronbach's alpha coefficient was calculated to provide an indication of whether the items in a scale were assessing the same construct. In addition, the scale reliability when one item is deleted was also calculated to help to determine whether any problematic items existed. The Cronbach alpha coefficient for the seven scales of the learning environment instrument ranged between 0.82 and 0.91 (with the individual as the unit of analysis) suggesting strong internal consistency reliability for each scale. For the three attitude scales, the alpha reliability ranged from 0.85 to 0.92 supporting the internal consistency reliability of these scales.

In addition, focus-group interviews, using a semi-structured format, were held with 17 students in 5 classes to help in checking the readability of the individual items and whether students were able to understand and respond to the items appropriately. The interviews also helped in ascertaining whether the questionnaires were user friendly. The qualitative data were captured under three categories.

- Students' understanding of the individual items within a scale and the scale as a whole;
- The administration process and the time it took for students to complete the questionnaire;
- Students' understanding of the response format and their ability to use it successfully.

For the pilot study, the focus groups were made up of three groups. Student responses indicated that the items had all been interpreted consistently by students. Student generally agreed that the items were easy to read and understand and, when asked about why they had responded to items in a particular way, their responses indicated that the items were generally interpreted in ways intended by the researcher.

Students in all of the focus groups agreed that the administration process was suitable. Students were reassured that their responses were confidential and that there was no pressure to participate. One student did confess, however, that he did not respond to all of the items as 60 items just seemed too many. All of the students who

were interviewed agreed that the response format was easy to use and was helpful in terms of comparing the face-to-face and online courses.

Based on the qualitative and quantitative data collected during the pilot study, supported the face validity of the new instruments, and confirmed that they did not require further refinement. Once the pilot study was complete, the researcher was confident about administering the questionnaires to the large sample. The next section reports results for the reliability and validity of the questionnaires.

4.4 Validity and Reliability of the Questionnaires

This section provides the results related to the validation of the newly-developed questionnaire, called the Comparative Learning Environment Questionnaire (COMPLEQ) for its ability to compare online and face-to-face learning environments, described in Section 4.2.1 and the attitude scales, described in Section 4.2.2.

4.4.1 Reliability and Validity of the Comparative Learning Environment Questionnaire (COMPLEQ)

Data collected from 991 students in 50 classes were analysed in various ways to examine the reliability and validity of the learning environment scales (Task Orientation, Responsibility and Independence, Access, Computer Usage, Authentic Learning, and Information Design and Appeal) when used in both the online and the

face-to-face courses. Analyses of the data included factor and item analyses and internal consistency.

4.4.1.1 Item and Factor Analysis

Principal axis factoring with oblique rotation (commonly used in learning environment research) was used to check the structure of the 42-item seven-scale COMPLEQ. A separate analysis was conducted for the online and face-to-face responses. The two criteria used for retaining any item were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on any of the other scales (Field, 1992; Thompson, 2004; Stevens, 2005). During the factor analysis, one of the scales, Active Learning, was omitted as the items did not meet the criteria and, there were found not to assess a unique dimension. The removal of the Active Learning scale increased the discriminant validity of the remaining scales. The remaining 36 items (6 items in each of 6 scales), without exception, had a factor loading of at least 0.40 on their *a priori* scale and no other scale. Tables 4.3 show the factor loadings obtained for the sample of 991 students in 50 classrooms for responses for both the online and face-to-face courses.

The factor analysis depicted in Table 4.3 supports a 36-item six-scale structure for both the online and face-to-face forms of the COMPLEQ. All of the items have a loading of at least 0.40 on their *a priori* scale and no other scale. The percentage of the total variance extracted with each factor (see Table 4.3) for the online environment varied from 7.50% to 11.20% for different scales, with the total variance accounted for being 57.70%. For the face-to-face learning environment, the percentage of variance ranged from 8.42% to 10.76% for different scales, with a total

variance accounted for being 56.49%. The value of the eigenvalue varied from 2.70 to 4.05 for different scales for online environment and from 3.03 to 3.87 for face-to-face environment.

4.4.1.2 Alpha Reliability

The Cronbach alpha reliability coefficient was used as an index of scale internal consistency and was generated separately for the online and face-to-face environments for the refined 36-item version of the COMPLEQ. It is important that items within a scale assess the same construct. A widely-used method for assessing the reliability of questionnaires is the alpha coefficient which was developed by Cronbach (1951) for measuring the internal consistency or reliability of a scale for a particular sample group. Alpha coefficients range in value from 0 (inconsistent) to 1 (perfectly consistent). This coefficient can be used to describe the reliability of factors extracted from questionnaires that involve rating scales. The higher the coefficient, the more reliable the generated scale is. An alpha coefficient of 0.70 is widely considered to be an acceptable value (Nunnally, 1978).

Table 4.4 reports the Cronbach alpha coefficient for the online and face-to-face learning environments for each of the six COMPLEQ scales. Using the individual as the unit of analysis, scale reliability estimates were high, ranging from 0.85 to 0.92 for the online course and from 0.85 to 0.91 for the face-to-face environment.

Table 4.3: Factor Loadings for the Learning Environment Scales for Online and Face-to-Face Courses

Item No.	Factor Loading											
	Task Orientation		Responsibility & Independence		Access		Computer Usage		Authentic Learning		Information Design & Appeal	
	Online	Face-to-face	Online	Face-to-face	Online	Face-to-face	Online	Face-to-face	Online	Face-to-face	Online	Face-to-face
1	0.67	0.61										
2	0.61	0.67										
3	0.60	0.63										
4	0.63	0.63										
5	0.56	0.58										
6	0.61	0.60										
7			0.48	0.58								
8			0.55	0.63								
9			0.61	0.67								
10			0.70	0.68								
11			0.66	0.70								
12			0.54	0.64								
13					0.43	0.44						
14					0.49	0.55						
15					0.61	0.62						
16					0.62	0.70						
17					0.61	0.68						
18					0.56	0.62						
25							0.62	0.62				
26							0.62	0.52				
27							0.73	0.76				
28							0.68	0.67				
29							0.71	0.78				
30							0.66	0.66				
31									0.50	0.50		
32									0.56	0.59		
33									0.43	0.61		
34									0.70	0.72		
35									0.78	0.79		
36									0.76	0.72		
37											0.62	0.62
38											0.72	0.71
39											0.74	0.71
40											0.80	0.78
41											0.75	0.73
42											0.64	0.67
% Variance	9.78	9.38	8.59	9.96	7.50	8.42	10.26	9.66	9.11	9.52	11.20	10.76
Eigen-value	3.52	3.38	3.09	3.59	2.70	3.03	3.69	3.48	3.28	3.42	4.05	3.87

Factor loadings smaller than 0.40 (as recommended by Field, 2005) have been omitted from the table.

N=991 students in each of the online and face-to-face courses.

Factor analysis involved principal axis factoring with varimax rotation.

Table 4.4: Internal Consistency Reliability (Alpha Coefficient) for Online and Face-to-face Courses for each Learning Environment Scale

Scale	Alpha Reliability	
	Online	Face-to-Face
Task Orientation	0.86	0.88
Responsibility & Independence	0.87	0.90
Access	0.85	0.85
Computer Usage	0.89	0.87
Authentic Learning	0.88	0.89
Information Design & Appeal	0.92	0.91

The sample consisted of 991 students.

4.4.2 Reliability and Validity of the Attitude Instrument

Data collected from the 991 students in 50 classes were analysed to investigate the reliability and validity of the questionnaire developed to assess student attitudes towards online and face-to-face courses. Principal axis factoring followed by varimax rotation was performed separately for online and face-to-face responses.

As for the learning environment instrument, the two criteria used for retaining any item in the attitude instrument, were that it must have a factor loading of at least 0.40 on its own scale and less than 0.40 on any of the other scales (Field, 1992; Thompson, 2004; Stevens, 2005). Factor analysis confirmed the *a priori* structure of the student attitudes instrument for the online and face-to-face courses comprising 18 items in three scales. All items had a factor loading of at least 0.40 on their *a priori* scale and no other scale (see Table 4.5).

The percentage of the total variance extracted with each factor is recorded at the bottom of Table 4.5. For the online course, the percentage of variance varied from

20.66% to 25.58% for different scales, with the total variance accounted for being 57.70%. For the face-to-face course, the percentage of variance ranged from 19.95% to 26.37% for different scales, with a total variance accounted for being 56.49%. The value of the eigenvalue ranged from 3.72 to 4.60 for online course and from 3.60 to 4.75 for face-to-face course.

