Cognitive Style and Hypermedia Learning: A Multi-Perspective Study

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This thesis is presented for the degree of
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I declare that this thesis is my account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

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(Catherine Hui Min Lee)
I would like to thank my extraordinary supervisor, Prof. Fay Sudweeks for her immense support, encouragement, patience and guidance throughout the journey of my candidature. Most importantly, despite the issue of long distance between U.S. and Australia, I am indebted to Fay’s kindness and generosity, especially for all her visitations which has helped kept me motivated as well as has made it possible for me to complete this thesis. I would also like to thank my parents, husband, children, sister and brother - for their love, support, patience and encouragement. Special thanks to Dr. Fu Ee Tang for obtaining the ethics approval and coordinating the survey invitations at Curtin University Sarawak. Most of all, the survey participants at Murdoch University and Curtin University Sarawak, thank you for your participation and contribution to the findings in this study.

ABSTRACT

The massive growth of information communication technologies (ICTs) has revolutionized students’ learning in higher education through the advancement of educational technologies. Technologies such as hypermedia learning systems have become widespread and offer significant contributions to improving the delivery of learning and teaching materials. One attribute of hypermedia in facilitating learning is the way it parallels how the human brain and memory works, particularly the way information is encoded and retrieved (Jonassen, 1988; 1991). The effectiveness of hypermedia systems as learning tools has been confirmed by numerous researchers (e.g. Buchanan, 2000; Ford & Chen, 2001; Fullerton, 2000; Guthrie, 2010; Lee & Boling, 2008; Thomas & McKay, 2010) who demonstrated their compatibility with cognitive processes due to variations in the way students perceive, understand and learn from complex information sources. In other words, a key factor in the development of hypermedia learning systems is their dependency on students’ cognitive style since they relate to users’ information processing habits and the representation of individual users’ typical modes of perceiving, thinking, remembering and problem solving. Specifically, Witkin, Moore, Goodenough, and Cox’s (1977) classification - field dependent and independent learners - is adapted in this study to identify the key factors that affect students’ cognitive style in educational environments supported by hypermedia systems.

Nevertheless, with the continuous development of hypermedia learning systems, there is still much to explore and learn about students’ cognitive styles and their effect on learning from cross-disciplinary perspectives. Hence, this thesis aims to answer two
broad questions: (i) What are the factors that affect cognitive style? (ii) Does cognitive style change over time? To address these questions, four groups of factors were explored and tested in two locations (Australia and Malaysia) and over two time periods (Semester 1 and Semester 2, 2008): (i) student demographics; (ii) learning dimensions (nonlinear learning, learner control, multiple tools); (iii) culture dimensions (power distance, uncertainty avoidance, individualism/collectivism, masculinity/femininity, long/short term orientation); and (iv) evaluation of units (content delivery).

The methodological design was a case study using a survey instrument. The study was conducted over two semesters in Australian and Malaysian universities. Both statistical and descriptive analyses were used to enrich the interpretive process of the complex dimensions and increase the relevance of the findings. The statistical analyses consisted of sample size determination, hypotheses testing and application of advanced statistical modelling methods (multiple linear regressions, tree-based regressions and linear mixed effects models) to extract the maximum information from the data. The results indicate that unit evaluation, which included questions related to students’ perceived satisfaction with the delivery of the unit material, was the primary variable to determine students’ cognitive style. The other variables determining cognitive style, to a lesser extent, were learning dimensions (particularly nonlinear learning and learner control) and culture (particularly power distance, long term orientation and individualism). It was found that neither demographics nor time affects cognitive style.

The outcomes of this study have important practical implications for educators and institutions. It is recommended that unit evaluations should be conducted at both the beginning and the end of each semester. By administering a survey that asks students
about their preferred delivery of material at the beginning of the semester, their cognitive style could be identified. The results would therefore be valuable information for tutors and lecturers who could adjust their delivery style accordingly. The students’ responses at the end of the semester would provide valuable feedback to tutors and lecturers.

This research drew on the perspectives of education, information systems, cognitive psychology and culture. The study incorporated multiple factors with detailed case studies and used extensive quantitative analyses to ensure the validity and reliability of the research findings. The findings in this study will contribute to the ongoing research cognitive style and hypermedia learning systems.
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Chapter 1

INTRODUCTION

The aim of this thesis was to identify the key factors that affect students’ cognitive style in educational environments supported by hypermedia systems. The research is a multi-perspective study that focused on students’ cognitive style (field dependent/field independent) tested in two locations (Australian and Malaysian universities) over two time periods (two different semesters in 2008) with specific investigations of: (i) student demographics (ii) learning dimensions in hypermedia (nonlinear learning, learner control, multiple tools); (iii) culture dimensions (power distance, uncertainty avoidance, individualism/collectivism, masculinity/femininity, long/short term orientation); and (iv) unit evaluation (content and delivery). This chapter introduces the background to the research topic, and presents the research aims and questions. The chapter also provides an overview of the research design, the significance of the research and an outline of the structure of the thesis.

1.1 Background

The advancement of educational technologies, made possible by a massive growth in information and communication technologies (ICTs), has revolutionized student learning in higher education. Numerous studies have characterised educational technologies as supportive cognitive tools in promoting students’ learning (e.g. Crandler, McNabb, Freeman, & Burchett, 2002; Krajcik, 2003; Parikh & Verma, 2002; Sethy, 2012; Sherman & Kurshan, 2005). Nevertheless, there remains much to learn and
explore about education technologies; in particular, hypermedia systems and their impact on the cognitive processing of learning materials. Additionally, there is a potential to generate new areas of research in cognitive style associated with hypermedia learning environments from a cross-disciplinary perspective since the hypermedia literature extends across a number of different but related fields; for example, educational technology, cognitive psychology, computer science, and geography (Eveland & Dunwood, 1999).

Hypermedia systems comprise structures that support the functionality to access, create and manipulate information (Nurnberg, Leggett, Schneider, & Schnase, 1996). A hypermedia system in education typically serves as a delivery medium of content matter that is either an alternative or a complement to the traditional classroom in an attempt to give learners and educators convenient access to information that would otherwise be imparted through face-to-face contact (Jackson, Gaudet, McDaniel, & Brammer, 2009; Li, 2008; Opfermann, Gerjets, & Scheiter, 2006). Specifically, online instruction is delivered via dedicated hypermedia (web-based hypertext) systems that are used to store and manage a variety of relevant course information, such as student assignments, lecture notes, tutorial materials, and announcements.

A number of studies (e.g. Crosby & Stelovsky, 1994; Frey & Simonson, 1993; Li, 2008) have confirmed the efficacy of hypermedia systems compared to traditional linear presentation of information. A key attribute of hypermedia systems in facilitating learning is the way it parallels how the human brain and memory work, particularly the way information is encoded and retrieved (Jonassen, 1988; 1991). Other studies discovered that effectiveness of hypermedia systems as learning tools is heavily
dependent on their compatibility with the cognitive processes by which students perceive, understand and learn from complex information sources (e.g. Ford & Chen, 2001; Fullerton, 2000; Guthrie, 2010; Lee & Boling, 2008; Thomas & McKay, 2010; Witten, 1989).

Importantly, cognitive style plays a significant role in determining how much is learned from a hypermedia learning environment. According to Witkin et al. (1977), cognitive style is a personality dimension that influences attitudes, values, and social interaction; in particular, the preferred way an individual processes information. In other words, cognitive style represents a person’s tendency to behave in a certain manner. In an educational context, cognitive style indicates a preference for learning.

A common problem faced by educators is that not all students are able to develop their learning paths in a given learning environment. In the case of hypermedia learning systems, not all users have the ability to locate information or assimilate internal knowledge. This leads to a variation in what students can achieve from a learning process. Research findings (Chen & Macredie, 2002; Ford & Chen, 2001; Fullerton, 2000; Lee, Cheng, Rai, & Depickere, 2005; Thomas & McKay, 2010) suggested that this type of problem could be solved if users were able to hold a cognitive overview of the hypermedia structure. In other words, users could independently locate specific information and understand how this information is oriented within a large information source if it corresponded with their cognitive style. Hence, hypermedia learning dimensions can affect a learner’s ability to structure a cognitive overview based on how information is structured and presented in the hypermedia environment.
Students with a certain classification of cognitive style typically have a preference for certain types of learning environments (Hancock, Bray, & Nason, 2002). Learning dimensions in hypermedia, such as its nonlinear learning structure, were reportedly suited for students who prefer student-driven learning and were characterised as independent learners (Andris, 1996; Chen & Macredie, 2002; Lee et al., 2005; Moos, 2009; Reed & Oughton, 1997; Schnotz & Heiß, 2009). Other studies have supported the importance of learning dimensions such as learner control. In a highly interactive environment, students who control and accomplish certain tasks at their own pace were more motivated in their learning (Callen, 2011; Chuang, 1999; Guthrie, 2010; Scheiter & Gerjets, 2007; Yoon, 1994). A number of studies have stressed the importance of investigating students’ navigation paths in hypermedia environments based on different representational formats (e.g. text, graphics and animation) and use of multiple tools (Calcaterra, Antonietti, & Underwood, 2005; Chen, 2010; Ford & Chen, 2000; Liu & Reed, 1995; Reed, Oughton, Ayersman, Ervin, & Giessler, 2000; Wang, Hawk, & Tenopir, 2000). These studies also discovered that highly dependent learners were more likely to experience disorientation in a complex hypermedia environment due to too many links and multiple tools. These circumstances have prompted the need to understand more fully the cognitive mechanisms underpinning learning dimensions in hypermedia environments. Although it is well established that students’ cognitive style is relatively stable over time (Messick, 1984; Peterson, Rayner, & Armstrong, 2009; Witkin et al., 1977), it is equally important to explore time and location effect on cognitive style since a number of studies (Pratt, 2002; Zhang, 2005) have discovered that cognitive style can be malleable over time.
A number of studies have investigated the link between demographic characteristics and cognitive style in hypermedia learning. Individual demographic characteristics were found to be significant predictor variables to determine students’ cognitive style in hypermedia learning; for example, older students were more likely to be field independent while younger students were more likely to be field dependent (Lee et al., 2005). Similarly, Carr (2000) and Digilio (1998) discovered that mature age students performed better in their learning. In terms of gender, Fan (2005) reported that gender differences significantly influenced students’ attitudes and perceptions in learning environments supported by hypermedia systems. Fan’s study also discovered that students’ computer experience and prior knowledge had significant effects on their learning performance.

Over the years, several researchers (e.g. Abeysekera, 2008; Greene, 1985; Hofstede, 1986; LaFaver, 2010) came to the consensus that culture has a definite influence on students’ cognitive style and the way that knowledge is developed and transferred in higher educational institutions. This is particularly evident in students who originate from certain countries and display variations in their learning structure preference, information processing, communication and cognition based on their cultural orientation. For instance, apart from geographic, genetic and linguistic differences between East Asian students and their Western counterparts, there are also differences in terms of social orientation. East Asian students’ social orientation tends to be more interdependent due to the influence of Confucian philosophy. Western students, on the other hand, tend to be independent due to the influence of Aristotelian philosophy (Varnum, Grossmann, Kitayama, & Nisbett, 2010). Hence, social orientation may be a
driving force behind the cultural differences in students' cognitive style. Incorporating a culture variable in this research may also contribute to a better understanding as to what extent it plays in influencing cognitive style and the way learning takes place in hypermedia learning environments.

*Evaluation* in education has long been used to determine the worth or value of the continuation of a unit\(^1\) within a course. Evaluation is important as it provides an overall picture of effective pedagogy. Feedback from students provides quality control over the design and delivery of teaching and learning activities (Newby, 1992). A considerable body of research has rigorously established that student evaluations are the most reliable and valid indicator of learning and teaching effectiveness as well as achieving learning outcomes (Ballantyne, Borthwick, & Packer, 2000; Chen & Hoshower, 2003; Hendry & Dean, 2002; Marsh, 1987; Watchel, 1998; Young & Shaw, 1999). Effective learning can be assessed from students’ satisfaction with the delivery of teaching and learning activities of the unit in higher education and provide an indication of learning in matched condition. Based on this reasoning, unit evaluation, specifically students’ satisfaction and perceived effectiveness of content and delivery, may play a vital role in determining students’ cognitive style in hypermedia learning. Additionally, investigating this variable may help educators to have a deeper understanding of ways to facilitate greater learning effectiveness of students through improving teaching method, unit content and delivery with matching teaching technologies with students’ cognitive style.

\(^1\) The term *unit* in Australia is the equivalent of a *course* in North America. It typically describes one subject that lasts an academic term. A *course* in Australia is the program of studies required to complete a university degree.
1.2 Research Aims and Questions

The advancement of educational technologies such as hypermedia systems has revolutionised learning in higher education. A problem with these rapidly changing technologies is that not all students have the ability to locate learning content or assimilate internal knowledge effectively from hypermedia systems. Hence, the use of hypermedia systems in delivering learning content has the capacity to facilitate or restrict learning. Therefore, the purpose of this study was to identify and understand learner characteristics in relation to their cognitive style to provide a deeper understanding of the potential of hypermedia technologies as cognitive tools in supporting teaching and learning in education environments. Given the limited knowledge available of the interactions, time and location effects of cognitive style, demographic characteristics, learning dimensions, culture, and unit evaluation of content and delivery with hypermedia systems, these variables were investigated to address the research questions that guided this study:

1. What are the factors that affect cognitive style?

2. Does cognitive style change over time?

1.3 Research Design

This research was designed as a multiple case study and was carried out in the form of cross-sectional and longitudinal studies. The multiple case studies comprised two research sites: Murdoch University, Australia; and Curtin University Sarawak, Malaysia. Each case study consisted of a number of embedded cases. The embedded cases for Murdoch University were units offered by the School of Information Technology. The
embedded cases for Curtin University Sarawak were units offered by the Department of Engineering. The participants were recruited on a voluntarily basis. An online survey instrument was developed and used to collect the data. The data was analysed using a mix of descriptive and inferential (elementary and advanced) statistics to determine the interactions of variables with cognitive style across time and location.