Table 4.5: Factor loadings for the attitude instrument for online and face-to-face courses

Item No.	Factor Loading					
	Enjoyment		Academic Efficacy		Anxiety	
	Online	Face-to-face	Online	Face-to-face	Online	Face-to-face
1	0.75	0.79				
2	0.80	0.84				
3	0.81	0.81				
4	0.83	0.86				
5	0.83	0.86				
6	0.83	0.82				
7			0.66	0.63		
8			0.76	0.75		
9			0.70	0.69		
10			0.74	0.69		
11			0.75	0.77		
12			0.70	0.69		
13					0.80	0.78
14					0.84	0.80
15					0.84	0.81
16					0.80	0.77
17					0.85	0.78
18					0.84	0.81
% Variance	25.58	26.37	20.66	19.95	23.22	21.79
Eigenvalue	4.60	4.75	3.72	3.60	4.18	3.92

Factor loadings smaller than 0.40 have been omitted from the table.

N=991 students

Principal axis factoring with varimax rotation was utilised.

Table 4.6 reports the Cronbach alpha coefficient for the online and face-to-face course for each of the three attitude scales. Using the individual as the unit of

analysis, scale reliability estimates were high, ranging from 0.91 to 0.95 for online course and from 0.91 to 0.96 for face-to-face course.

Table 4.6: Internal Consistency Reliability (Alpha Coefficient) for Online and Face-to-face courses for the Attitude Scales

Scale	No of Items	Alpha Reliability	
		Online	Face-to-Face
Enjoyment	6	0.95	0.96
Academic Efficacy	6	0.91	0.89
Anxiety	6	0.93	0.91

The sample consisted of 991 students.

The data presented in Table 4.6, in conjunction with the factor analysis results in Table 4.5, support the contention that the three scales are valid and reliable for the assessment of students' attitudes for both the online and face-to-face responses among polytechnic students in Singapore.

4.5 Comparing Online and Face-to-Face Courses in Terms of Learning Environment and Student Attitudes

To compare the online and face-to-face courses, two different methods were used. To provide an overview of students' perceptions of the learning environment and their attitudes towards the respective courses, surveys were administered to the students. The results of the analyses for the data collected using questionnaires are reported in section 4.5.1. After the administration of the questionnaires, students were invited to join semi-structured focus-group interviews which were used to help add depth to the quantitative findings and, thus, provide a more insightful evaluation of the

effectiveness of the online course. The qualitative findings are presented in Section 4.5.2.

4.5.1 Questionnaire Results

To explore the relative effectiveness of the two learning environments (online and face-to-face), the average item mean (the scale mean divided by the number of items in a scale) was calculated for each learning environment and attitude scale and separately for the online and the face-to-face courses (see Table 4.7). All analyses were conducted separately for the COMPLEQ and Attitude scales.

Table 4.7: Average Item Mean, Average Item Standard Deviation, Effect Size and MANOVA Results for Differences between Online and Face-to-Face Courses

Scale	Average Item Mean ^a		Average Item Standard Deviation		Difference	
	Online	Face-to-Face	Online	Face-to-Face	Effect Size ^b	F
Learning Environment						
Task Orientation	4.06	3.79	0.51	0.71	0.44	3.90**
Responsibility	4.19	3.95	0.52	0.72	0.39	3.77**
Access	4.03	3.58	0.54	0.76	0.70	4.69**
Computer Usage	4.13	3.78	0.64	0.85	0.46	3.96**
Authentic Learning	3.75	3.25	0.65	0.85	0.66	4.49**
Information Design	3.85	3.35	0.67	0.84	0.66	4.82**
Attitude						
Enjoyment	3.72	2.85	0.74	1.06	0.91	5.04**
Academic Efficacy	3.57	2.82	0.68	0.87	1.00	5.51**
Anxiety	2.45	3.00	0.82	0.93	-0.64	4.64**

** $p < 0.01$

N= 915 students attending a face-to-face and online course.

a Average item mean=Scale mean divided by the number of items in that scale.

b Effect sizes show the difference between means expressed in standard deviation units.

A one-way MANOVA was performed with the six COMPLEQ scales as dependent variables and the course (online or face-to-face) as the independent variable. When

the multivariate test yielded significant results ($p < 0.01$) in terms of Wilks' lambda criterion for the set of criterion variables as a whole, the one-way ANOVA was interpreted for each of the six individual COMPLEQ scales. The results of the F tests are reported in Table 4.7 along with descriptive statistics. In order to estimate the magnitudes of between-course differences (in addition to their statistical significance), effect sizes were calculated as recommended by Thompson (1998, 2001). The effect size was calculated by dividing the difference between the means for the two courses by the pooled standard deviation.

With respect to students' perceptions of the learning environment, analyses revealed that students had statistically significantly more positive perceptions of the online course for all six learning environment scales when compared with their perceptions of the parallel face-to-face course. The effect size for the between-course differences for each learning environment scale was of reasonable size, ranging from about one-third of a standard deviation (0.39) to over two-thirds of a standard deviation (0.70). According to the guidelines proposed by Cohen (1988), these effect sizes range from medium (for the scales of Task Orientation, Responsibility and Computer Usage) to large (for the scales of Access, Authentic Learning and Information Design), suggesting that the latter could be of educational importance. Figure 4.1 provides a graphical representation of the average item means for the online and parallel face-to-face scores on the COMPLEQ, showing that, for all six scales, students perceived that the online course had a more favourable learning environment.

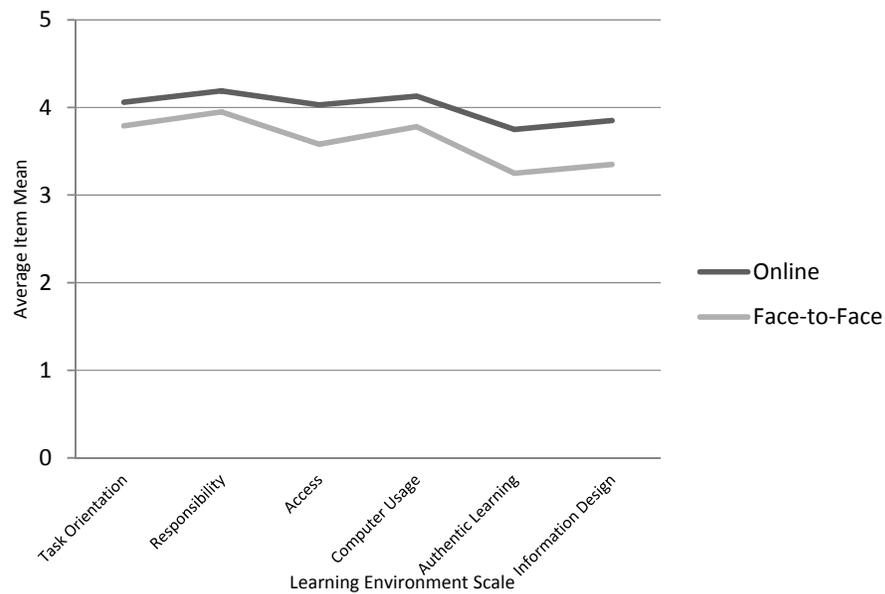


Figure 4.1 Differences between students' perceptions of the online and face-to-face course as assessed by the COMPLEQ

Multivariate analyses of variance (MANOVA) also were performed to investigate differences in students' attitudes to the online and face-to-face course. The results indicate that, for all three attitudinal scales (Enjoyment, Academic Efficacy and Anxiety), students' scores were statistically significantly ($p < 0.01$) different for the online and face-to-face courses. Figure 4.2 provides a graphical representation of the student scores (average item mean) for each of the three attitude scales (Enjoyment, Academic Efficacy and Anxiety) for the online and face-to-face course. This profile illustrates that the student scores were more favourable for the online course for all three scales. Student scores were higher for Enjoyment and Academic Efficacy and lower for Anxiety in the online course when compared to the face-to-face course. The effect size (in standard deviation units) for all three attitude scales was above 0.5 which suggests, according to Cohen's (1988) guidelines, a medium (and arguably

educationally important) difference between students' attitudes towards the online and face-to-face courses.