1.4 Significance of Research

This study used perspectives from the multiple disciplines of education, information systems, cognitive psychology and culture to investigate the impact of learner characteristics on cognitive style in hypermedia environments. The significant findings were:

1. a new survey instrument in gathering data based on multiple factors associated with students’ cognitive style;
2. an in-depth understanding of the differences in students’ cognitive style and their learning characteristics;
3. an in-depth understanding of interrelated significant factors that represent cognitive mechanisms hypermedia learning through the development of a new research model;
4. guidelines for more effective learning by reducing the discrepancies of students’ learning preferences with the structure presented by hypermedia learning systems; and
5. directions for designing and implementing effective applications of hypermedia learning systems in educational environments.
Given the widespread use of hypermedia systems for delivering learning materials and supporting learning, the overall findings from this study should benefit educational institutions, particularly those based in Australia and Malaysia. The most significant finding of this study will provide guidelines for distinguishing and understanding the interactions of different types of cognitive styles with hypermedia learning systems as these learning technologies may not satisfy the learning needs of all students and consequently affect their performance.

1.5 Outline of the Thesis

This thesis has eight chapters. The next chapter is an extensive literature review relevant to the research topic in order to form a theoretical framework for this study. In particular, it covers the theoretical background of hypermedia, cognitive styles, learning dimensions, culture and unit evaluation (content and delivery).

Chapter 3 justifies the mixed method approach chosen from various types of research methods available to address the research topic. The stages of the research process are explained in detail including hypotheses formulation, the constructs and relationships of all variables relevant to the research topic in a research model, the development of the online survey as the choice of instrument in collecting data, issues relating to research ethics, and the choice of statistical analysis methods used to test and model the data to determine the outcome of both cross-sectional and longitudinal studies.
Chapter 4 outlines the case selection method and criteria used in determining the research sites. This chapter also presents an overview of the two case studies selected as research sites for this study, including detailed descriptions of the embedded cases.

Chapter 5 and Chapter 6 report the results of the study. In Chapter 5, the descriptive statistics of participant demographics are presented and discussed. In Chapter 6, findings from the elementary and advanced statistical analyses are presented. Chapter 7 discusses the implications of significant results reported in Chapters 5 and 6 and a framework for the effective implementation of hypermedia in learning is developed.

Chapter 8 concludes the thesis by presenting the responses to the research questions based on the discussions in Chapter 7. This is followed by suggestions for the practical applications to educational environments. This chapter also addresses the limitation of this study and possible areas for future research.

1.6 Conclusion

This chapter introduced the research topic undertaken in this study. The background to the study was discussed briefly; in particular, the significant role of cognitive style in determining how students learn depending on the structure of a hypermedia learning environment. Additional considerations were discussed in terms of variations in students’ learning dimensions, culture orientation, and satisfaction with unit content and delivery and demographic characteristics, which also served as a justification for the cross-disciplinary study. The research aims were identified which led to the formulation
of two broad research questions. A brief overview of the research design was described, followed by a brief outline of the thesis chapters.
Chapter 2

LITERATURE REVIEW

This chapter reviews the literature on the primary issues related to this study: hypermedia, cognitive styles, culture and the role of unit evaluations in students’ learning. The purpose of the review is to explore the developments of these areas of research and how they relate to the present study in order to form a theoretical framework.

2.1 Hypermedia

2.1.1 Definition

Hypermedia systems focus on structures (Wiil, 2005), particularly the associative structures that support the functionality to access, create, and manipulate information (Nurnberg et al., 1996). A predecessor to the present term of hypermedia was ‘hypertext’ (Nelson, 1965, p. 96). The difference between the two terms is that hypermedia is an extension of hypertext. Hypermedia is not limited to text but may include media such as graphics, animation, audio, video, models, simulations and visualisations, allowing users to structure and manipulate information in multiple formats within a spatial network of nodes and links through interactive browsers. A more descriptive definition of hypermedia is “on-line settings where networks of multimedia nodes are connected by links which are used to present information and manage retrieval” (Federico, 2000, p. 362). In other words, hypermedia is simply the fusion of hypertext and multimedia (Cunliffe, 2000).
2.1.2 Evolution

The development of computer technology was the catalyst for the real achievements of hypertext and hypermedia. The following sections discuss the developmental stages of hypermedia architectures in a brief historical perspective and the time line is depicted in Figure 2.1.

![Diagram showing the developmental stages of hypermedia architectures from the 1940s to the 2010s.]

**Figure 2.1** The Developmental Stages of Hypermedia Architectures

*Proto-hypermedia*

Vannevar Bush is well known for a proposed system that is recognised today as the inspiration of hypermedia (Conklin, 1987; Cunliffe, 2000). Bush (1945, p. 6) introduced a theoretical proto-hypermedia system of text and graphics known as the memory extender or Memex. The essential feature of Memex was its ability to link two items via an associative structure. Bush’s proposal came into realization with the development of Xanadu and NLS (oN-Line System) in the 1960s. Both systems represented the earliest hypermedia systems (Engelbart & William, 1968; Nelson, 1999).
**Monolithic System**

Earlier hypermedia systems were predominantly the monolithic type. The system ran within a single process of “application, link service and storage” (Wiil, Nurnberg, & Leggett, 1999, p. 2). It was a closed system in which all functionality was in the core system and services were not provided to external applications. A closed system generally required the application to make use of a specific format for specifying both structure and data (Wiil, Hick, & Nurnberg, 2001). Examples of the monolithic system in the late 1980s included NoteCards (Halasz, Moran, & Trigg, 1987) and KMS (Akscyn, McCracken, & Yoder, 1988). Over the years, other researchers were inspired to improve the monolithic hypermedia system, which resulted in the client-server system (Wiil et al., 1999).

**Client-Server System**

The purpose of the client-server system was to improve the shortcomings of the monolithic system. A client-server system consisted of “one or more server process that provided services to an open set of clients” (Wiil et al., 2001, p. 84). In other words, the application or user interface was moved out of the core system, enabling other applications to have access to the hypermedia systems. Nevertheless, some applications were custom made for the client-server system to operate the entire set of functionality. The Link Server System (LSS) and the HyperBase Management System (HBMS) were two types of the client-server system. LSS mainly focused on the structure (association between documents) whereas HBMS focused on structure and content (Wiil et al., 1999). Examples of client-server systems in the early 1990s included HyperBase (Schutt
& Streitz, 1990) and the World Wide Web (WWW) (Berners-Lee, Cailliau, Luotonen, Nielsen, & Secret, 1994).

**Open Hypermedia System**

The Open Hypermedia System (OHS) was a further development of the client-server system. It functioned as a link services provider to an open set of applications (Wiil et al., 1999). OHS allowed numerous applications to interact with the system in any data format (i.e. graphics, HTML, text) since data was store separately from structure. Examples of this system included Microcosm (Hall, Davis, & Hutchings, 1996) and Chimera (Anderson, Taylor, & Whitehead, 1994).

**Component-based Open Hypermedia System**

The Component-Based Open Hypermedia System (CB-OHS) was very similar to the basic OHS. CB-OHS was “more open and modular with general and extensible system components that [provided] well-defined services” (Wiil et al., 2001, p. 84). This indicates that CB-OHS supported several types of structure domains and could store its data at different locations. There were two types of CB-OHS: multiple open services and structural computing. Multiple open services provided links, integration, distribution and collaboration services whereas structural computing provided structural abstractions to their clients (Wiil et al., 1999). Examples of CB-OHS included HOSS (Nurnberg et al., 1996) and HyperDisco (Wiil & Leggett, 1997).
2.1.3 Hypermedia Characteristics

An important attribute of hypermedia is that it parallels the way the human brain and memory work (Jonassen, 1988; 1991). Hypermedia imitates the human mind in the way it gathers knowledge by association, jumping from one concept to another in a complex web of connections that are machine supported. This non-linear function of hypermedia is unlike the linear presentation of information in print form (Conklin, 1987). For instance, in order to get the information F, as shown in Figure 2.2, we must read from A to E in sequence first. This structure causes difficulties and inconvenience in querying and getting information when there is a great deal of information available.

Figure 2.2 The Linear Structure of Traditional Text

Figure 2.3 is a representation of the same information in a hypermedia system. The nodes representing content A to F are connected by links, which are shown as arrows. To access content F, we can choose, for example, the path A-B-F. This system provides greater convenience and improvement in gaining access and obtaining information (Conklin, 1987).
2.1.4 Hypermedia Learning Systems

Hypermedia characteristics have a great appeal to educators, particularly its perceived benefits. In the 1960s, the use of computers for learning opened the door to accommodate more learner differences than traditional media (Egan, 1988). However, learning was still limited to traditional instructional design principles (Steinberg, 1989). In the late 1980s, the computer technology revolution not only sped up the improvement of individualized instruction, but also created a new notion of learning; learning as a process of knowledge construction (Duffy & Jonassen, 1992). Among other computer technologies, educational hypermedia technology seems to hold the greatest promise to end-users in a variety of benefits (Collins, 1990; Ellis, 2001). A general overview of the hypermedia learning system is illustrated in Figure 2.4, showing its capability of resolving some of the needs of learners, educators, and student service administrators.
A hypermedia-based learning system is a form of web-based educational system. It is a valuable educational tool because it presents information in multiple modes that provide learners with easy and nonlinear access to large amounts of information, in contrast to traditionally linear-structured information, as well as giving students greater autonomy and responsibility in their quest for learning (Andris, 1996; Ford & Chen, 2000; Li, 2008; Liaw, 2001). The amount of information students can access, and the hard-wired relationships among different types of information established through links, cannot be replicated in a paper-based equivalent environment (Spicer & Husock, 2000).

Several researchers (e.g. Chavero, Rossell, & Vega, 1999; Chrisman & Harvey, 1998; Greene & Azevedo, 2007; Lee & Boling, 2008; Liu, 2006) have shown that students play a more active role in the educational process. The hypermedia learning system’s rich content encourages learning in a task-driven process, where learners are motivated to explore alternative navigational paths through the domain knowledge and different resources, and subsequently the system promotes effective learning as it allows

Figure 2.4 Hypermedia Learning System
students to construct their own learning goals and plans. A hypermedia-based learning system is capable of facilitating multiple forms of communication such as chat rooms, bulletin boards, email, and video conferencing.

Hypermedia features have made it an ideal tool for supporting multilinear thinking and facilitating self-directed learning in a pragmatic way to empower and tangibly stimulate learners in meeting today’s educational needs, particularly in offering an innovative learning and teaching instructional delivery system that connects learners with educational resources (Schwen, Goodrum, & Dorsey, 1993).

The objective of an educational hypermedia system is to simplify the administration of learning programs and support communication. One of the most popular hypermedia software development platforms is the Learning Management System (LMS). The key attributes of the LMS being widely adopted for educational and training are to:

• alleviate time constraints and the place of learning;
• provide an excellent degree of flexibility concerning the way of learning;
• support advanced interactivity between tutors and learners; and
• grant one-stop maintenance and reusability of resources (Psaromiligkos, Orfanidou, Kytagias, & Zafiri, 2011, p. 188).

Current LMSs constitute the basic software platform for supporting web-based learning in an easy-to-use, pedagogically flexible and cost-efficient manner, providing a uniform interface to all users (IEEE LTSC 2003). The purpose of an LMS is to promote portability of learning resources and interoperability between each user by providing integrated services such as the creation and distribution of online learning material,
communication, and collaboration among the stakeholders and the management of instructional systems. It is an ideal platform, particularly in higher educational institutions, because it can hold these complex interactions between learner and learner, learner and content, and learner and educator during the instructional process. LMSs that are widely used for educational and training purposes are available both commercially (e.g. WebCT, Blackboard, Learning Space, Centra, TopClass, Edvance360) and open source (Moodle, ATutor, Ilias) (Coates, James, & Baldwin, 2005; Muñoz-Merino, Kloos, & Naranjo, 2009; Psaromiligkos et al., 2011).

Users of the LMS can be classified into three categories (Avgeriou, Papasalouros, & Skordalakis, 2003, p. 14):

• The learners who use the system in order to participate in the educational process across distance and time. In fact, the learners are the focal users of LMS in the sense that these systems are being developed in order to satisfy some of their needs and resolve their problems.

• The instructors (teachers and their assistants) who use the system in order to coach, supervise, assist and evaluate the students (e.g. notify important issues on an electronic notice board, engage in discussions in electronic forums, communicate and exchange personal messages with students, collect, assess and return deliverables).

• The administrators who undertake the support of all the other users of the system and safeguard its proper operational status.