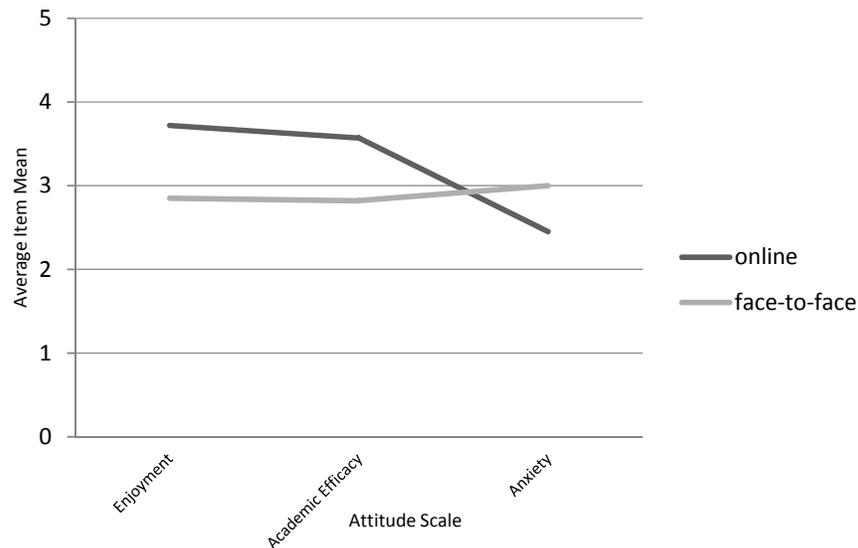


Figure 4.2 Differences between students' attitudes towards the online and face-to-face courses

Intuitively, some of these differences in scores for the online and face-to-face learning environment made sense. For example, one would expect there to be a large difference between student scores on the Access scale, which assesses the extent to which the learning environment is convenient for the students. However, differences in scores between the two learning environments, whilst useful in providing an overview, did not convey the reasons for students' responses (which are necessary to provide a comprehensive understanding of the effectiveness of the online learning environment). Therefore, an important component of the present study was the gathering of qualitative information, collected during focus-group and individual interviews with students, to help to provide insights into the profiles provided in Figures 4.1 and 4.2. The results of the interviews are provided below.

4.5.2 Interview Results

An important component of the evaluation of the online course was the inclusion of qualitative data to add depth to the quantitative data. Information, collected from 90 students who volunteered to be part of focus-group interviews (Patton, 2002), helped me to understand not only the quantitative results but also reasons for those results, thereby providing a more holistic view that assisted with the evaluation (Bogdan & Biklen, 1982; Patton, 1990). Section 3.6.2 describes the selection of the sample used for focus group interviews and Section 3.7.2 describes the analysis of the interviews. This section discusses each of the COMPLEQ and attitude scales in turn and, through using the results of both the quantitative and qualitative data, evaluates students' perceptions of the effectiveness of the online course.

4.5.2.1 Task Orientation

Discussions and interviews with 90 students (from the 991 students who responded to the questionnaires) indicated that most of them had a good understanding of what the individual items in the Task Orientation scale meant. The general consensus amongst the respondents was that they were more task-oriented in the online learning environment than in the face-to-face learning environment, reflecting the quantitative results. It would appear that, because each online session clearly spells out the goals and expectations for that particular session, students generally had a clearer picture of the expectations and goals than during the face-to-face sessions. This notion of providing clear and meaningful tasks (Hung & Chen, 2001) for which students are provided with clear goals (Bocchi, Eastman & Swift, 2004) appears to have been achieved as exemplified by one student's comment, "I know the goals of each

session and I can always refer back to them immediately since they're there always as a reminder". Another stated, "Although I know how much work I need to do in both of the classes, it is clearer in my online course because, at the beginning of every lesson the goals are stated and I can read and reread the focus of the lesson".

It would appear that the increased task orientation in the online course was largely due to having the goals of the lesson stated up-front and available for the students to refer back to as the lesson proceeded, which was an advantage to students and helped them to stay on task. In addition, the online course provided opportunities for students to revisit aspects about which they were unclear and to proceed at their own pace, thereby reducing students' extraneous load (as recommended by Swellar & Chandler, 1994).

4.5.2.2 Responsibility and Independence

According to constructivist theory, one of the goals is to provide the means for learners to become independent and to take responsibility for their own learning. During the focus-group interviews conducted with students, they were asked to reflect on whether they were given opportunities to make decisions about their own learning and to take responsibility in their online and face-to-face courses. The students who were interviewed generally agreed that the online learning environment was more flexible than the face-to-face environment as it gave them opportunities to be independent in deciding when and where to study. They also expressed the need for more independence and responsibility in their face-to-face classes. One student said, "It is my responsibility to achieve my goals. I don't need a teacher repeating what I need to do. I can do it in my own time. I like the online course because it

gives me breathing space”. Another student put a different spin on the notion of responsibility and independence when she said, “I am so happy to be free and independent! I am capable of doing things on my own. I do not need spoon-feeding”. By scaffolding student learning and providing sufficient guidance to the students (as recommended by Mostyn, 2009), it would appear that many students participating in the online course believed that they had been given opportunities to be more independent in their learning.

4.5.2.3 Access

During the focus-group discussions, most of the students felt that the online course provided a greater amount of flexibility, in terms of where they can study and the pace at which they can study, than the face-to-face course. Students felt that the lock-step method of the classroom was often side-stepped in the online course. Whereas the face-to-face course required the teacher to go at a standard pace, the online course provided students with the flexibility to devote either more or less than the average time to any task to be completed. In addition, students discussed the convenience and flexibility of the online course when compared to the face-to-face course. For example, one student commented, “I can study anytime, anywhere, even when I am waiting for my cousin to arrive at the airport”.

The interview also indicated that this increased flexibility allowed students to visit and revisit material about which they were not sure, thereby ensuring that the intrinsic load (Sweller, 2010) usually is neither too high or too low. As one student commented, “Sometimes I need more practice and I have the means to do so in the online course”.

4.5.2.4 Computer Usage

Students' perceptions of computer usage was more favourable for the online course than for the face-to-face course because a computer is not the sole means of learning in the face-to-face course whereas, in the online course, students use computers as the primary means through which they gain subject knowledge.

In my experience, most students in Singapore are adept at using computers for entertainment. Students who were interviewed felt that they were also adept at using their computers effectively in their online course to perform tasks associated with their studies. These students also agreed that they were able to effectively find information using the internet. One student stated, "I always use the computer to study this course; it is complete in the sense that there are instructions, lessons, illustrations, supporting videos and voice-overs – everything that I need to study and score well in the tests". He added, "I always used the computer to play. I now use it to study and I like it". Another student commented, "I love the online course because it allows me to use the computer effectively. I can listen and watch the videos which explain the lessons to me just like a teacher does. The difference is I can play and replay until I get it right". It would appear that the online course enables students to be in greater control of the learning process, an important feature of cognitive load theory (Pass, van Gog & Swellar, 2010).

4.5.2.5 Authentic Learning

During focus-group interviews, students were asked to reflect on the items of the Authentic Learning scales and to discuss how the online and face-to-face courses differed in terms of how their studies might apply to their everyday experiences. The

students who were interviewed indicated that both online and face-to-face courses were helpful in authentic learning, but they generally agreed that the online course provided more opportunities for authentic learning. It would appear that a number of features of the online course, particularly the use of audio-visual materials (videos, etc.) helped to reduce extraneous load. In addition, those students who were interviewed generally agreed that the models, illustrations and exercises were meaningful and could be related to everyday activities and problem solving exercises. One student commented, “When I use the online course, I am able to actually see two people on the video presenting a speech and I can evaluate them in terms of best presentation styles and techniques. It is not just theory; it is what happens in real life”. Another commented, “When I use the online course I am able to study the stress patterns first and then record words as I say them. After that, I can replay my recording and compare it to the standard stress pattern. This real practice helps me gain confidence and during my oral presentation assessment for all of my courses”. It would appear, therefore, that the new online course provides learning objectives and tasks that are meaningful to many students.

4.5.2.6 Information design and appeal

Students involved in the focus-group interviews were also asked to attempt to explain why the online course was perceived by students as more aesthetically and academically appealing than the face-to-face course. Those students whom were interviewed generally agreed that the materials in the online course were visually appealing and that the choice of design made the text clear. It is possible that these students were also swayed by the fact that they generally preferred the online course. One student explained that, “In the face-to-face course, there is nothing but text and

more text. In the online course there are things which make the text easier to understand such as tables, figures, and animations”. Another student explained, “I find it easy to understand the online course because there are videos and audios along with the text which help to explain the meaning. I am able to listen and watch again and again until I get the concept right”.

A small number of students whom were interviewed felt that the use of more sophisticated graphics might improve their motivation to learn. Toohey (1999, p.17) emphasises that "it is in the act of engaging with the material that learning begins", highlighting the fact that instructional method and materials are crucial to effective online learning and building an effective online learning environment. Given the students comments, therefore, it would be worth considering changing the information design and appeal to increase the effectiveness of the online environment.