Nevertheless, there are potential risks with the LMS that can impede learning. First, there is spatial disorientation, also known as the “lost in space” phenomenon (Conklin, 1987, p. 38). This disorientation occurs due to a high degree of learner control.
in a nonlinear space and can be frustrating if instruction support is insufficient, as students may find it difficult to get ‘a good grasp’ of where to find specific learning material. Second, a number of studies (e.g. Moos, 2009; Seufert, Jänen, & Bünken, 2007) have demonstrated that cognitive load impedes learning if not carefully managed. This can occur due to constantly assimilating and referring to previous hyperlinks while trying to understand the next link (Chandler, 2009; Chen, Czerwinski, & Macredie, 2000; Moos, 2009; Seufert et al., 2007).

While LMS is the most common term used for a hypermedia learning system, other terms used include learning management system courseware, computer-assisted learning, computer-based teaching, computer assisted instruction, and collaborative learning. However, in the context of this research, the broader term ‘hypermedia learning system’ is used.

2.1.5 Adaptive Hypermedia
Findings reported in Lee et al. (2005) highlight the importance of understanding various learner characteristics and preferences in hypermedia learning systems and the potential of achieving effective learning through adaptive hypermedia systems that focus on individualised instruction. Research in adaptive hypermedia systems is relatively new. There are only a few studies that have confirmed the effectiveness of adaptive hypermedia systems. Mampadi, Chen, Ghinea, and Chen (2011) presented a study that developed an adaptive hypermedia learning system tailored to students’ cognitive style. The findings indicated that, in general, this adaptation improves student learning. The results also showed that adaptive hypermedia learning systems have more effect on
students’ perceptions than performance. Similarly, Lo, Chan, and Yeh (2012) developed an adaptive web-based learning system that identified and tailored students’ learning according to their cognitive style based on students’ browsing behaviour. The proposed system demonstrated its effectiveness in identifying students’ cognitive style with high accuracy.

2.1.6 Open Source Hypermedia

Another recent development and increasingly popular form of hypermedia learning systems is the open educational platforms in which learning materials are distributed globally through various types of networks and offered in a wide range of subjects. The most appealing aspect of this form of hypermedia is that it is free and has minimal restrictions and access conditions imposed on individual participants. Prominent open source hypermedia systems include Coursera, Skillshare, Khan Academy and Udacity. Although open source hypermedia holds enormous potential in the academic community, a surprisingly low rate of student retention was evident (e.g. Clow, 2013; Downes, 2010; Lewin, 2013). Adamopoulos (2013) analysed user-generated online reviews and identified the cause of the low retention rate as the inability of the systems to meet students’ educational needs. Additional factors that influenced retention rate were self-paced structure of courses, level of difficulty, workload and duration of the course.
2.2 Cognitive Style

There has been a growing interest in researching the nature of the cognitive interactions that occur between learners and hypermedia-based learning environments. The effectiveness of these environments depends, to a large extent, on their compatibility with the psychological processes by which students perceive, understand and learn from complex information sources. This section provides the definition of cognitive style that will be used in this study, discusses the various classifications of cognitive style, selection of cognitive style framework, and explores the relationships between cognitive style, demographic characteristics, hypermedia learning dimensions and culture.

2.2.1 Definitions

Cognitive style is one of the commonly researched measures of learner differences (Oughton & Reed, 1999). According to Armstrong and Priola (2001), cognition includes activities of thinking, knowing and processing information, whilst cognitive style is the possibility that these activities are carried out differently. To be more specific, cognitive style represents an individual’s psychological differentiation that determines the individual’s responses and functioning in numerous situations that include stable attitudes, choices, and habitual strategies related to perceiving, remembering, thinking and solving problems (Saracho, 1998). Messick (1984) refers to cognitive style as individual differences in preferred ways of organising and processing information and experience. Another definition states that cognitive style is a learner’s habitual mode of information processing being manifestly reflected in his/her perceptual ability and personality (Durfresne & Turcotte, 1997). Ultimately, many researchers (e.g.
Papanikolaou, Mabbott, Bull, & Grigoriadou, 2006; Peterson et al., 2009; Riding, 1994; Witkin, Goodenough, & Karp, 1967) agree that cognitive style refers to a distinct and consistent way that individuals encode, store and perform, and one that is mainly independent of intelligence.

Although most cognitive style definitions are characterised as a consistent and static element, there is a possibility that cognitive style is malleable over time. Several longitudinal studies detected that individuals behave and process information inconsistent with their habitual way. For instance, Zhang (2005) discovered that British students’ cognitive styles were consistent; however, there were significant shifts in cognitive style among female Chinese students due to acculturation after studying abroad in the UK. Additionally, Pratt (2002) conducted experiments to study strategic skill acquisition of visual discrimination of computer displayed graphics and found that participants with one type of cognitive style developed and used flexible strategies longitudinally compared to participants with another cognitive style. Drawing from these studies, it would be interesting to explore if cognitive style does change with location and time.

The term cognitive style has often been used synonymously with the term learning style and frequently they share the same concept in the literature (Cassidy, 2004; Dunn & Griggs, 1989; Riding & Cheema, 1991; Tucker & Warr, 1996). Nevertheless, there are several researchers (e.g. Jonassen & Grabowski, 1993; Kolb, 1976; Triantafillou, Pomportsis, & Demetriadis, 2003) who attempted to differentiate the two terms; specifically, learning style was distinguished as a broader construct that included cognitive along with affective psychological styles whereas cognitive style was
described as a personality dimension that influenced attitudes, values and social interaction.

The most recent attempt to provide inclusive definitions for both styles was made by Armstrong, Peterson, and Rayner (2012), who suggested that cognitive style refers to:

individual differences in people’s preferred way of processing (perceiving, organizing and analyzing) information using cognitive brain-based mechanisms and structures. They are assumed to be relatively stable and possibly innate. Whilst cognitive styles can influence a person’s behavior, other processing strategies may at times be employed depending on task demands – this is because they are preferences (p. 451) and learning style refers to:

individuals’ preferred ways of responding (cognitively and behaviourally) to learning tasks which change depending on the environment or context. They can affect a person’s motivation and attitude to learning, and shape their performance (p. 451 & 454).

Despite these terms often being used interchangeably and inconsistently, they will be discussed in this literature review as the preferred way that individuals process information and their preference for learning.

2.2.2 Classifications of Cognitive Style

There are numerous classifications of cognitive style. Some of the more widely used classifications are described in this section.

Pask (1976) classified cognitive style into holist and serialist dimensions. Holist individuals are considered to “have many goals and working topics under [their] aim topic” and those that who fall in the serialist class “have one goal and working topic, which may be the aim topic” (p. 130). Holists process information based on a “global description of topics” approach whereas serialists process information that focuses only on “the topic for which they are constructing an explanatory model” (Pask, 1976, p.
In the educational context, holists prefer a broad objective, whilst serialists prefer a specific objective.

Riding and Cheema (1991) categorised cognitive style as two polarised dimensions: wholist-analytical and verbal-imagery. Analytics are “able to impose their own structure” whilst wholists tend to “benefit from help in structuring materials” (Riding & Rayner, 1997, p. 313). Verbalisers “learn best from verbal presentation” whereas imagers are “inclined to represent information during thinking verbally or in mental images” (Riding & Rayner, 1997, p. 132 & 133).

Allinson and Hayes (1996) developed the Cognitive Style Index (CSI) for the purpose of measuring individual cognitive styles according to intuitive and analytical dimensions. Intuitive learners are considered right-brain thinkers and tend to make “immediate judgement based on feelings and the adoption of a global perspective” (Allinson & Hayes, 2000, p. 122). Intuitivists also “tend to be nonconformist, prefer an open-ended approach to problem solving, rely on random methods of exploration, remember spatial images most easily and work best with ideas requiring overall assessment” (Allinson & Hayes, 2000, p. 122). Analytical learners are considered left-brain thinkers who make judgements “based on mental reasoning and focus on the detail” (Allinson & Hayes, 2000, p. 122). They also tend to be “more compliant, favour a structured approach to problem solving, depend on systematic methods of investigation, recall verbal material most readily and are especially comfortable with ideas requiring step by step analysis” (Allinson & Hayes, 2000, p. 122).

Witkin (1962; Witkin et al., 1977) described cognitive style as a personality dimension, which influences attitudes, values, and social interaction; in particular, the
preferred way an individual processes information. He defined cognitive style based on a continuum between two processing approaches - field dependent (FD) and field independent (FI) - in which each style differs in certain characteristics. Specifically, individuals with a FD cognitive style are “likely to refer to external referent as guide to information processing” whereas individuals with a FI cognitive style rely on their “internal referent” to process information (Witkin et al., 1977, p. 197). In other words, FI individuals’ reliance on an internal referent is defined by their attributes of strong personal autonomy and restructuring skills, but having a lack of sensitivity and being low on social skills. Conversely, FD people tend to be more autonomous in relation to the development of high interpersonal skills and less autonomous in relation to the development of cognitive restructuring skills.

According to Witkin et al. (1977) the FI/FD constructs had gone through numerous types of testing that involved perceptual and problem solving task such as embedded figure test, Gestalt test, Piaget’s three mountain problem, conservation and concept attainment tasks. Ultimately, an aptitude measurement tool to assess FI/FD dimensions, known as the group embedded figures test (GEFT), was developed. GEFT is administered in the form of a test booklet consisting of 25 questions of interpolated cognitive tasks that focus on the process rather than content of the variable.

2.2.3 Selection of Cognitive Style Framework

It is evident that Pask (1976), Riding and Cheema (1991), Allinson and Hayes (2000) and Witkin’s (1962; Witkin et al., 1977) studies share conceptual links. For instance, Pask’s holists, Riding & Cheema’s wholists, and Allinson & Hayes’s intuitivists are
similar to Witkin’s field dependents. Similarly, Pask’s serialists, Riding & Cheema’s analyticals, and Allinson & Hayes’s analyticals, are similar to Witkin’s field independents.

Comparing the classifications of cognitive style frameworks shed some light in understanding the different aspects and similarities of the various cognitive style concepts. In addition, further exploration of the literature may provide further understanding of cognitive styles to assist in developing a cognitive framework for this study, although the choice also depends on consistency of the measurement and research findings.

Chen and Macredie’s (2002) extensive literature review on Witkin’s work has confirmed the ongoing influences of his work in the field of cognitive style in the past decades. However, Coffield, Moseley, Hall, and Ecclestone (2004), who conducted an extensive literature review of cognitive styles literature, questioned the validity and reliability of Witkin’s theoretical framework due to the conflation of style and ability and noted that measurement of style is closely linked with ability in a particular task. Although they highly recommended Allinson and Hayes’s CSI model as the ideal research model in carrying out cognitive style research due to its relatively high psychometric credentials, they acknowledged that CSI is more relevant to the organizational and business context than the educational context.

Fundamentally, Witkin’s cognitive style framework has been used widely in educational research. For instance, Desmedt and Valcke (2004) carried out a citation analysis to determine the scientific impact of cognitive style and learning style research from extensive literature related to both concepts. The results showed that Witkin’s
work scored the highest impact in cognitive style research and is highly influential, particularly in the educational context. Kozhevnikov (2007) also claims that Witkin’s theoretical work has played a crucial role in contributing to the development of cognitive style research to date and that his studies have had great appeal and important implications for cognitive and interpersonal behaviour associated with learning. However, Kozhevnikov further claims that although Witkin’s theoretical construct was appealing, its lack of in-depth explanation has contributed to confusion among future researchers.

Since this study focuses on investigating cognitive style in a hypermedia learning environment, Witkin’s FD/FI framework is regarded as the most relevant theoretical framework applicable to this study because it has been widely studied and it has the broadest application in the education field. While Witkin’s framework may have experienced mixed reviews and scrutiny, there are a number of established studies that have confirmed and validated the reliability of his theory under several types of learning conditions. Table 2.1 summarises the characteristics of Witkin’s classification.
Table 2.1 Characteristics of Field Dependent and Field Independent Learners

<table>
<thead>
<tr>
<th>Field Dependent Learners</th>
<th>Field Independent learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>More likely to face difficulties in restructuring new information and forging links with prior knowledge</td>
<td>Able to reorganise information to provide a context for prior knowledge</td>
</tr>
<tr>
<td>Personalities show a greater social orientation</td>
<td>Influenced less by social reinforcement</td>
</tr>
<tr>
<td>Experience surroundings in a relatively global fashion, passively conforming to the influence of the prevailing field or context</td>
<td>Experience surroundings analytically, with objects experienced as being discrete from their backgrounds</td>
</tr>
<tr>
<td>Demonstrate fewer proportional reasoning skills</td>
<td>Demonstrate greater proportional reasoning skills</td>
</tr>
<tr>
<td>Prefer working in groups</td>
<td>Prefer working alone</td>
</tr>
<tr>
<td>Struggle with individual elements</td>
<td>Good with problems that require taking elements out of their whole context</td>
</tr>
<tr>
<td>Externally directed</td>
<td>Internally directed</td>
</tr>
<tr>
<td>Influenced by salient features</td>
<td>Individualistic</td>
</tr>
<tr>
<td>Accept ideas as presented</td>
<td>Accept ideas strengthened through analysis</td>
</tr>
</tbody>
</table>

Source: Chen and Macredie (2002, p. 4)

The following sections summarise and discuss three major types of learning conditions (structured and unstructured learning conditions, matched learning conditions and demographics conditions) in which the applications of Witkin’s FD/FI theoretical framework were widely researched.

Structured and Unstructured Learning Conditions

Numerous studies that investigated learners’ cognitive style in unstructured learning environments (e.g. Chen et al., 2000; Chou, 2001; Moo & Azevedo, 2008; Seufert et al., 2007) have confirmed that FD individuals prefer to be guided in their learning processes, employ less analytic approaches to learning and require more instructional guidance to assist them in finding relevant and meaningful information to reduce disorientation whereas FI individuals employ less guided but a more analytical and
autonomous approach to learning. In other words, FD learners are likely to process information passively by operating an external reference, as opposed to the self-regulated or self-directed characteristics of FI learners, who prefer actively imposing their own structure.

In addition, other studies have discovered the effect of FD/FI’s learning processes and academic achievements in certain types of conditions (Summerville, 1999; Triantafillou et al., 2003), such as the ability to learn from social environments, types of educational reinforcements needed to enhance learning, and amount of structure preferred in an educational environment. These studies indicate that FD students succeed best with socially oriented learning tasks; for example, a cooperative learning style. FI students, on the other hand, prefer working on abstract and less socially oriented assignments (Saracho, 1998). Chen and Liu (2009) presented an empirical study that identified students’ cognitive style based on Riding’s (1991) analysis to examine the effects of cognitive style on students’ learning patterns and the effects of learning patterns on learning performance. The results revealed that FI students frequently used an alphabetical index whereas FD students often chose a hierarchical map. This has a negative impact on FD students’ learning performance, particularly due to their dependency on guided learning.

**Matched Learning Conditions**

Several studies have supported the observation that effective learning can be achieved in matched learning conditions (instructional style is matched to the student’s cognitive style) whereas students perform poorly in mismatched conditions. Pask and Scott (1972)
carried out a study on matched learning conditions administered in a traditional teacher-led paper-based environment. Their findings indicated that effective learning was demonstrated by young students and those of low ability. Witten’s (1989) investigation found that FD students performed at essentially equivalent levels as FI students in a congruent teaching method; however, their learning was adversely affected when taught with an incongruent method. A similar result was reported by Ford (1995), in which learning in matched conditions was significantly superior to that in mismatched conditions. Thomas and McKay’s (2010) results highlighted the distinction between spatial and object visual styles, and provided evidence that learning outcomes improved when instructional material was matched to students’ cognitive style. An empirical study by Ford and Chen (2001) also revealed that students in conditions matched with their cognitive style performed better.

On the other hand, studies by Fullerton (2000) and Lee (2000) demonstrated that FD students’ learning performance deteriorated when they received an instructional strategy that contradicted their cognitive style. Interestingly, Ruttun’s (2009) study found that FI students’ performance was not affected in a hypermedia learning environment that did not feature their preferred learning tools. A similar research outcome by Lee (2000) showed that FI individuals outperformed FD individuals since FI learners tended to be internally driven in contrast to FD learners who rely on external forces to perform a task. Another study found that students who were independent learners developed learning strategies to cope with mismatched learning materials (Riding & Rayner, 1999). These studies suggest that mismatched learning conditions
have less effect on FI students than FD students, and support the need for a range of learning materials to accommodate FD students.

Nevertheless, there are studies that disputed the notion of efficacy of cognitively matched learning environments. A recent study by Eyuboglu and Orhan (2011) showed no statistically significant difference on paging or scrolling navigational patterns and learning achievement of university students with different cognitive styles. Despite that, matching the style of teaching to students’ cognitive style is essential with regard to learning effectiveness as learners’ performance could decline if a representational approach is used that contradicts their cognitive style (Lee & Boling, 2008).

Demographic Conditions

A number of studies have confirmed the link between demographic characteristics and cognitive style in hypermedia learning. Steele (2012) has found students’ demographic profile to be useful in predicting cognitive behaviour and learning pattern. Similarly, Kotsiantis (2012) suggested more personalised and adaptable hypermedia learning environments could be attained by predicting students’ performance with hypermedia systems through regression analyses on students’ key demographic characteristics and study patterns.

Lee et al. (2005) discovered that, among the demographic characteristics investigated, age was a significant predictor variables in determining students’ cognitive style in hypermedia learning. Older students were more likely to be FI while younger students were more likely to be FD. Other studies such as Carr (2000) and Digilio
reported that mature age students were independent learners and performed better in their learning.

In terms of gender, Chou (2001) discovered that gender significantly moderated the effects of cognitive style and training method on learning performance and computer self-efficacy. Similarly, Fan (2005) reported that gender differences significantly influenced students’ attitudes and perceptions in learning environments supported by hypermedia systems. Fan’s study also reported that students’ computer experience and prior knowledge had significant effects on their learning performance.

Research has confirmed that learning performance is influenced by the combination of learners’ computer experience and their different cognitive style, especially in a non-explicit learning structure. A study by Kim (2000; 2001) found that, among students who had little to no computer experience with online search, FI students outperformed FD students. Korthauer and Koubek (1994) found cognitive style and computer experience affected performance; specifically, experienced FD’s performance was lower than experienced FI’s performance.

Nevertheless, there are studies that found no relationship between students’ demographic characteristics and cognitive style in hypermedia learning environments. For example, Song (2003) specifically investigated gender, status, age, language and years of computer experience and found no effects. Some studies found FD and FI students learned equally well although they adopted different navigation tools, media, learning aids (Liu & Reed, 1995) and different patterns to process learning (Ford & Chen, 2000). Other studies discovered that FD and FI students performed equally well in an equivalent amount of time in the same learning program (Fitzgerald, 1998) and
female and male students were equally capable of learning in a music classroom that was based on hypermedia and traditional learning instruction (Bush, 1999).

Although there were mixed findings regarding the relationship between students’ demographic characteristics and cognitive style in hypermedia learning environments, this study focuses on investigating a broader range of demographic characteristics: gender, age, country of origin, nationality, ethnicity, first language, religion, marital status, employment status, course major, year of enrolment, enrolment type, residency status, financial situation, computer skills, computer experience.

2.2.4 Cognitive Style and Hypermedia Learning Dimensions
Based on both the hypermedia and cognitive style literature, hypermedia systems can affect a learner’s ability to structure a cognitive overview based on how information is structured and presented. This further indicates the importance of cognitive style in determining how much is learned from a hypermedia learning environment that is essentially nonlinear in nature. This section presents literature related to the classification of cognitive style in hypermedia learning dimensions.

Research carried out by Chen and Macredie (2002) classified previous studies on the effects of cognitive style on hypermedia learning and presented them in a summary of the relationships between key learning dimensions. They developed a learning model that forms a bridge between cognitive style and hypermedia learning. Chen and Macredie’s model is adapted for this study (see Section 3.2). Students’ learning pattern in this type of learning environment can be categorised according to three dimensions:
non-linear learning, learner control and multiple tools. The dimensions are illustrated in Figure 2.5 and explained below.

**Figure 2.5** FD and FI Learning Dimensions (Chen & Macredie, 2002, p. 12)

*Non-linear Learning*

Non-linear learning environment refers to a learning condition that is unstructured or flexible. A study by Hancock et al. (2002) discovered that students prefer specific types of learning environments. Students who prefer student-driven (nonlinear) learning environments tend to be self-regulated learners who desire unstructured learning, open communication and greater learning control. On the other hand, students who prefer teacher-driven (linear) learning environment tend to be dependent or passive learners who desire highly structured learning. The teacher in this type of learning setting is expected to play an active role as a knowledge provider, particularly in presenting specific and in-depth learning materials, explanation of lessons, tasks, enforcing rules and actively monitoring students’ progress.
Numerous researchers (e.g. Andris, 1996; Chen & Macredie, 2002; Chou, 2001; Lee et al., 2005; Reed & Oughton, 1997) share similar conclusions regarding students’ cognitive style in non-linear learning environments. In particular, FD students are more likely to face difficulties in an unstructured environment since they demonstrate fewer proportioning skills when they have to restructure new information and forge links with prior knowledge. Also, they tend to demonstrate strong social orientation, which means that they will most likely enjoy working in groups. Conversely, FI students prefer working alone and using a discovery approach to explore the topic of interest and to generate ideas. They tend to seek meaning in order to understand the course content. In addition, they attempt to relate ideas between courses and use evidence when making conclusions (Chen & Macredie, 2002; Chou, 2001).

*Learner Control*

Learner control is the degree to which individuals control their own learning experience based on the interactivity built in the system (Lin & Hsieh, 2001; Scheiter & Gerjets, 2007). Learners generally browse, search and navigate through a hypermedia system and look for specific information that will enable them to accomplish certain tasks at their own pace. It is claimed that a hypermedia learning system that supports and caters to different cognitive styles provides students with greater control over their learning process (Guthrie, 2010). There has been an increasing importance of learning dimensions, such as learner control, as it is assumed that students will be more motivated to learn if allowed to control their own learning (Lin & Hsieh, 2001). FD students perform better with the program control version of computer-based instruction,
as they are relatively passive and less capable of learning independently (externally directed and requiring guidance). These students can be characterised as using fewer control features in hypermedia programs.

On the other hand, FI students use more control features in hypermedia programs, as they possess a higher ability to engage in independent learning (internally directed) with analytical thought (Chen & Macredie, 2002; Weller, Repman, & Rooze, 1994; Yoon, 1994). FI students can make their own decisions to meet their own needs at their own pace and in accordance with their existing knowledge and learning goals, whilst skipping material they already know and concentrate on the material they deem relevant (Lin & Hsieh, 2001). Hence, FI students are likely to perform significantly better and learn more effectively than FD students in a hypermedia learning environment (Umar, 1999).

Multiple Tools
A hypermedia environment is usually designed with multiple tools to facilitate non-linear multidimensional paths traversing the subject matter to provide multiple perspectives of the content in order to guide student acquisition of the subject matter. Past research (e.g. Chen, 2010; Chen & Macredie, 2004; Ford & Chen, 2000) has supported the connection between students’ cognitive style and the multiple tools dimension, particularly how students’ cognitive style influences their choice of tools and navigation path. The different approaches demonstrated by individuals when using multiple tools are associated with identifying the differences between FD and FI students. FD students are more inclined to browse and follow the sequence (linear way)
of the program whereas FI students tend to jump freely from one point to another using the index tool (Lee et al., 2005; Liu & Reed, 1995). FD students’ navigation pattern and use of tools are strongly connected to their characteristics of processing information in a global fashion (accept ideas as presented). They rely on maps to build the entire perceptual field or context. Conversely, FI students tend to analytically approach a problem and be task oriented in using indexing and other tools to find specific information (Chen & Macredie, 2002).

However, learners can quickly and easily get lost or become disoriented in cyberspace given a hypermedia environment’s complexity, such as having too many links and multiple tools (Chen & Macredie, 2002; Wang et al., 2000). In such a situation, FD students tend to desire greater navigational support than FI students (Chen & Macredie, 2002). In other words, FD students are less likely to utilise all the tools provided as they feel uncomfortable using them to navigate the web or when carrying out an assigned task without being assisted. As a result, FD students tend to express difficulty in learning and are less likely to value their overall learning experience.

A number of studies support the correlation between experience and effective hypermedia navigation (see also Chen, Fan, & Macredie, 2006; Moo & Azevedo, 2008; Rezende & de Souza, 2008). Other research discovered that FD students with little or no experience in hypermedia navigation preferred a linear representation of content (Palmquist & Kim, 2000). It has also been found that computer experience affects the time spent in hypermedia navigation with the more experienced users spending less time navigating than less experienced users (Fiorina, Antonietti, Colombo, & Bartolomeo,
2007). However, it has been found that inexperienced users improve in navigation over time (Reed et al., 2000).

2.3 Culture

Defining culture is a difficult proposition since culture is an extremely broad and complex concept. In fact, Kroeber and Kluckhohn (cited in Avruch, 2002, p. 6) identified more than 150 definitions of culture. In addition, increasingly more challenging is to define culture in cross-cultural research, particularly in addressing the issue of whether culture value is a stable entity. This issue has an indirect connection with convergence and divergence theories. For instance, researchers (e.g. Gaspy, Dardan, & Legorretta, 2008; Hofstede, 1999; Reisinger & Crotts, 2010) who claimed that the core value of culture is relatively stable overtime are supporters of the divergence theory. This suggests that societies are uniquely maintaining their national value, characteristics and lifestyle, which further suggests that cultural values are resilient against influences and change. Researchers (e.g. Decker, 1983; Hermeking, 2006) who support the convergence theory argue that the acceleration of globalisation results in the homogenization of culture toward a common set of traits and practices as a consequence of intensive worldwide interactions of people and exchanges of goods, services and capital through the advancement of technologies, information, travel and tourism, increasing immigration and cross-national and ethnic marriages. Hence, it would be interesting to explore the stability of cultural values and practices, and the important implications for research in students’ cognitive style in educational environments supported by hypermedia systems.
2.3.1 Cultural Frameworks

This section discusses various influential cultural frameworks in IT related research such as the work by Hall (1976), Kluckhohn and Strodtbeck (1961), Trompenaars and Hampden-Turner (2004), Schwartz (1994) and Hofstede (1980) (Table 2.2). This is followed by the justification for using Hofstede’s dimensions as the primary cultural framework for this study to explore cultural relationships with hypermedia learning dimensions and cognitive style.