4.5.2.7 Enjoyment

Focus-group interviews were used to examine whether the quantitative data were a true reflection of the students’ feelings about the courses. Students whom were interviewed were asked to discuss whether they considered the face-to-face and online courses to be fun and, if so, what they enjoyed about the two courses. The students indicated a preference for the online course for a variety of reasons. Some students attributed their enjoyment to the ability to study independently. One student stated, “I prefer the online course and enjoy the quiet. It is better with no teacher yelling instructions in the class”. Other students explained that they enjoyed the online course more because of its flexibility. For example, one student said, “I enjoy

the online course as I study it whenever I get the time”. Another student enjoyed the online course more because she found it to be less stressful. One student stated, “I enjoy the online course a lot. It is not at all stressful like other courses”. Other students preferred the online course without really knowing why. One student stated, “I think both online and face-to-face courses are fun, but to be honest, and don’t ask me why, I enjoy online course better”.

Three of the students whom were interviewed pointed out that the online course was boring because they preferred classes with face-to-face interaction. However, the results of the qualitative data analyses generally supported the quantitative data by indicating that overall, students enjoyed the online learning environment more than the face-to-face learning environment.

4.5.2.8 Academic Efficacy

The quantitative data indicated that students had statistically significantly higher scores for the Academic Efficacy scale for the online course than for the face-to-face course. Students whom were interviewed also were generally more confident about their ability for the online course than the face-to-face course. One student stated, “I can safely say that I am quite confident when it comes to completing assignments and scoring well in tests in the online course”. Another student reflected the majority of students’ feelings when he claimed, “I am more confident in my online course than in my face-to-face course”.

It would appear that many of the students whom were interviewed were less confident about their abilities in the face-to-face course because they were often

required to express their ideas and opinions in class and were self-conscious about doing so. As one student stated, “I am capable of doing well. Maybe my personality is not so good so I may not leave a good impression in the face-to-face course where I have to meet teachers face-to-face. But, in the online course, there is no such criterion and so I am more confident”. In contrast, four of the 90 students whom were interviewed felt that they were less confident when using the online course as they felt that they needed more support. In addition, these students doubted their performance because they were working on their own and had no-one with whom they could compare themselves.

4.5.2.9 Anxiety

The quantitative data indicated that students experienced statistically significantly more anxiety in the face-to-face course than the online course. Focus-group interviews confirmed that this was the case. The students whom were interviewed generally agreed that working online was less stressful as they could work at their own pace and at times that suited them. If they were unsure about an aspect of the course, it was possible to revisit that aspect until they felt confident that they had learned it. One student commented, “I am not anxious about the online course because I know I have all day and all night to study in order to score well”. It would appear that another cause for anxiety was the fear of making mistakes in front of classmates as exemplified in the comment, “I am rather more anxious in the face-to-face course as the mistakes made there are noticed by my classmates. Here, in the online course, I can try many times on my own and then get it right”. These reflections suggest that the online learning environment provides students with a degree of anonymity which makes some students less anxious. In contrast, four of the

90 students whom were interviewed said that the online course made them more anxious. These students all felt alone and that, when they could not locate the required information, they became anxious.

For all scales, the focus-group interviews supported the questionnaire data, and indicated that most the students found that the learning environment of the online course provided better task orientation, more opportunities for students to take responsibility and be independent, better access to lessons, an active learning environment, greater opportunities for computer usage, authentic learning, and information design and appeal. Their interview responses concerning their attitudes to the online course in terms of enjoyment, academic efficacy and anxiety also indicated that students typically had a preference for the online learning environment compared to the face-to-face environment.

4.6 Investigating Associations between the Learning Environment and Attitudes with regard to Online Courses

Although much past research has been conducted into environment–outcome associations in face-to-face classrooms, only limited research has examined the influence of learning environment variables on student outcomes in an online setting. Therefore, this study used only the data pertaining to students’ attitudes and perceptions of the learning environment in the online course. This section presents the results for associations between students’ perceptions of the learning environment of the online course and students’ attitudes (enjoyment, academic

efficacy and anxiety) towards the same course, based on simple correlation and multiple regression analyses.

Simple correlation analysis was used to examine the bivariate relationships between each attitudinal scale and COMPLEQ scale. Multiple correlation analysis was undertaken using the set of several scales of the COMPLEQ questionnaire as independent variables and each attitude scale as the dependent variable. This analysis provided more parsimonious information about relationships between correlated independent variables and reduced the risk of a Type I error often linked with simple correlation analysis. The results of the analyses are reported separately, below, for each attitudinal outcome (Enjoyment, Academic Efficacy and Anxiety) and show that the multiple correlation were statistically significant for all three outcomes. Finally, the standardised regression coefficients were used to identify which of the individual learning environment scales were significant independent predictors of a student outcome. The results of the simple correlation and multiple regression are reported separately for each student outcome: enjoyment; academic efficacy; and anxiety.

4.6.1 Enjoyment

Simple correlation analysis revealed that each of the six learning environment scales was statistically significantly and positively related to students' enjoyment of their online course. The multiple correlation (R) (reported in Table 4.8) for the six COMPLEQ scales was 0.76 and statistically significant ($p < 0.01$) for the Enjoyment scale. To identify which learning environment scales contributed to the variance in

student enjoyment, standardised regression weights (β) were examined (Table 4.8). Four classroom environment scales were significant ($p < 0.05$) independent predictors of student enjoyment: Task Orientation, Access, Authentic Learning and Information Design and Appeal. In all cases, the significant correlations were positive in direction.

These results indicate that, to increase the likelihood of students' enjoying the online course, then the instructional design should ensure that material is presented in manageable sized modules with clear guidelines and instructions (Task Orientation) and that opportunities are provided for students to proceed through the course at their own pace and to repeat components that have not been understood (Access). Further, student enjoyment is likely to be enhanced through the use of authentic tasks to which students can relate (Authentic Learning) and audio and visual materials, tables and graphics to assist students to understand the content (Information Design and Appeal).

Table 4.8: Simple Correlation and Multiple Regression Analyses for Associations between Three Student Attitudes (Enjoyment, Academic Efficacy and Anxiety) and Learning Environment Scales

Learning Environment Scale	Enjoyment		Academic Efficacy		Anxiety	
	<i>r</i>	<i>B</i>	<i>r</i>	β	<i>r</i>	β
Task Orientation	0.55**	0.17**	0.52**	0.20**	-0.01	0.05
Responsibility & Independence	0.46*	-0.01	0.41**	-0.06	-0.01	0.02
Access	0.56**	0.11**	0.53**	0.17**	-0.04	-0.14**
Computer Usage	0.49**	0.02	0.47**	0.07*	0.02	0.01
Authentic Learning	0.70**	0.42**	0.61**	0.35**	-0.07*	-0.06
Information Design & Appeal	0.60**	0.20**	0.49**	0.08*	-0.12**	-0.19**
Multiple Correlation (<i>R</i>)		0.76**		0.67**		0.18**

* $p < 0.05$ ** $p < 0.01$

N = 911 students attending online courses

4.6.2 Academic Efficacy

Simple correlation analyses indicated that the Academic Efficacy scale was positively and statistically significantly ($p < 0.01$) related to each of the six learning environment scales in the online learning environment. The multiple correlation (R) between the COMPLEQ scales and the students' academic efficacy was 0.67 and statistically significant ($p < 0.01$). Standardised regression weights (β) were used to describe the influence of a particular learning environment variable on student academic efficacy when all other environment variables in the regression analysis are mutually controlled. The regression weights (β) (reported in Table 4.8) indicate that five of the six learning environment scales (namely, Task Orientation, Access, Computer Usage, Authentic Learning and Information Design and Appeal) were positively, significantly ($p < 0.05$) and independently related to students' Academic Efficacy.

These results suggest that, if an online environment provides clear instructions and breaks learning into manageable sized components (Task Orientation), ensures that students are able either to proceed or to return to information that has not been understood (Access), provides authentic tasks to which students can relate (Authentic Learning) and supports the learning with models, tables and appealing audio and visual aids (Information Design and Appeal), then students are more likely to have positive beliefs about their ability to succeed in the course.

4.6.3 Anxiety

Simple correlation analysis indicated that only two learning environment scales, namely, Authentic Learning and Information Design and Appeal, had a statistically significant and negative relationship with Anxiety. The multiple correlation (R) between the COMPLEQ scales and Anxiety was 0.18 and statistically significant. The standardised regression weights (β) used to provide information about the independent influence of each learning environment scale on Anxiety, indicate that two scales, Access and Information Design and Appeal, were statistically significantly ($p < 0.05$) and independently related. For both scales, the relationship was negative, implying that students studying the online course were likely to be less anxious if there was more Access and Information Design and Appeal. These results are in line with cognitive load theory, suggesting that course designers wishing to reduce student anxiety should provide opportunities for students to revisit work that is not understood and to proceed at their own pace (Access), as well as ensuring that extraneous load is minimised by providing alternatives to written paragraphs by including information in alternative forms including models, diagrams, and audio and visual objects (Information Design and Appeal).