Table 2.2 Summary of Commonly Used Cultural Dimensions

<table>
<thead>
<tr>
<th>Researcher(s)</th>
<th>Cultural dimensions</th>
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<tbody>
<tr>
<td>Hall</td>
<td>(i) high-context versus low-context</td>
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<td></td>
<td>(ii) polychromic versus monochromic</td>
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<tr>
<td></td>
<td>(iii) perception of space - categorized as intimate, social, or public</td>
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<tr>
<td>Kluckhohn &amp; Strodtbeck</td>
<td>(i) human nature</td>
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<tr>
<td></td>
<td>(ii) man-nature relationship</td>
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<tr>
<td></td>
<td>(iii) time sense</td>
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<td></td>
<td>(iv) activity</td>
</tr>
<tr>
<td></td>
<td>(v) human relations</td>
</tr>
<tr>
<td>Trompenaars &amp; Hampden-Turner</td>
<td>(i) Universalism versus particularism</td>
</tr>
<tr>
<td></td>
<td>(ii) individualism versus collectivism</td>
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<tr>
<td></td>
<td>(iii) neutral versus emotional</td>
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<td>(iv) specific versus diffuse</td>
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<td></td>
<td>(v) achievement versus ascription</td>
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<td></td>
<td>(vi) specific versus diffuse</td>
</tr>
<tr>
<td></td>
<td>(vii) achievement versus ascription</td>
</tr>
<tr>
<td>Schwartz</td>
<td>(i) power</td>
</tr>
<tr>
<td></td>
<td>(ii) achievement</td>
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<td></td>
<td>(iii) hedonism</td>
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<td></td>
<td>(iv) stimulation</td>
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<td></td>
<td>(v) self-direction</td>
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<tr>
<td></td>
<td>(vi) universalism</td>
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<td></td>
<td>(vii) benevolence</td>
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<td></td>
<td>(viii) tradition</td>
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<td></td>
<td>(ix) conformity</td>
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<td></td>
<td>(x) security</td>
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<tr>
<td>Hofstede</td>
<td>(i) individualism versus collectivism</td>
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<tr>
<td></td>
<td>(ii) uncertainty avoidance</td>
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<td></td>
<td>(iii) power distance</td>
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Hall’s (1976) culture concept centred on “[w]hat gives man his identity no matter where he is born – is his culture, the total communication framework: words, actions, postures, gestures, tones of voice, facial expressions, the way he handles time, space and materials” and emphasised that “everything man is and does is modified by learning and is therefore malleable” (p. 37). The concept was categorised in continuum-based dimensions of high-context versus low-context communication, polychronic versus monochronic time and perception of space. High-context and low-context refers to the way information is transmitted or communicated. High-context cultures rely on non-verbal elements (e.g. facial expression, gesture, voice tone) to communicate. In contrast, low-context societies communicate information in an explicit mode that emphasises direct verbal messages based on words rather than the non-verbal context. People in low-context cultures generally develop fast but unstable relationships and are often individualistically oriented within a decentralised social structure. Monochronic and polychronic refer to the perception of time. Monochronic cultures view time as linear, tangible and divisible so events are scheduled one item at a time in an orderly and timely manner. Polychronic cultures are characterised by the simultaneous occurrence of many events resulting in less structured time events. Typically, interpersonal relationships take precedence over schedule events. Perceptions of space relate to the various levels of proximity that people are comfortable with depending on the closeness of the relationship. The distances are classified as intimate, social or public. Communication and interactions within intimate space is only used by people who have a close

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<tr>
<td>(iv)</td>
<td>masculinity versus femininity</td>
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<tr>
<td>(v)</td>
<td>long-term versus short-term orientation</td>
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</table>
relationship. Social space is generally used for routine social interactions with friends and associates within the workplace. Public space is used for interactions between acquaintances.

Kluckhohn and Strodtbeck (1961) developed the value orientations method (VOM) and defined it as “complex but definitely patterned principles, resulting from the transactional interplay of three analytically distinguishable elements of the evaluative process – the cognitive, the effective and the directive elements – which give order and direction to the ever-flowing stream of human acts and thoughts as these relate to the solution of “common human” problems” (p. 4). The VOM measures the basic assumptions and meaning of people in five categories: human nature, man-nature, time, activity and relational. The innateness of human nature can be interpreted as either mutable or immutable from the perspective of evil, neutral or good. The relationship of man-nature orientation can be measured as either subjugation to nature or harmony with nature or mastery over nature. Time orientation comprises a detailed interpretation of the temporal focus of human life and is classified as past, present or future. Activity orientation focuses on grouping the modality of human activity into one of the following categories: being, being in becoming, and doing. The relational orientation focuses on measuring the modality of human’s relationship to other human, according to one of the categories: lineality, collaterality, and individualism.

Trompenaars and Hampden-Turner (2004) classified cultural differences into seven binary dimensions: (i) universalism versus particularism (universalistic cultures presume that general rules and principles are important to maintain orderly behaviours in society whereas particularistic cultures regard human relationships as more important
than rules and principles); (ii) individualism versus collectivism (individualistic cultures place greater importance on individual interest whereas collectivistic cultures view group interests as the highest); (iii) neutral versus emotional (neutral orientation cultures emphasise controlling and managing emotions effectively whereas emotional cultures encourage the use of emotion to express themselves); (iv) specific versus diffuse (specific cultures tend to keep personal life and work life separate whereas diffuse cultures focus on building and maintaining good relationships in both personal and work life); (v) achievement versus ascription (achievement cultures value performance regardless of family and socio-economic background whereas ascription cultures believe that family and socio-economic background define a person’s life); (vi) sequential versus synchronic time (sequentially oriented cultures prefer doing one task at a time whereas synchronically oriented cultures take on several tasks at once); and (vii) internal versus external control (internally controlled cultures seek to control and exploit the environment for their own benefit whereas externally controlled cultures tend to adapt rather than control).

Schwartz’s (1994) theory consisted of ten motivational value types: power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity and security. Power value depends on social status and prestige to control or dominate other people and resources. Achievement value is gaining success and social recognition through demonstration of competence. Hedonism value is achieved through pleasure and sensuous gratification. Stimulation value is attained through excitement, novelty and challenge in life. Self-direction results from valuing freedom, independent thought and control over actions. Universalism value promotes peace, equality and
concerns about the welfare of all people and nature. Benevolence value is characterised by voluntary and generous actions. Traditional value comes from preserving customs and ideas that are featured in traditional cultures or religions in the world. Conformity value results from self-restraint of actions to prevent disruption and interference within a social group. Security value is concerned with the safety, harmony and stability of relationships within a society.

Hofstede (2001) defined culture as “the collective programming of the mind” (p. 9). He further explains that “culture in this sense includes values; systems of values are a core element of culture” (p. 10). In 1980, Hofstede identified cultures according to four dimensions: power distance, individualism versus collectivism, masculinity versus femininity and uncertainty avoidance. Hofstede based his four dimensions of culture on extensive surveys at IBM in which he investigated the influence of national culture to explain systematic differences in work values and practices. His methodology was unique in both size and structure. A fifth dimension was added to the framework after a second survey by Hofstede and Bond (1988). It was initially called Confusion dynamism but eventually changed to long-term versus short-term orientation. Detailed descriptions of each of these cultural dimensions are described below.

*Power Distance (PD)*

PD is the extent to which members of institutions and organizations expect and accept that power is distributed unequally. Low power distance countries (e.g. Austria, Israel, Denmark, New Zealand) expect and accept power relations that are more consultative or democratic. People relate to one another more as equals regardless of formal positions.
Subordinates are more comfortable with and demand the right to contribute to and critique the decision making of those in power. In high power distance countries (e.g. Malaysia, Slovakia), people accept power relations that are more autocratic and paternalistic. Subordinates acknowledge the power of others simply based on where they are situated in formal, hierarchical positions. As such, the PD that Hofstede defines does not reflect an objective difference in power distribution but rather the way people perceive power differences.

*Individualism versus Collectivism (IC)*

IC refers to the extent to which people are expected to stand up for themselves and to choose their own affiliations or, alternatively, act predominantly as a member of a life-long group or organization. Latin American cultures rank among the most collectivist in this category, while Western countries, such as the USA, UK Australia, are the most individualistic.

*Masculinity versus Femininity (MF)*

MF refers to the value placed on traditionally expected male or female roles (as understood in most Western cultures). High MF (or masculine) cultures value competitiveness, assertiveness, ambition, and the accumulation of wealth and material possessions, whereas low MF (or feminine) cultures place more value on relationships and quality of life. Japan is considered the most masculine culture (replaced by Slovakia in a later study), and Sweden the most feminine. Anglo cultures are moderately masculine. Because of the taboo on sexuality in many cultures, particularly masculine
ones, and because of the obvious gender generalizations implied by the Hofstede's terminology, this dimension is often renamed by other researchers; for instance, Hofstede and Bond (1988) uses quantity of life versus quality of life. Quantity of life refers to valuing material things whereas quality of life refers to valuing relationships and concern for the welfare of others.

*Uncertainty Avoidance (UA)*

UA reflects the extent to which members of a society attempt to cope with ambiguity by minimizing uncertainty. Cultures that scored high on UA prefer rules (e.g. about religion and food) and structured circumstances, and UA people tend to remain longer with the same employer. Mediterranean countries, Latin America and Japan rank the highest in this category. Countries that scored low on UA (e.g. Jamaica and Denmark) experience less stress, are curious about differences and open-ended learning, and are tolerant of opinions different from their own.

*Long Term versus Short Term Orientation (TO)*

TO describes a society's "time horizon" or the importance attached to the future versus the past and present. In long-term oriented societies, values include persistence, ordering relationships by status, thrift, and having a sense of shame; in short term oriented societies, values include normative statements, personal steadiness and stability, protecting one’s face, respect for tradition, and reciprocation of greetings, favours, and gifts. China, Japan and other Asian countries score especially high (long term); Western nations score rather low and many of less developed nations (e.g. Pakistan) very low.
2.3.2 Selection of Culture Framework

There has been an increasing debate regarding the significance and credibility of cultural dimensions used in a wide variety of empirical studies. Numerous studies have compared these cultural dimensions. For example, Robbin (2001) conducted a literature review that focused on the application of national culture theories to IT research and found Hofstede’s cultural framework was by far the most widely used. Based on this finding, they conducted a comprehensive review of 50 IT articles that applied Hofstede’s framework in quantitative and qualitative analyses. They concluded that Hofstede’s cultural framework is an excellent tool for IT adoption and diffusion research, particularly identifying differences and similarities between cultures.

Hermeking’s (2006) research on the influence of culture on the global use of the Internet was drawn from Hofstede’s and Hall’s cultural framework. Despite various researchers’ claims that the Internet will eliminate cultural differences due to globalization, Hermeking (2006) maintained that Hofstede’s and Hall’s frameworks provide the foremost basis for research into cultural backgrounds and differences, particularly in the discipline of web marketing. Similar research findings were also presented by Wurtz (2006). In addition, Barnett and Sung (2006) research examined Hofstede’s cultural framework and the structure of the Internet hyperlink network. The results revealed a significant relationship between national culture and the overall structure of networks, particularly with the individualism/collectivism dimension.

Pors (2007) published a research paper based on a review of invited papers consisting of experiences of library professionals who moved across national boundaries. Pors also discussed the similarities in the cultural frameworks of
Trompenaar & Hampden-Turner, Hofstede and Schwartz in relation to national or regional cultural characteristics, their relevance in contextualizing the diverse experiences, and their close connection to the concepts of social capital. Research by Everdingen (2003) identified the major overlap between Schwartz and Hofstede’s frameworks. Their findings confirmed that variables describing national culture based on Hofstede’s and Hall’s frameworks have a significant influence on the adoption of innovations.

There are several researchers who have been critical of the cultural dimensions discussed above. For instance, Ess and Sudweeks (2006) provided a review consisting of research and findings from various disciplines in relation to computer-mediated communication (CMC). According to their review, while studies have shown correlations between culture and media use, there are limitations in Hofstede’s and Hall’s cultural frameworks. They suggested that culture research should consider going beyond those of the existing frameworks given the characteristic of intercultural communication online. Research by Jacob (2005) also identified shortcomings in Hofstede’s and Trompenaar & Hampden-Turner’s cultural dimensions. He stressed that these frameworks diminish the effectiveness of identifying cultural differences in cross-cultural studies given the increasing cultural diversity due to globalization. He suggested that emerging concepts such as cultural convergence should supplement the more commonly known cultural dimensions for the purpose of producing more meaningful and relevant cultural research.

Todd (2009) shared a similar view but focused on serious shortcomings in Hall’s framework in identifying cultural differences; in particular; the use of quantitative
methods to measure culture content, despite the framework being influential in business and management. Ng, Lee, and Soutar (2007) also conducted a study that examined potential similarities and differences between Hofstede’s and Schwartz’s frameworks through calculating the cultural distance score using Kogut and Singh (1988) formula from Hofstede and Schwartz data. It appeared that Schwartz’s framework may be superior in a trade context. Overall, it was argued that, due to significant shifts in cultural values, Hofstede’s and Schwartz’s research could be obsolete given that their data were collected 34 and 14 years ago, respectively.

Perhaps the most vocal dissident of Hofstede’s work is McSweeney (2002) who claimed that: Hofstede’s surveys are not suitable for measuring cultural differences; nations are not the best units to study cultures; a study of subsidiaries of one organisation does not provide information about the entire national cultures; the data are old and obsolete; and the five cultural dimensions are not sufficient to conceptualised the findings.

Despite mixed reviews of the cultural dimensions highlighted by various researchers, these well-known frameworks have, to a certain degree, succeeded in demonstrating the importance of cultural differences in a wide variety of empirical research. The cultural theoretical framework that will guide this study is Hofstede’s cultural dimensions based on the following grounds:

(i) Hofstede’s investigation was based on 160,000 managers and employees of IBM surveyed from 60 countries, which remains the most influential in cultural classification due to the research-based validation and widespread acceptance by research scholars (Chapman, 1997; Downey, Wentling,
Wentling, & Wadsworth, 2005; Gaspy et al., 2008; Reisinger & Crotts, 2010; Zakour, 2003). Further support for Hofstede’s work is Harzing’s Publish or Perish citation index, which finds over 91,966 citations to his work (Harzing, 2013). Such an outstanding record attests to Hofstede’s continuing impact on a wide variety of empirical studies.

(ii) Hofstede’s cultural theory has consistently helped to explain the complexities of the impact that national culture has on various areas of IT-research (Gaspy et al., 2008; Gevorgyan & Porter, 2008).

(iii) Hofstede’s theory has many similarities with Schwartz’s and Trompenaars & Hampden-Turner’s cultural dimensions; that is, they share a belief that culture consists of values and preferred behaviour related to the values.

(iv) Hofstede’s framework has not yet been applied to research on the impact of national culture on students’ cognitive style in hypermedia systems.

2.3.3 Hofstede’s Culture Dimensions and Learning

A number of studies (e.g. Goh, 2009; Goodwin & Goodwin, 1999; Keng, 2010; Manikutty, Anuradha, & Hansen, 2007; Mitsis & Foley, 2009; Sugahara & Boland, 2010) have used Hofstede’s framework and discovered that students from certain countries displayed variations in learning structure preference based on their cultural orientation (see Table 2.3).
Table 2.3 Hofstede’s Cultural Dimension Scores in Relation to Learning

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Learning characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power distance</td>
<td><strong>High</strong> Teacher driven learning, students not treated equally, communicate only when prompted by lecturer, unwilling to challenge and criticise lecturer</td>
</tr>
<tr>
<td></td>
<td><strong>Low</strong> Student driven learning, students treated equally, initiate and spontaneous communication with lecturer, willing to challenge and criticise lecturer</td>
</tr>
<tr>
<td>Individualism/Collectivism</td>
<td><strong>High</strong> Prefer to work individually, look after their own interests, positive attitude to learning and acquiring competence</td>
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<tr>
<td></td>
<td><strong>Low</strong> Prefer to work and take responsibility as a group, believe education is to gain prestige in their social environment</td>
</tr>
<tr>
<td>Masculinity/Femininity</td>
<td><strong>High</strong> Value wealth and material objects, goal-driven, aggressive, assertive, competitive</td>
</tr>
<tr>
<td></td>
<td><strong>Low</strong> Modest, humble and nurturing characteristics to ensure cooperation, good working relationships, security within society</td>
</tr>
<tr>
<td>Uncertainty avoidance</td>
<td><strong>High</strong> Low tolerance for stress and anxiety</td>
</tr>
<tr>
<td></td>
<td><strong>Low</strong> Accept uncertain conditions and risks</td>
</tr>
<tr>
<td>Short/long term orientation</td>
<td><strong>Short</strong> Value the past and present, focus on short term effect</td>
</tr>
<tr>
<td></td>
<td><strong>Long</strong> Value the future, focus on long term effect</td>
</tr>
</tbody>
</table>

Source: (Hofstede, 1986; Hofstede & Minkov, 2010)

i) Low PD countries foster a learning environment that is highly interactive and very much student-driven, encouraging two-way informal communication between students and their lecturers. This informal, direct and participative learning environment encourages analytical thoughts and independent learning, and stimulates effective learning among students. In contrast, the learning environment of students from countries with a high PD score is expected to be strongly hierarchical and teacher-driven. Lecturers are perceived as highly credible and ranked higher than students on the basis of knowledge and authority, which contributes to students behaving
apprehensively to questioning and challenging their lecturers (Hofstede, 1986).

ii) Students from countries that score low on the IC dimension possess strong collectivist traits that value relationships and they respect their lecturers, friends and family members. Students from strong collectivist countries generally prefer to work and take responsibility as a group and treat education as a means to improve their social status in order to maintain relationships with other people. On the other hand, students with strong IC characteristic are independent and self-regulated learners. Their preference is to work individually and look after their own interests due their lack of interpersonal connection with people.

iii) A country of high MF score indicates that its students place greater importance and value on material things, and they tend to be driven by competition, ambition, achievement, success, assertiveness and accumulation of wealth and material possessions. On the other hand, a low MF score indicates that students place greater importance on mutual relationship in the learning environment. They generally associate achievement with the establishment of close human relationship. Such characteristics may possibly be attributed to their modest, humble and nurturing characteristics (Manikutty et al., 2007). Hofstede (1986) cautioned against the use of the MF dimension in relation to learning since it was the least reliable dimension.
iv) A country of high UA score indicates that its students have a lower tolerance for stress and anxiety. They tend to display active, aggressive, emotional and compulsive behaviours. A low UA score indicates students accept the uncertain conditions and risks. They tend to display contemplative, less aggressive, unemotional, relaxed and tolerant behaviours.

v) Students from countries with a high TO score are long term oriented, which means they attribute success to effort and failure to lack of effort. The exercises of perseverance are necessary in order to acquire the necessary skills and knowledge in the hope of successfully completing their studies and increase career opportunities. On the other hand, students from countries with a low TO score value freedom, individual rights and achievement (Hofstede & Minkov, 2010).

2.3.5 Culture and Hypermedia Systems

Many researchers suggest that the social context in which technology developments take place has significantly influenced the way that learning takes place and the way that knowledge is developed and transferred in higher educational institutions. Eteokleous-Grigoriou (2009) asserted that technology such as educational hypermedia is an essential component of educational systems and represents an excellent curricular tool as well as a revolutionary classroom approach that can help students achieve important gains in knowledge and learning. In addition, there appears to be a consensus that culture has a definite and very strong influence on the design and use of information, communication and learning systems. This is due to the increasing presence of cultural
differences among students in higher education institutions as a result of globalisation. Educational hypermedia users may understand the same system in different ways. Some metaphors, navigations, interaction or appearance of hypermedia might be misunderstood and confuse or even offend the users (Downey et al., 2005).

Culture has various influences and effects on students’ learning experiences, particularly in how they perceived and prefer the type of learning environment. A study by Luna, Perrachio, and de Juan (2002), for instance, detected that congruity of a website was due to the effect of culture on attitudes towards website and navigation experience. Researchers such as Dunn, Gemake, Jalali, and Zenhausern (1990), Hillard (1989), Moore (1990), and Vasquez (1990) have indicated that different cultural groups vary in their sensory modality strength. Asian students were found to have a stronger preference for visual learning than American students. The use of different language-writing systems also has an impact on Western and Chinese learners’ modes of representation of information. Western learners tend to be verbalizers who “consider the information they read, see, or listen to, in words or verbal associations,” whereas Chinese learners tend to be imagers who “experience fluent spontaneous and frequent pictorial mental pictures when they read, see, listen to or consider information” (Riding, 1994, p. 48). Studies indicate that verbalizers prefer text, while imagers prefer pictorial information during their learning processes (Riding & Douglas, 1993). This suggests that Asian students may favour the use of visualization as a study strategy more than other cultural groups because the visualization task falls into their visual learning preference. Therefore, the use of student-generated visualization as a study strategy may
be more beneficial to the scientific concept of learning of, say, Taiwanese students than American students.

2.3.6 Culture and Cognitive Style

Societal culture can influence students’ learning depending on the type of learning environment, and such learning interactions ultimately affect the learning outcome (Abeysekera, 2008; Hofstede, 1986). There is a need to ensure flexibility and access to learners of diverse cultural background because culture and learning are interwoven and inseparable (Downey et al., 2005). Moreover, hypermedia is a relatively new medium of learning delivery; it is not clear what the relationship is between a user’s cultural background and cognitive style in a hypermedia system. As a result, the educator’s tasks have become more complex since individuals who are fostered by different cultures may have different cognitive styles. Although some research has been conducted in relation to different aspects of culture and technology, very little is known about the ramifications that cultural influences have on students’ cognitive style in educational hypermedia learning systems. This calls for further research as culture may play an important role in defining, conceptualizing, inventing, adapting and distributing teaching and learning materials through hypermedia learning systems to assist students in achieving effective learning.

A number of studies have claimed that differences in sociocultural orientation are responsible for differences in cognitive style. Greene (1985) claimed that human action is influenced by three key domains that function as causal factors in the production of action: sociocultural, physiological, and psychological. A cultural perspective on
cognition assumes that humans are not only prepared biologically with a variety of physiological and psychological components but also with socially shaped propensities. This profile includes particular ways of adaptation and adjustment to one’s sociocultural environment. The sociocultural shaping of cognition may transpire in the production of action in particular ways in each culture. An assortment of interpersonal and social factors in various cultures may be significant predictors of cognition. Similarly, Varnum et al. (2010) findings suggest that sociocultural orientation does indeed cause cultural differences in cognition. Evidence was drawn from the fact that Westerners tend to be independent, leading to a more analytic cognition, and East Asians tend to be interdependent, leading to a more holistic cognition. These differences correspond with differences in social orientation. They also rule out alternative explanations for the cognitive differences, such as linguistic and genetic differences, as well as cultural differences other than social orientation.

Several cross-cultural studies supported that students’ cognitive style is significantly reflected by their national culture. For instance, Engelbrecht and Natzel (1997) conducted a cross-cultural study using the Children’s Embedded Figures Test (CEFT) to examine males and females students’ cognitive style of whom 100 represented black South African and 100 represented African American students from 4th and 5th grades. The African American students’ learning approaches were more likely characterized as FI and the black South African students’ learning approaches were more likely characterized as FD. It appeared that both sampling groups had adapted to the dominant culture and selectively met the demands of their particular environment. This suggests that culture appears to be a key determinant of students’
cognitive style. Likewise, Faiola and Matei (2006) explored issues related to web designers’ cultural cognitive style and their impact on user responses through sites presentation to American and Chinese users created by both Chinese and American designers based on an online experimental study. The results indicated that users perform information-seeking tasks faster when using web content created by designers from their own cultures. Research by Luna et al. (2002) incorporated cross-cultural dimensions into their cognitive framework to investigate the effect of culture on attitudes towards website and navigation experience. Their findings revealed that a person’s national culture significantly affects their attitude towards website content and navigation, which suggested that culture is an important factor to be taken into consideration in web design.

Hill, Puurula, Sitko-Lutek, and Rakowska (2000) explored the general propositions about the nature of the analysis/reflection dimension based on Allinson and Hayes (1996) Cognitive Style Index (CSI) at both individual and national levels. Specifically, the study used qualitative instruments that assessed attitudes to early schooling and personal confidence against predictions about national cultural differences derived from Hofstede’s (1980) framework. Their findings showed significant differences between national groups in cognitive approaches and some aspects of socialisation. It was suggested that individual characteristics are not fixed and innate, but are learned through processes of personal and cultural socialisation. On the other hand, empirical evidence from Allinson and Hayes’ (2000) research showed mixed results of cultural differences in cognitive style. They claim that their study contributed to providing a wider ranging cross-national comparison of the cognitive style in a
management context than had been reported previously. A similar study by Oyserman and Lee (2008) discovered that the individualism/collectivism dimension in Hofstede’s framework produced different shifts in cognitive procedures, suggesting that a different national cultural spectrum influenced information processing and thoughts. Tullett (1997) investigated Prato Previde’s (1991) hypothesis that the Adaptive-Innovative (A-I) cognitive style is a stable process within the individual, which is largely uninfluenced by national culture. Based on the empirical findings and statistical analysis drawn from a range of studies from different countries, it was concluded to be consistent with the hypothesis.

2.4 Unit Evaluation

The literature on teaching evaluation is abundant and well researched, particularly in ways that teachers can present content and skills to enhance the opportunities for students to learn. It is equally filled with suggestions of what not to do in the classroom. However, there is no consensus on which teaching methods match best to which skills and/or content being taught. This is because students often have little expertise in knowing if the method selected by an individual instructor was the best teaching method or just “a method” or simply the method with which the teacher was most comfortable.

Despite that the use of students’ ratings for evaluating teacher effectiveness is one of the most researched issues in higher education. According to Ory and Ryan (2001), over 2000 articles and books have been written on this topic over the past 70 years. The most accepted criterion for measuring good teaching is the amount of student learning that occurs. There are consistently high correlations between students’ ratings of the
“amount learned” in the course and their overall ratings of the teacher and the course. Those who learned more gave their teachers higher ratings (Cohen, 1981; Marsh & Overall, 1980; Theall & Jennifer, 2001). In other words, it is a process that detects any differences between present achievement and intended goals and, if necessary, finding solutions to narrow the difference. This section therefore provides an overview of the evaluation process and the various types and phases of evaluation.