Overall, the results in Table 4.8 suggest strong and positive associations between students' perceptions of the learning environment of the online course and students' attitudes of enjoyment and academic efficacy. In contrast, the negative associations between students' perceptions of the learning environment of the online course and students' attitudes for anxiety were smaller in magnitude. The associations found

between Enjoyment, Academic Efficacy and Anxiety and the classroom environment replicate considerable prior research (Fraser, 2007, 2012).

4.7 Chapter Summary

The present research compared students' attitudes and their perceptions of the learning environments created in an online and a face-to-face course. The overarching aim of the research was to evaluate the effectiveness of an online course. To this end, two questionnaires (one to assess students' attitudes and one to assess student perceptions of the learning environment) were developed and piloted with 117 students.

The development of the learning environment questionnaire was carried out in four stages, as discussed in the previous chapter. The scales of the questionnaire were adapted from previously-developed and valid classroom environment instruments, with particular attention being given to the needs of an online learning environment at a polytechnic in Singapore. The final version of the new instrument (named the Comparative Learning Environment Questionnaire, COMPLEQ) included the six scales: Task Orientation (from *What is Happening In this Class?*, developed by Fraser, Fisher & McRobbie, 1996); Responsibility and Independence (adapted from Young Adult Ethos scale of *Technology-Rich Outcomes-Focused Learning Environment*, developed by Aldridge & Fraser, 2008, 2011); Access (obtained from *Web Based Learning Environment Inventor*, developed by Chang & Fisher, 2003); Computer Usage (from *Technology-Rich-Outcomes Focused Learning Environment*, developed by Aldridge & Fraser, 2008, 2011); Authentic Learning (from

Constructivist Learning Environment Survey, developed by Taylor, Fraser and Fisher, 1997); and Information Design and Appeal (from the Online Learning Environment Survey, developed by Clayton, 2004).

An attitude instrument was also created to permit investigation of the effectiveness of the online course in terms of student enjoyment, academic efficacy and anxiety. The scales were Enjoyment, adapted from Test of Science-Related Attitudes (TOSRA, Fraser, 1981), Academic Efficacy, adapted from the Morgan-Jinks Efficacy Scale by Aldridge et al. (2008) and Anxiety, a new scale created for the purpose of this study and based partly on the work of Taylor (2004) and Gillis (1995).

To provide an economical format for administration, both the learning environment and the attitude scale were integrated into one questionnaire sheet, and also the two response blocks for the two courses that were being compared were placed side by side. The same response alternatives involved a five-point frequency scale of Almost Never, Seldom, Sometimes, Often and Almost Always for all scales.

A pilot study involved 117 randomly-selected students, who were asked to respond to the new survey. In addition, 17 of the students also took part in semi-structured, focus-group interviews. These data were used to ensure the readability of the items and to ensure that the administration process was appropriate in terms of length of time involved and students' ability to understand the response format. The results of the pilot study confirmed that the questionnaire was suitable for use in the study.

The main study included survey data (COMPLEQ and attitude scales) collected from 991 students in 50 classes for both the online and face-to-face courses that were analysed using different statistical methods to check validity. For the COMPLEQ, Principal axis factoring followed by varimax rotation led to the removal of one of the scales (Active Learning). The remaining 36 items (six items in each of six scales) all had a factor loading of at least 0.40 on their *a priori* scale and no other scale for both the online and face-to-face responses. The total variance for the online course was 57.70% ranging from 7.5% to 11.2% for different scales. For the face-to-face course, the total variance was 56.49% ranging from 8.42% to 10.76% for different scales. The eigenvalues ranged from 2.7 to 4.05 for the online environment and from 3.03 to 3.87 for the face-to-face course.

The alpha coefficient for different COMPLEQ scales ranged from 0.85 to 0.92 for online course and from 0.85 to 0.91 for the face-to-face course, thus indicating that the items assess similar constructs for each scale. The results indicated that there was strong factorial validity, internal consistency, reliability and discriminant validity for the COMPLEQ for both the online and face-to-face courses.

For the three-scale attitude instrument, principal axis factoring followed by varimax rotation showed that all items in each of the three scales had a loading of 0.40 on their *a priori* scale and no other scale for both the online face-to-face course. For the online course, the percentage of variance varied from 20.66% to 25.58% for different scales, with the total variance accounted for being 57.70%. For the face-to-face course, the percentage of variance ranged from 19.95% to 26.37% for different scales, with a total variance accounted for being 56.49%. The eigenvalue varies from

3.72 to 4.60 for online course and 3.60 to 4.75 for face-to-face course. The alpha reliability ranged from 0.91 to 0.95 for the online course and from 0.89 to 0.96 for the face-to-face course. The discriminant validity ranged from 0.01 to 0.34 for the online and 0.25 to 0.45 for the face-to-face course. These results support the reliability and validity of the attitude scales when used with students in Singapore.

When comparing the learning environment and student attitudes created in the online and face-to-face courses, students were found to have statistically significantly more favourable scores for the online learning environment, when compared with their face-to-face learning environment, in terms of every COMPLEQ and attitude scale. In addition, the effect sizes (calculated to determine the magnitude of the differences in standard deviations) were found to be large (ranging from 0.39 to 1.00) for all COMPLEQ and attitude scales. Analyses of the qualitative information collected from 90 students who took part in the semi-structured interviews and focus-group discussions helped to confirm and provide reasons for the quantitative findings. The student reflections supported the results of the quantitative results – students generally had more positive views of their online course than the face-to-face course.

To investigate whether associations existed between the learning environment created in the online course and students' attitudes (enjoyment, academic efficacy and anxiety), simple correlations and multiple regression analysis were undertaken. The multiple correlation between the learning environment scales and each of the attitude outcomes was statistically significant for all three scales (enjoyment, academic efficacy and anxiety). Overall, the results suggest strong and positive associations between students' perceptions of the online learning environment and

students' attitudes of enjoyment and academic efficacy. In contrast, there was a weaker and negative association between students' perceptions of the online learning environment and students' anxiety.

Chapter 5

CONCLUSION AND IMPLICATIONS

5.1 Introduction

The research reported in this thesis was carried out at a polytechnic located in Singapore. The overarching aim of the study was to evaluate a new online course that was introduced as part of the curriculum at this institution and which used predominantly face-to-face teaching. The study involved two courses, one taught online and a parallel face-to-face course, both of which were integral in developing the technical communication skills of the students in their first year of a three-year engineering diploma. The online course was the polytechnic's first attempt to provide online education for its students. Because the students at this institution were familiar only with traditional face-to-face models for teaching, I considered it prudent for the students to compare the learning environment created in both modes to gain a better understanding of students' perceptions and attitudes. To assess the effectiveness of this online course and to compare it with a traditional face-to-face course, two questionnaires were developed and validated, one to assess students' perceptions of the learning environment (the COMPLEQ) and the other to assess their attitudes (the attitude scales). To reduce sampling errors, almost 80% of first-year students, who were enrolled in both of the modules at the time of administration, were selected. The questionnaires were administered to 1000 students, of whom 991 provided complete and usable responses.

This chapter is organised under the following headings:

- Summary of Major findings of the study (Section 5.2);
- Limitations and Recommendations for Future Research (5.3);
- Significance of the Study (5.4)
- Practical Implications (Section 5.5).
- Concluding Remark (Section 5.6)

5.2 Summary of Major Findings of the Study

The focus of this study was to assess the effectiveness of an online course in terms of students' perceptions of the learning environment. The major findings of the study are reported below with special reference to each of the research questions.

5.2.1 Research Objective #1

To develop and validate surveys to assess:

- c) Students' perceptions of the learning environment created in online and face-to-face courses.
- d) Students' attitudes towards their online and face-to-face courses (enjoyment, academic efficacy and anxiety).

A major contribution of the present study was the development of two surveys, one to assess students' views of their online and face-to-face learning environments, and the other to examine students' attitudes towards the two courses. The development of

both instruments involved a four-stage approach. The first stage involved a review of literature pertinent to assessing learning environments and attitudes. The second stage involved identifying and developing salient scales, writing and modifying individual items, while bearing in mind the unique nature and characteristics of e-learning environments. The third stage involved making decisions related to the response format, organisation and layout of the questionnaires. The last stage involved seeking advice from experts and field testing the newly-created instruments.