2.4.1 Purpose of Evaluations

It is important to understand the basic concept of evaluation. According to Gay (1985, p. 6) “evaluation is the systematic process of collecting and analyzing data”. The purpose of conducting an evaluation is to determine the current status of the object of the evaluation, to compare that status with a set of standards or criteria, and to select other alternatives to make a decision (Gay, 1985, p. 7). The evaluation of a unit usually takes the form of a paper or electronic survey that requires a written or selected response answer to a series of questions. The aim is to collect feedback that the teacher and the university can use to improve their quality of teaching. The process involves: (a) gathering information about the impact of learning and teaching practice on student learning; (b) analysing and interpreting this information, and (c) responding to and acting on the results (Rahman, 2006). It is a valuable tool for teachers to review how others interpret their teaching methods and thereby improve their teaching. In addition, the information can assist university committees in making summative decisions (e.g. promotion) or formative recommendations (e.g. identify areas where a teacher needs to improve) (Dunegan & Hrivnak, 2003).
The validity of decisions depends on the validity of the data collection and analysis procedures. The validity of data collected from an evaluation process fundamentally depends on good measurement. Measurement is defined as “the process of quantifying the degree to which someone or something possesses a given trait” (Gay, 1985, p. 8). Measurement permits more an objective description of the data collected concerning traits and facilitates comparisons. Thus, in the educational context, measurement represents the extent to which a person or entity possesses “something” (Gay, 1985). Theoretically, all traits of interest can be measured; however, a major challenge is indirect measurements, such as knowledge, achievement, attitude, skills, feelings, intelligence or aptitude of an individual or group. Measurement of such aspects relies heavily on inference. Moreover, it can be further complicated by the lack of a well validated instrument. Although the validity of such measures is questionable, it is generally considered that student evaluations are more useful, accurate and valid than other measures of teaching performance and have the added benefit of being a direct measure of student satisfaction (Marsh, 1987; Marsh & Roche, 1994; Ramsden, 1991).

Therefore, due to the accountability in decision making, it is important to have sufficient validity and reliability in the evaluation process. Gay (1985, p. 10) stated that “accountability means being answerable, or responsible, for one’s own actions”. In the educational context, accountability serves as a purpose for a performance indicator or quality assurance system in an effort to increase teaching effectiveness and to improve the educational opportunities for all students since part of the wealth of the community is invested by the government through funding the universities. Thus, educational institutions have a responsibility to their current and prospective students as well as the
community. The demand of accountability serves as a purpose for a performance indicator or quality assurance system in an effort to increase teaching effectiveness and to improve the educational experiences of all students (Ballantyne et al., 2000; Chen & Hoshower, 2003; Gursoy & Umbreit, 2005; Hendry & Dean, 2002; Smith, 2008). In short, student evaluations are generally used to provide (Chen & Hoshower, 2003):

(i) formative feedback to the university for improving teaching, course content and structure;
(ii) a summary measure of teaching effectiveness for promotion and tenure decisions; and
(iii) information for students to assist in the selection of units.

2.4.2 Evolution of Student Evaluations

The pioneering research work on student evaluations of teaching began in the 1920s (Bradenburg & Remmers, 1927; Remmers, 1928; Remmers & Bradenburg, 1927). Remmers’ research focused on major issues, such as whether the judgments of students agree with those of student peers and alumni. The evolution of student evaluation research has been summarised by Centra (1993, p. 49) into four periods:

i) Between 1927 and 1960, Remmers and his colleagues at Purdue University dominated the field of study.

ii) In the 1960s, the use of student evaluations was almost entirely voluntary.

iii) The 1970s was the golden age of research on student evaluations. Student ratings were used for both formative and summative purposes.
During the 1980s, evaluations were regarded as controversial in reflecting effective teaching and the validity of students’ evaluation was questionable due to variation in research findings.

The controversy associated with the use of student evaluation to determine teaching effectiveness during the 1980s was largely due to the variation in research findings. For instance, Dowell and Neal (1982) raised the issue on the validity findings of students’ evaluations of teaching effectiveness on the basis of numerous contradictory findings after reviewing selected empirical studies. McCallum (1984) concluded there was a lack of consistency or validity after reviewing several studies related to students’ evaluations of teaching effectiveness due to the frequent reported low correlations. On the other hand, Marsh’s (1987) research findings indicated that evaluations were clearly multidimensional, reliable, reasonably valid, and relatively uncontaminated by many variables often seen as sources of potential bias. In addition, Cashin (1988) claimed that students’ evaluations tended to be statistically reliable, valid, relatively free of bias, and probably useful. Consequently, the construct-validation approach was established and widely used by researchers as an indication of effective teaching. This approach depends on the correlation of student ratings with indicators of effective teaching (Marsh & Overall, 1980; Murray, 1997).

Since the 1990s, a considerable number of studies have investigated the reliability and validity of student evaluation (Ballantyne et al., 2000; Chen & Hoshower, 2003; Hendry & Dean, 2002; Watchel, 1998; Young & Shaw, 1999). Reliability involved verifying the stability or consistent pattern of responses between students and over time. Conversely, research on validity addresses issues such as response bias and
measure effectiveness. An example of a study that addressed reliability and validity is Spooren, Mortelmans, and Denekens (2007) who suggested that constructing an evaluation based on scaling techniques provided a more valid, reliable and useful instrument than the single-item approach for measuring teacher performance. Scale-type evaluations were less sensitive to social desirability, ambiguity, interpretations and accidental fluctuations of the answers given. In addition, the internal consistency of each scale was tested by calculating the Cronbach’s alpha statistic. These studies indicate that the construction of valid and reliable scales requires systematic research, in which both the literature and empirical data should play an important role.

2.4.3 Reliability and Validity of Unit Evaluation

Units are typically evaluated by surveying students about their satisfaction with teaching, content and delivery. Students’ evaluations of teachers have proven to be a reliable and valid tool in identifying factors that differentiate between good and poor teaching. For instance, Watkins (1994) conducted a cross-cultural study on student evaluations of teaching in six different countries (India, Nepal, Nigeria, Philippines, Hong Kong and New Zealand) and reported that these countries had similar internal reliability, convergent and discriminant validity. However, it can be argued that the mode of evaluations can affect the validity and reliability of the data. For example, a study by Gamliel and Davidovitz (2005) measured internal reliability by comparing the traditional paper-and-pencil method with the online method. They found the stability of evaluations using paper-and-pencil method was substantially higher than the online method. They explained that a possible reason for this finding is the different visual
presentation of the scales. The typical paper-and-pencil method presents scales horizontally, enabling subjects to examine the profile of their answers. Another possible reason for biased responses for paper survey could be due to the sense of different level of anonymity compared to online survey (Ward, Clark, & Zabriskie, 2012). This might result in an artificially lower variability of the evaluations. In contrast, Helgeson and Ursic (1989) found that answers using an electronic medium remain stable compared to paper when the extremity of scale anchors changed. This indicates that the electronic answering form can abolish artificial answering effects. Apart from a more accurate measurement process, recent studies (de Leeuw, 2012; Ward et al., 2012) have confirmed that the online survey method served as an effective tool in reaching student populations in a cost effective and timeliness administration process as well as in obtaining a higher responsiveness from participants.

Although there is an apparent consensus that evaluations cannot judge all aspects of teaching performance, numerous colleges and universities have accepted this measurement based on student satisfaction because it is more useful, accurate and valid than other measures of teaching performance (Ballantyne et al., 2000; Chen & Hoshower, 2003; Gursoy & Umbreit, 2005; Hendry & Dean, 2002). Bentley and Selassie (2010), who conducted a three-year longitudinal study, claimed that students’ satisfaction and learning effectiveness increased following improvements to the delivery approach, enrichment of content, and education quality based on students’ feedback.

Another study by Haan, Britt, McClellan, and Parks (2010) found that age is an important factor in influencing students’ satisfaction. While younger students were typically more technologically savvy, older students were generally more highly
motivated, relatively independent and achievement oriented. Older students regarded education as an investment and preferred flexible learning schedules and instruction (Bentley & Selassie, 2010; Haan et al., 2010; McKenzie & Gow, 2004; Pincas, 2007). Although evaluations have served their purpose in assessing students’ satisfaction and learning, they have also been a valuable tool in detecting students’ confidence (Pryjmachuk, Gill, Wood, Olleveant, & Kelley, 2012). This has established a strong indication that students’ evaluation of teaching, content and delivery could provide valuable information in assessing the functioning of hypermedia systems.

2.4.4 Determining Students’ Cognitive Style Using Unit Evaluation

There have only been a few attempts to study students’ perceptions of units, particularly content delivery, to predict their cognitive style. For instance, FD students were found to be more satisfied with the modular approach and more negative toward the traditional semester-long courses than FI students (Drummond & McIntire, 1977). A study based on a heuristic evaluation method by Ling and Salvendy (2009) found that FD evaluation performance improved when evaluators worked in groups as opposed to working on individually assigned evaluation tasks, although both FD and FI evaluators were experienced with computers. Prosser and Trigwell (1990) showed that, based on Entwistle and Tait’s (1990) categorisation of approaches to study, Australian university students taught by highly rated teachers tended to use deep rather than surface study strategies. Similar findings based on Entwistle’s framework were found by Diseth (2007) who suggested that students’ evaluation and perception of the learning
environment and delivery of content material are important predictors of students’ approaches to learning as they affect examination performance.

Miller (2007) explored the effects of cognitive style and expected evaluation on creativity with the assumption that students classified as FI are more likely to have higher creativity scores. The results indicated that the hypothesis was partially supported as FI students scored significantly higher on creativity measure than FD students. Kember, Jenkins, and Ng’s (2004) findings suggested that students faced with a teaching style incompatible with their conception of learning were likely to give poor ratings in their evaluation. Konradt (2004) conducted student evaluations regarding the features and functions aspects of hypermedia learning environment and discovered that the educational technology had motivated and supported students’ learning.

In the context of this study, the increasing student engagement activities and greater control over their learning due to advancements in technologies such as hypermedia, act as a major drive in the underlying changes to the learning and teaching process. The key to improving teaching practice is to understand and encourage students to learn which in turn help teachers to teach (Hendry & Dean, 2002). Additionally, formative evaluation was reportedly effective and efficient during the design and development of adaptive hypermedia system (Triantafillou et al., 2003). This suggests that student evaluations and perceptions of the learning environment and content delivery are important predictors of student learning. Thus, this study investigates the interaction of student evaluations and cognitive style.
2.5 Conclusion

This chapter has presented the literature across a number of different but related fields. The review discussed hypermedia, cognitive style, learning dimensions, culture and unit evaluation. The evolution of hypermedia has been found to be an important concept related to students’ learning since its functionality (information management, retrieval and storage) parallels the way human brain and memory work. As a result, it is not surprising that hypermedia technology has an increasing role in supporting teaching and learning.

Despite numerous studies that endorsed the impact of hypermedia learning systems on students’ learning, there is an ongoing issue related to variations in what students can achieve since they do not locate information or assimilate internal knowledge the same way. This has prompted the need to understand the cognitive mechanisms underpinning hypermedia learning. Additionally, past studies have found that culture plays a significant role in influencing the way learning takes place and the way that knowledge is developed and transferred in educational settings. This suggests that culture and learning are interwoven and inseparable so students from different cultures may have different cognitive styles. There are, however, consistently high correlations between student evaluations of teaching and content delivery with learning outcomes. Hence, the complexity of the relationships projected by these issues provides the foundation for the theoretical framework of this study, which is discussed in Chapter 3.
Chapter 3

RESEARCH METHODOLOGY

This chapter discusses the various types of research methodologies from philosophical and theoretical perspectives. Such investigation assists in determining the choice of methodological tools to guide the research design and to produce a well-constructed research framework, specifically the methods and procedures for collecting and analysing the necessary information to formulate answers to the research questions. Methodology in this study refers to the approach used to guide the research conduct whereas methods refer tools used to accomplish the research conduct. This chapter is organised into several major sections: theoretical background to research methodologies; research design and model; survey instrument; participants; ethical considerations; and statistical methods applied to the data.

3.1 Theoretical Background to Research Methodologies

Positivism and interpretivism are the two major types of methodologies that are associated with the theoretical frameworks or paradigms that a researcher should consider prior to determining the way a research study should be conducted. Both methodologies have varying degrees of fundamental antinomies and practical implications for the conduct of research (Bryman, 1984). Positivism is a research methodology that employs quantitative methods where empirical investigation is carried out systematically and rationally in an objective world. The purpose is to search for explanations and predict what happens in the social world by studying regularities and
causal relationships between its constituent elements (Burrell & Morgan, 1979). The process, also known as a deductive approach, involves evaluating an explanation by logically deducing from theory then collecting data and analysing it in ways that exclude alternative explanations and enable replication of the study (Neuman, 2000; Shanks, Rouse, & Arnott, 1993). In addition, the positivist approach requires a researcher to remain detached, neutral and objective. Positivist researchers use quantitative measures of phenomena and may use coded qualitative data so that it can be analysed quantitatively. Examples of quantitative methods include systematic observations, surveys, experiments and statistical analyses. Quantitative methods fit well with hypothesized questions based on variable relationships as these can be measured (Walle, 1997).