5.2.1.1 Development and Validation of the COMPLEQ

Based on the review of literature, six scales that can be considered salient for the evaluation of an online and face-to-face learning environment were developed: Task Orientation, Responsibility and Independence, Access, Computer Usage, Authentic Learning, Information Design and Appeal. The learning environment questionnaire, named the Comparative Learning Environment Questionnaire (COMPLEQ) for its ability to compare the two different learning environments, had six items in each of the six scales. All of the items were positively scored and responded to on a five-point frequency scale consisting of Almost Never, Seldom, Sometimes, Often and Almost Always. The questionnaire involved a side-by-side format that enabled students to respond to each item with respect to their views of the online and the face-to-face course.

Once developed, the questionnaire was pilot tested with a randomly-selected group of 117 students – all of whom were enrolled in the newly-developed online course and the parallel face-to-face course. The pilot study aimed to ensure that the wording of the various items was clear and unambiguous and to check that students

interpreted the individual items in similar ways to the researcher. In addition, the pilot study provided the opportunity to ascertain whether the five-point response format was meaningful when used with this group of students (who were from a range of backgrounds) and to record the length of time taken to complete the two surveys. In addition to the administration of the questionnaires to these students, 17 students were also selected (based on their willingness) to be interviewed about the individual statements on the questionnaire. The results of the pilot study provided information that enabled the researcher to refine and improve some of the items.

Once refined, the COMPLEQ was administered to a sample of 1000 students who were enrolled in both the online and the parallel face-to-face courses. A total of 991 student questionnaires were complete and usable. These data were used to determine the reliability and validity of the instrument. Separate statistical analyses were conducted for the online course and the face-to-face course data. Analyses included principal axis factoring followed by varimax rotation and Cronbach alpha reliability. The results indicated that, for both the online and face-to-face courses, from the COMPLEQ, all 36 items had a factor loaded of at least 0.40 on their *a priori* scale and less than 0.40 on all other scales. The eigenvalues for each of the six learning environment scales ranged from 2.70 to 4.05 for the online course and from 3.03 to 3.87 for the face-to-face course. The total percentage of variance accounted for was a sizable 57.70% for the online course and 56.49% for the face-to-face course. The Cronbach alpha coefficients for both the online and face-to-face data from the COMPLEQ were considered to be high and were above 0.85 for all scales.

The results of these statistical tests indicated strong factorial validity and internal consistency reliability for the students' perceptions of their learning environments as assessed by the COMPLEQ for both the online and face-to-face courses.

5.2.1.2 Development and Validation of the Attitude Scales

The attitude questionnaire included the three scales of Enjoyment, Academic Efficacy and Anxiety. The three-scale instrument measuring attitudes was similar in design to the COMPLEQ, incorporating the same side-by-side layout and response format. The statistical analyses utilised to check the validity of the attitude scales also were similar to those used with the COMPLEQ and included principal axis factor analysis with varimax rotation and alpha reliability for the online course and face-to-face course.

The results of the factor analysis of data collected from 991 students enrolled in both the online and the parallel face-to-face courses confirmed the *a priori* factor structure of the three scales. All 18 items had a loading of at least 0.40 on their *a priori* scale and no other scale. The eigenvalues for each scale ranged from 3.72 to 4.60 for the online course and from 3.60 to 4.75 for the face-to-face course. The total variance accounted for was a sizable 57.70% for the online course and 56.49% for the face-to-face course.

This Cronbach alpha reliability coefficient for all of the scales for both the online and face-to-face courses were high. For the online course, the scale reliability estimates ranged from 0.91 to 0.95 and, for the face-to-face course, they ranged from 0.91 to

0.96. These data supported the reliability and validity of the attitude of students when used in Singapore at the polytechnic level.

5.2.2 Research Objective #2

To compare students in face-to-face and online courses in terms of:

- c) Perceptions of learning environment, and
- d) Attitudes (enjoyment, academic efficacy and anxiety).

The data collected using the new COMPLEQ and attitudes scales were analysed using MANOVAs to examine whether there were differences in students' perceptions of and attitudes towards the online and face-to-face courses. The results indicated that students' scores for the online course were statistically significantly ($p < 0.01$) higher for all six learning environment scales than for the face-to-face course. It was interesting to note, also, that not only were all of the differences statistically significant, but the effect sizes were medium to large according to Cohen (1982), suggesting a degree of educational importance. The effect sizes ranged from about one third of a standard deviation (for Responsibility and Independence) to over two thirds of a standard (for Authentic Learning).

In addition, all three of the attitude scales were statistically significantly different for the online and face-to-face courses, with students perceiving more Enjoyment and Academic Efficacy and less Anxiety for the online course compared to the parallel face-to-face course. Again, the effect sizes for these three scales were educationally

important as they ranged from two thirds of a standard deviation (Academic Efficacy) to one standard deviation (for Academic Efficacy).

To examine more closely the reasons for these significant differences in students' perceptions of and attitudes towards the online and face-to-face courses, qualitative information was collected from 90 students who took part in the semi-structured, focus-group interviews. This qualitative information provided reasons for the quantitative findings and insights into the effectiveness of the online course.

By using Miles and Huberman's (1984) inductive method of analysis involving the combining of common themes found in the data, the qualitative results corroborated the quantitative findings and helped to identify reasons behind students' responses and to evaluate the effectiveness of the online course. The focus-group interviews with 90 students provided evidence related to why students' perceived their online environment to be more positive when compared to their face-to-face environment. In addition, the students felt that there was a degree of authenticity in the tasks that they were expected to do. Finally, students explained that, in terms of design, the online course was appealing and easy to follow.

Cognitive Load Theory of learning helps to explain the importance of reducing the load for online learners by providing them with an effective learning environment. This theory emphasises the importance of providing illustrations, tables, and multimedia support to lighten the cognitive load. The interviews indicated that the online course made appropriate use of video, audio and graphic support throughout the online unit, thus ensuring that the students were provided with examples and models which helped to reduce the extraneous load.

The interviews with students indicated that the online course presented the learning materials in ways that helped them to understand their immediate goals and tasks, take more responsibility for their own learning and to be more independent in their learning. It would appear from the interviews that the online course succeeded in reducing student cognitive load by making the online materials clear and well organised so that students knew what they are doing and where they were going. It would appear that the online course fulfilled the requirements in terms of good instructional design. Considerations of sectioning information into manageable sizes, scaffolding tasks and ensuring that clear goals were stipulated at the commencement of each unit assisted students to stay on track and to understand the material more easily. In addition, the ability to revisit work that was not understood also gave students the opportunity to go over lessons more than once.

These areas, as well as the attitudes such as Enjoyment, Academic Efficacy and Anxiety, were brought forth by interview quotes as being supportive of the quantitative findings. The interviews indicated that students generally enjoyed the online course due to its flexibility when compared with the face-to-face environment. They also identified a sense of confidence resulting from many factors of the online learning environment such as the control that they have, the access that is given to students and also the appeal of the multimedia nature of the content. Students' interviews supported the quantitative data, indicating that they viewed the online learning environment more favourably than the face-to-face course's learning environment.

5.2.3 Research Objective #3

To investigate whether associations exist between students' perceptions of the online learning environment and students' attitudes of:

- a) Enjoyment,
- b) Academic efficacy, and
- c) Anxiety.

Simple correlation and multiple regression analysis were conducted to explore associations between the learning environment scales and each of the student outcome scales. This analysis was conducted using only students' perceptions and attitudes of their online learning environments.

The investigation of the associations between students' perceptions of their online learning environment and the attitudes of Enjoyment, Academic Efficacy and Anxiety suggested moderate environment-outcome associations. For associations between student perceptions of the online learning environment and enjoyment, all six learning environment scales were statistically significant and positive. The multiple correlation for the six learning environment scales also was statistically significant for the enjoyment scale. The standardised regression weights indicated that four of the six learning environment scales were statistically significantly and positively related to student enjoyment: Task Orientation, Access, Authentic Learning, and Information Design and Appeal.

For the Academic Efficacy scale, simple correlations revealed that all six learning environment scales were positively and significantly related to this outcome. The multiple correlation also was statistically significant and positive. The standardised regression weights indicate that five of the six learning environment scales were statistically and positively related to students' perceptions of Academic Efficacy, these being, Task Orientation, Access, Computer Usage, Authentic Learning and Information Design and Appeal.

The simple correlation analysis indicated that two of the six learning environment scales, Authentic Learning and Information Design and Appeal, were statistically significantly and negatively associated with student anxiety. The multiple correlation was statistically significantly and positively correlated. The standardised regression weights indicated that two of the scales (Access and Information Design and Appeal) were statistically significantly and negatively related to Anxiety.

5.3 Limitations and Recommendations for Future Research

Although careful consideration was given to the design of the present study, there are still potential limitations. A possible concern is that, because I was both the researcher and a lecturer at the university, students might not have been completely honest. Every attempt was made, however, to ensure that this risk was minimised. Throughout the study, I ensured that students were provided with clear information related to the procedures of the study. Students who were involved in the study (both in responding to the questionnaires and in focus-group interviews) did so without threat or inducement.

To guard against the possibility of biased responses during interviews, a rapport between myself and the interviewees was established prior to the commencement of the interviews. During this time, I went to lengths to ensure that information that was recorded during interviews would remain strictly confidential and that the information would not be linked to any particular students. Also, it was made clear to students that the information that they provided would not influence their grades or outcomes at the polytechnic in any way.

Given that I was involved in the development and design of the online course that was evaluated during this research, there was the potential for researcher bias. This potential was identified and acknowledged. To help to overcome the potential threat of bias, I relied heavily on the perceptions of students who were enrolled in the online course. In addition, I minimised the threat of bias and enhanced the validity to the data collected through the triangulation of data from range of research methods.

Careful consideration of the design included administration to 80% of the students enrolled in the online course during the first year of their study. In addition, focus-group interviews were conducted with 90 of the 991 students who responded to the questionnaire. This large sample of students for interviews was useful in providing insights into the questionnaire data and providing further data that could be used in the evaluation of the online course. However, it is recognised that the questionnaire sample, although large, included only freshman or first-year students and, therefore, the generalisability of the findings should be made with caution when applied to students in different year levels or students who may be studying at different

polytechnics. Therefore, it is recommended that further research be conducted using other samples.

A further limitation of the present study is the absence of any achievement scores. Although three important student outcomes were investigated (enjoyment, academic efficacy and anxiety), the omission of achievement in the evaluation of the effectiveness of the may be considered a limitation. It is recommended that future research related to the evaluation of an online course include a measure of student achievement.

5.4 Significance of the Study

A major contribution of the present study was the development and validation of a learning environment survey that can be used to compare students' views of an online and face-to-face course. Given the premise that good instructional design and utilisation of theories related to teaching and learning need to be incorporated whether one is teaching an online or a face-to-face course, this questionnaire helps to tap into students' perceptions of aspects of instructional design that that can inform the development of face-to-face and online courses.

This research has shown the COMPLEQ to have sound psychometric properties, with its overall factor structure comparing favourably with classroom environment instruments developed over the past two decades and reported in reviews of classroom environment research by Fraser (2007, 2012). The researcher has succeeded in developing and validating an instrument for the evaluation of online

courses with special emphasis on the learning environment. It has to be emphasized here that this questionnaire also had a comparative dimension to help students to compare a familiar experience (a face-to-face course) with an unfamiliar experience (the new online course) in order to understand the effectiveness of the online course. Further, the data gathered through the questionnaire highlighted the importance of the complementary nature of the face-to-face and online courses and emphasised the need for similar integrated courses for effective online education.

Though the questionnaire was comprehensive for the purposes of the study, a retrospective consideration of the items related to the different scales has made me aware of the fact that authentic data could have been lost because of the length of the questionnaire. Therefore, future research should also consider the fact that researchers alternatively could use a purposive selection of scales for interviews or retrospective analysis by the students

This questionnaire was used successfully to examine the effectiveness of the online course in terms of the learning environment perceived by the students. The questionnaire has the potential to provide practitioners and online course developers with important information related to a range of aspects related to instructional design from the students' perspective that can be used to improve and enhance the learning environment provided. In addition, the questionnaire can be added to the growing list of tools, used by researchers intending to evaluate students' perceptions of their learning environment.

In the context of the growing demand for acquiring knowledge and information in a globalised world, educational institutions should also plan for future eventualities and competitive environments so that the business of education can be continued without interruption. As such, this study has particular significance because online education has become an inevitable part of the education systems around the world. Considering that the specific online course discussed in this study is the first of its kind in this polytechnic, it is pertinent to raise issues regarding the quality of the online learning environment, particularly as the demand for online courses increases. This study has demonstrated the usefulness of including classroom environment assessments as process measures of effectiveness when evaluating the effectiveness of online educational programmes.

The results of the present study could influence course planning, especially online course planning, in the context of teaching at a polytechnic in Singapore.

5.5 Practical Implications

In most Asian contexts, the notion of an educational environment within the realm of online education has not received the attention that online courses have received elsewhere. The quantitative and qualitative results of this study have practical implications for future developers of online courses that could not only help in dispelling such reservations but also help stake holders in the education field appreciate and understand the benefits of sound instructional design in online education.

Further, the results of the survey data (comparing the online and face-to-face environments) suggest that online education has the potential to develop greater autonomy in learners. The interviews with students indicated that the online course required them to take greater responsibility for their own learning than the face-to-face course. Practically, then, academics wishing to increase the autonomy of their students might involve more online requirements.

In addition, the questionnaire has the potential to be used as a regular evaluation tool in future online programmes even if it has to be modified to suit particular contexts or environments. The COMPLEQ, however, does not include any scales that are related to Moos' (1974) Relationship dimension. Given the importance of the social aspects of learning (as purported in the constructivist learning theory) (Kirschner, Sweller & Clark, 2006; Mayer 2004), this dimension should be included in future questionnaires that assess students' perceptions of the online learning environment.

In light of the findings about the complementing and supplementing roles of online and face-to-face modes of instruction, review sessions should be an essential part of planning online courses and should be made more rigorous to incorporate changes and perceptions both from the point of view of the teachers and learners (for example if students found something irrelevant or uninteresting or difficult to manage). This would also necessitate the need for piloting of planned courses on a regular basis to make online programmes reap maximum benefits.

5.6 Concluding Remark

With the advent of technology, most educational institutions in Singapore are conducting some form of computer assisted education. The current research involved the evaluation of one such attempt by a Polytechnic. The introduction of a new online subject required evaluation that would allow the curriculum planners and teachers to make necessary improvements to the subject. This study has developed a comparative learning environment questionnaire which will provide insights into the psychosocial environments of both the online subject as well as the face to face subject. The evaluation was undertaken to facilitate necessary revisions to the content and delivery of the subject.

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APPENDIX A

Comparative Learning Environment Questionnaire (COMPLEQ)¹

Directions for Students

This questionnaire contains statements about the online and face-to-face technical communication courses. You will be asked how often each statement is true for each of the courses. Respond in the lightly shaded block for the online course and in the darker block for face-to-face course.

Draw a circle around

1	if you feel this way	Almost Never
2	if you feel this way	Seldom
3	if you feel this way	Sometimes
4	if you feel this way	Often
5	if you feel this way	Almost Always

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

¹ Source of scales

Task Orientation – WIHIC (Aldridge, Fraser & Huang, 1999).

Responsibility & Independence – modified from Young Adult Ethos Scale, TROFLEI (Aldridge & Fraser 2008, in press).

Access – WEBLEI (Chang & Fisher, 2001, 2003).

Active Learning – modified from Investigation Scale, WIHIC (Aldridge, Fraser & Huang, 1999).

Computer Usage – TROFLEI (Aldridge & Fraser, 2008, in press).

Authentic Learning – CLES (Taylor, Fraser & Fisher, 1997).

Information Design & Appeal – OLLES (Clayton, 2004).

All scales were used in my study and included in this thesis with the permission of their authors.

Task Orientation	Online Course					Face-to-Face Course				
	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>In this subject ...</i>										
1. Getting a certain amount of work done is important to me.	1	2	3	4	5	1	2	3	4	5
2. I do as much as I set out to do.	1	2	3	4	5	1	2	3	4	5
3. I know the goals.	1	2	3	4	5	1	2	3	4	5
4. I know what I am trying to accomplish.	1	2	3	4	5	1	2	3	4	5
5. I try to understand the work.	1	2	3	4	5	1	2	3	4	5
6. I know how much work I have to do.	1	2	3	4	5	1	2	3	4	5
Responsibility and Independence										
<i>In this subject ...</i>										
7. I am given responsibility.	1	2	3	4	5	1	2	3	4	5
8. I am expected to think for myself.	1	2	3	4	5	1	2	3	4	5
9. I make decisions about my learning.	1	2	3	4	5	1	2	3	4	5
10. I am given the opportunity to be independent.	1	2	3	4	5	1	2	3	4	5
11. I am encouraged to take control of my own learning.	1	2	3	4	5	1	2	3	4	5
12. I play an important role in my learning	1	2	3	4	5	1	2	3	4	5
Access										
<i>In this subject:</i>										
13. I access the learning activities at times convenient to me.	1	2	3	4	5	1	2	3	4	5
14. I work at my own pace to achieve learning objectives.	1	2	3	4	5	1	2	3	4	5
15. I decide how much I want to learn in a given period.	1	2	3	4	5	1	2	3	4	5
16. I decide when I want to learn.	1	2	3	4	5	1	2	3	4	5
17. I work during times that I find convenient	1	2	3	4	5	1	2	3	4	5
18. There is flexibility in terms of when I choose to do my work.	1	2	3	4	5	1	2	3	4	5

Computer Usage	Online Course					Face-to-Face Course				
	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>In this subject ...</i>										
19. I use a computer to word-process my assignments.	1	2	3	4	5	1	2	3	4	5
20. I use a computer to email assignments.	1	2	3	4	5	1	2	3	4	5
21. I use a computer to find out information about the subject.	1	2	3	4	5	1	2	3	4	5
22. I use a computer to find out information about how my work is assessed.	1	2	3	4	5	1	2	3	4	5
23. I use a computer to find information related to the subject.	1	2	3	4	5	1	2	3	4	5
24. I use a computer to obtain information from the Internet.	1	2	3	4	5	1	2	3	4	5
Authentic Learning	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>In this subject ...</i>										
25. I can relate what I learn to my life outside this polytechnic.	1	2	3	4	5	1	2	3	4	5
26. I can connect my studies to my activities outside.	1	2	3	4	5	1	2	3	4	5
27. I apply my everyday experiences in this subject.	1	2	3	4	5	1	2	3	4	5
28. I study real cases.	1	2	3	4	5	1	2	3	4	5
29. I work on assignments that deal with real-world information.	1	2	3	4	5	1	2	3	4	5
30. I work with real examples.	1	2	3	4	5	1	2	3	4	5
Information Design and Appeal	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>In this subject ...</i>										
31. The choice of design makes the text clear.	1	2	3	4	5	1	2	3	4	5
32. The material is visually appealing.	1	2	3	4	5	1	2	3	4	5
33. The layout used in tables and illustrations is attractive.	1	2	3	4	5	1	2	3	4	5
34. I find that the photographs and tables visually appealing.	1	2	3	4	5	1	2	3	4	5
35. I find the photographs and tables help me to understand.	1	2	3	4	5	1	2	3	4	5
36. The multi-media used (animation, sound or video) help me to understand concepts.	1	2	3	4	5	1	2	3	4	5

APPENDIX B
Attitude Survey²

² Origin of scales

Enjoyment – originated from TOSRA and adapted by Aldridge & Fraser, (2007).

Self-Efficacy – originate from MJES and adapted by Aldridge & Fraser, (2008).

All scales were used in my study and included in this thesis with the permission of their authors.

	Online Course					Face-to-Face Course				
	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
Enjoyment										
37. I look forward to lessons in this subject.	1	2	3	4	5	1	2	3	4	5
38. Lessons in this subject are fun.	1	2	3	4	5	1	2	3	4	5
39. This is one of my favourite subjects.	1	2	3	4	5	1	2	3	4	5
40. Lessons in this subject interest me.	1	2	3	4	5	1	2	3	4	5
41. I enjoy lessons in this subject.	1	2	3	4	5	1	2	3	4	5
42. I enjoy activities that we do in this subject.	1	2	3	4	5	1	2	3	4	5
Academic Efficacy	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
43. I find it easy to get good grades in this subject.	1	2	3	4	5	1	2	3	4	5
44. I am good at this subject.	1	2	3	4	5	1	2	3	4	5
45. My friends ask me for help in this subject.	1	2	3	4	5	1	2	3	4	5
46. I find this subject easy.	1	2	3	4	5	1	2	3	4	5
47. I outdo most of my classmates in this subject.	1	2	3	4	5	1	2	3	4	5
48. I help my friends with their homework in this subject.	1	2	3	4	5	1	2	3	4	5
Anxiety	Almost Never	Seldom	Some times	Often	Almost Always	Almost Never	Seldom	Some times	Often	Almost Always
<i>I feel anxious when ...</i>										
49. Working on a task in this subject.	1	2	3	4	5	1	2	3	4	5
50. Getting my schedule and seeing this subject on it.	1	2	3	4	5	1	2	3	4	5
51. Thinking about this subject.	1	2	3	4	5	1	2	3	4	5
52. Taking a test in this subject.	1	2	3	4	5	1	2	3	4	5
53. Learning about grammar lessons in this subject (e.g. passive voice, dependent clause).	1	2	3	4	5	1	2	3	4	5
54. Looking through the modules of this subject.	1	2	3	4	5	1	2	3	4	5

APPENDIX C

Example Lessons for Online and Face-to-Face Courses

Example Lessons of Online and Face-to-Face Courses

Although the content is the same for both the online and face-to-face components, there are differences in the manner in which teachers and curriculum developers handle the topic. Carefully devised pedagogical techniques have been used to ensure their suitability for the respective modes of instruction. The grid below compares the online subject and the face-to-face subject with respect to one of the modules that is taught, Effective Public Speaking. The grid below compares the learning objectives and methodology of this component of the course for the online and face-to-face subjects. It should be noted that both components involve much planning and revisions are made continuously on the basis of feedback from staff and students.

Online subject	Face-to-face subject
The learning objectives of each lesson are stated at the opening of the session.	Learning objectives of the session are stated at the beginning of the module and not at the beginning of every session.
Recognising the characteristics of an effective public speaker.	How to make an effective presentation.
Students analyse video clips and complete tasks such as self-check quizzes.	Students are involved in discussions and classroom tasks related to what makes an effective presenter.
Five short video clips are presented with a quiz at the end of each clip Each clip shows two speakers Speaker A and B whose speech highlights some aspect of effective speaking such as pronunciation of words, stress, intonation, pace, pauses etc.	Discussions revolve around pronunciation, voice modulation, voice projection, effective gestures.

<p>Students are asked to view the videos and take a quiz that probes their understanding of the features of effective speaking. The quizzes can be taken any number of times and are for self-check purposes.</p>	<p>In-class discussion with the peers and the teacher and practice of the above. The time is limited for practice. Extracts of speeches are given and the students' tasks are to practice these.</p>
<p>Individual work that involves checking one's own pronunciation by recording and listening to. Checks are based on what is taught through the online material.</p>	<p>In-class practice with peers in groups or pairs in making use of the above techniques for making an effective speech.</p>
<p>Video clips showing effective use of body language.</p>	<p>Students are provided with notes on effective body language, watch demonstrations and are involved in class discussions.</p>
<p>Students are given a quiz which allow multi-viewing and multi-trials.</p>	<p>In-class discussions and practice of making use of effective body language.</p>
<p>Finally, video clips of two different speakers making a 5 minutes presentation, each on a similar topic, are shown to the students. Students are required to rate the speakers and to explain why they preferred one speaker over the other. This is followed by a quiz covering major aspects studied in this lesson.</p>	<p>Students practice a speech in pair or in groups and ask for feedback from peers about their presentation style and technique.</p>

APPENDIX D

Example of an Interview Schedule

Interview Schedule

Focus Group 1

Agenda

(Before session starts, check if that all students have completed the COMPLEQ)

1. Welcome and introduction to the project
2. Introductions among interviewees
3. Main session questions

Question 1 - You have just completed the COMPLEQ questionnaire. Do you have any general comments that you would like to make?

Question 2 - Do you have a preference between the online learning environment or the face-to-face learning environment for this course? Why might that be? Would you care to elaborate?

Question 3 - Having been enrolled in the online unit, did you feel that there were any benefits to studying in this mode? If so, what were they?

Question 4 - Were there any disadvantages to studying in the online environment? Can you elaborate on what these were?

Question 5 - Did you face any problems as you worked through the online course? How did you resolve these problems?

Question 6 - Are there any final thoughts or comments that you would like to make with respect to the online course?

4. End session by thanking the interviewees.

To add clarity, depth and validity to the natural course of the conversation I used many techniques, a few of which I have described below:

- ✓ Ask for clarification ('What do you mean by...?' 'Can you say a little more about...?')
- ✓ Seek comparisons ('How does that relate to...?' 'Some others have said that...');
- ✓ Aim for comprehensiveness ('Have you any other...?' 'Do you all feel like that?' 'Have you anything more to say on that?');
- ✓ Summarise occasionally and ask for corroboration ('so...?' 'What you are saying is...?' 'Would it be correct to say ...?')
- ✓ Play the devil's advocate ('An opposing argument might run...'' 'What would you say to the criticism that...?').