The most challenging part of this approach is the extent to which the research results can be replicated. Quantitative methods are reinforced by theories of validity and reliability as they use numbers in a more absolute unit of measurement and these measures are based on numbers that can be assessed for errors and omissions (Hamilton & Bowers, 2006; Miller, Marshall, & Seibold, 2011; Simsek & Veiga, 2000). Quantitative methods also facilitate comparisons and analyses that frequently use well established statistical measures; that is, means, frequencies, standard deviations, correlation, and so forth. The sampling theory of this method can be used to estimate and generalise the finding to the greater population. Quantitative methods provide a powerful methodology in research, specifically in evaluating previous findings and developing refined or new measures to extend them (Walle, 1997). To this day, it is a leading methodological framework in economics, psychology, and management, and
continues to appeal to researchers due to the clear, precise and unequivocal criteria for distinguishing scientific evidence from personal opinion (Buchanan, 2000; Fraenkel & Wallen, 1991; Shanks et al., 1993; Walle, 1997).

Interpretivism, also known as phenomenology or anti-positivism, is a research methodology that employs qualitative methods. An interpretivist methodology uses a systematic analysis of socially meaningful action through direct observation of people in natural settings to deepen an understanding and an interpretation of how people create and maintain their social world (Buchanan, 2000; Neuman, 2000). In other words, this research approach is based on evidence about what people say and do. Interpretivism is not concerned about the reproducibility of an explanation; instead, it is concerned about the extent to which the explanation makes sense to those being studied and to which it allows others to understand the reality of the subjects being studied (Neuman, 2000).

The process of data collection involves detailed observation and deep analyses of the language used. The techniques include video/audiotapes and transcripts of what people say or write about the meanings they attach to social phenomena. Other frequently used techniques are participant observation and field research, which involve intense personal contact with subjects (Shanks et al., 1993).

There are several weaknesses to the interpretivist approach. First, it is time consuming, particularly in studying humans as individuals, as their daily experience and interpretations introduce the risk of collecting data that is not as useful as anticipated. Another problem is reliability due to subjectivity and ethical issues such as privacy. The advantage of qualitative methods is that they enable the individual to be studied in depth and in detail (Herbert & Higgs, 2004). The researcher can address questions that are not
open to quantification. They enable the more complex relationships and findings to be studied. The data collected is clearer and more readable as the concepts are articulated in words and so the skill of numeric interpretation is not an absolute. It permits a more flexible approach so it is ideal for hypothesis generation. There is usually more freedom associated with qualitative methods as there is less structure and more scope to elaborate in words.

The differences in both methodologies are presented in Table 4.1. Drawing from the philosophical differences of quantitative and qualitative paradigms, the simplest distinction between these two is that quantitative research methods involve enumeration and qualitative research methods employ non-numerical judgments in the exploration of the phenomena studied (Herbert & Higgs, 2004). Despite their philosophical and methodological differences, it is suggested that both methodologies have valuable features to offer in the understanding of the research; in particular, when the value of quantitative methods complements the value of qualitative methods, commonly known as a mixed methodology (Herbert & Higgs, 2004; Miller et al., 2011) or a complementary methodology (Riva & Galimberti, 2001; Sudweeks, 2008; Sudweeks & Simoff, 1999).
Table 3.1 Dimensions of Quantitative and Qualitative

<table>
<thead>
<tr>
<th>Areas of Differences</th>
<th>Quantitative Research</th>
<th>Qualitative Research</th>
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<tbody>
<tr>
<td>Purpose of inquiry</td>
<td>- Explanation of observed phenomenon</td>
<td>- Understanding of observed phenomenon</td>
</tr>
<tr>
<td></td>
<td>- Hypothesis testing and refinement</td>
<td>- Emergent theory development</td>
</tr>
<tr>
<td>Role of investigator</td>
<td>- Objective observer</td>
<td>- Active interpreter</td>
</tr>
<tr>
<td></td>
<td>- Active manipulator of experimental setting</td>
<td>- Participant observer in naturalistic setting</td>
</tr>
<tr>
<td>Acquisition of</td>
<td>- Use of quantitative, numerical data</td>
<td>- Use of loosely structured textual data</td>
</tr>
<tr>
<td>knowledge</td>
<td>- Construction of knowledge, explanations as models</td>
<td>- Discovery of knowledge as interpretations</td>
</tr>
<tr>
<td></td>
<td>- Generalization, theory building from results</td>
<td>- Extrapolation, theory building from results</td>
</tr>
<tr>
<td>Presentation of</td>
<td>- Data reduction using graphical visualization methods</td>
<td>- ‘Thick’ interpretation of results using quotes from raw data</td>
</tr>
<tr>
<td>research</td>
<td></td>
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</tbody>
</table>

Source: Adapted from Sudweeks & Simoff (1999, p.33-36)

3.2 Research Design

The decision about which research approach is more appropriate can be determined by further classification of research activities into research stages and purposes (Galliers, 1992; Neuman, 2000). Defining the research questions and hypotheses are the most important steps in guiding the choice of research method (Bryman, 1984; Walle, 1997). The form of the question(s) can provide an important indication of the appropriate research method to be used. In essence, the type of research questions being asked guides the choice of research method. In general, there are three conditions that guide the preferred methodology:

(i) the type of research questions

(ii) the control an investigator has over actual behaviour events
Based on the extensive review of the literature in Chapter 2, hypotheses were formulated and developed to address the two broad research questions presented in Chapter 1:

1. **What are the factors that affect cognitive style?**

H1.1: There is a difference between Australian and Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation.

H1.2: Australian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

H1.3 Malaysian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

H1.4: Students’ approaches to learning, culture dimensions and unit evaluation affect their cognitive style.

H1.5: Higher order interactions among students’ learning dimensions, culture dimensions and unit evaluation affect their cognitive style.

H1.6: Students’ demographic characteristics affect their cognitive style.

2. **Does cognitive style change over time?**

H2.1: Students’ cognitive style changes with time in the development of hypermedia learning.
H2.2: Time and location affect students’ cognitive style in hypermedia learning.

H2.3: Time and location affect students’ learning dimensions, culture dimensions and unit evaluation.

H2.4: Individual students’ cognitive style varies with the changes in their learning dimensions, culture dimensions or unit evaluation.

The cross-disciplinary inquiry indicated in the research questions and hypotheses of this study requires extensive resources and time for planning, implementing a research design and completing the study. To address the complex dimensions of this study, a mixed methodology design framework consisting of qualitative (exploratory research questions and case studies) and quantitative tools (convenience sampling, survey methods, statistical analysis) is well-positioned and appropriate, as illustrated in Table 3.2. The use of statistical analyses on the survey data helps to enrich the interpretive process in case study research and increases the relevance of the findings.

Table 3.2 Dimensions of this Study

<table>
<thead>
<tr>
<th>Dimensions of study</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Theoretical assumptions</td>
<td>- Cognitive style plays a significant role in how much is learned from a hypermedia learning system. Thus it acts as an indicator to determine the effectiveness of a hypermedia system.</td>
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</tbody>
</table>
| Area of inquiry                  | - Cross-disciplinary, involving hypermedia learning systems, cognitive psychology and cultural studies.  
- Multiple factors, including learning dimensions, cognitive style, culture dimensions, unit evaluation, demographic characteristics, location and time effect. |
| Purpose of inquiry               | - To comprehend cognitive mechanisms underpinning hypermedia learning, particularly how humans represent connections among different units of information on the web  
- To uncover which predictor variables are significant in determining students’ cognitive style.  
- To promote ideas to improve usability of computer software |
and implementation of efficient hypermedia learning instructions and learning in education.

<table>
<thead>
<tr>
<th>Object of inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple-case study of a hypermedia system used in undergraduate/postgraduate units in two separate university setting.</td>
</tr>
<tr>
<td>Cross-sectional and longitudinal effects of students’ cognitive style in hypermedia learning at both university setting.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acquisition of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of knowledge, explanations as models.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positionality of researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non participant objective observer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Choice of data types, sources and methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data types/sources:</td>
</tr>
<tr>
<td>Qualitative: descriptive data from units descriptions</td>
</tr>
<tr>
<td>Quantitative: statistical data from responses to closed-ended survey questions</td>
</tr>
<tr>
<td>Instrument:</td>
</tr>
<tr>
<td>Online survey</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presentation of research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative results:</td>
</tr>
<tr>
<td>Report on descriptive data</td>
</tr>
<tr>
<td>Quantitative results:</td>
</tr>
<tr>
<td>Elementary statistical analyses: descriptive statistics mean, standard deviation, Pearson correlation coefficient and t-tests,</td>
</tr>
<tr>
<td>Advance statistical analyses:</td>
</tr>
<tr>
<td>Cross-sectional effect (MLR &amp; TBR modellings)</td>
</tr>
<tr>
<td>Longitudinal effect (MLR &amp; LME modellings)</td>
</tr>
<tr>
<td>Graphical representation of relationship interaction</td>
</tr>
</tbody>
</table>

In general, a case study involves an “in-depth examination of a single instance of some social phenomenon” (Babbie, 2010, p. 309). According to Yin (2009), a case study method can be further classified into three categories:

- **Descriptive case study**: describes who, what, where and when in a detailed narrative of a specific event in a place.

- **Explanatory case study**: describes how and why relationships are formed.

- **Exploratory case study**: describes entirely new fields of research based on few or no antecedents.
Drawing from the definition of the typologies of case studies, descriptive and exploratory case studies are relevant classifications of research methods for this study. The descriptive case is relevant because this study attempts to describe and portray the cognitive mechanisms underpinning hypermedia learning based on multiple factors from a cross-country perspective as well as investigating the over-time effect. Nonetheless, this study also attempts to explore which factor is a better indicator to predict students’ cognitive style in a hypermedia learning system.

Generally, a case study will consist of either a single case or multiple cases. Thus, it is important to decide whether a single-case or multiple-case study is an appropriate design to address the research questions and meet the research circumstances. The next stage is to consider the four types of case study design as illustrated in Figure 3.2. A single-case or multiple-case study can have embedded sub-cases within its overall case. There are four different case study designs portrayed in a two-by-two matrix; that is, “(Type 1) single-case (holistic) design, (Type 2) single-case (embedded) design, (Type 3) multiple-case (holistic) design, (Type 4) multiple-case (embedded) design” (Yin, 2009, p. 46-47).
Among the four types of case study designs, Type 4 is deemed as a more applicable design framework to explore the dimensions of this study because a multiple-case (embedded) design examines the phenomenon of two or more organizations using the same replication strategy (pattern matching) (Yin, 2009). The embedded units in a multiple-case study can be selected through sampling or cluster techniques. In addition, its design approach resembles the replication logic used in multiple experiments. The
replication procedures depend heavily on a rich theoretical framework of the study that “states the condition under which the phenomenon is likely to be found (literal replication) and when it is not likely to be found (theoretical replication)” (Yin, 2009, p. 54). This study focused on predicting contrasting results. A multiple-case study is also considered more robust than a single-case study, provided all the cases are as predicted, since the number of multiple-case studies is comparable to the number of multiple experiments (Yin, 2009). Yin (2009) cautioned that a multiple case study design is difficult to implement because of the uncertainty in determining the number of case studies required to obtain credible findings. This risk is handled by applying a quantitative framework to produce a quantitative outcome.

Figure 3.3 is a detailed illustration of the overall stages and processes of the multiple-case (embedded) design for this study.

![Figure 3.2 Type 4 Case Design: Stages and Processes (adapted from Yin, 2009, p. 57)]
The research design has been developed to carry out a cross-country longitudinal study as efficiently as possible. One of the best options was to utilise the readily available and convenient access to students at two universities by conducting cluster sampling. A cluster sampling approach was chosen to accelerate the sample collection as well as to ensure that the required sample size for both groups was met, given the project time constraints.

According to Babbie (2010, p. 218), cluster sampling is “a multistage sampling in which natural groups (clusters) are sampled initially, with the members of each selected group being sub-sampled afterward”. In other words, cluster sampling involves taking random subsamples of preceding random samples. This sampling method is generally used “when it is either impossible or impractical to compile an exhaustive list of the elements composing the target population” (Babbie, 2010, p. 218). Hence, the nature of cluster sampling is deemed to be an appropriate sampling approach for this study since the research questions are targeted at a small number of events. In addition, the ability to use multiple sources and techniques to estimate the size of an effect as opposed to generalising a population (Woodside & Wilson, 2003) justify that case study research is a more appropriate approach for this study.

Cluster sampling, for the purpose of this study, is clustered according to time and location. Generally, the study of longitudinal effects depends on a strong pattern of evidence, which requires a long-term set of data collection in a qualitative research method. However, quantitative methods can facilitate the study of change and development over time (Miller et al., 2011). This is due to the fact that qualitative data may be coded for the purpose of quantitative measures of phenomena and analysed
quantitatively, which provides a convenient way of describing a complex set of data particularly to differentiate the causal relationships possible (Herbert & Higgs, 2004).

This study uses advanced statistical modelling methods, such as multiple linear regression, tree based regression and linear mixed effects models, to extract maximum information from a limited collected data set within a short study time frame. Although a quantitative method is used to analyse and support data from the case study, integrating case study and survey evidence allows complementarity of findings. In other words, qualitative data, in a contextualised form, provides a deeper meaning to the relationships found in the survey results. Research has shown that having a combined methodology helps to capitalise on the strengths of both (Miller et al., 2011). Hence, it is believed that the qualitative criteria set in this case study can be fulfilled and achieved with the support of statistical methods using survey method for data collection.

Based on the considerations discussed above, the research model presented in Figure 3.3 represents the connections between students’ cognitive style and the multiple factors investigated in this study – learning dimensions, culture dimensions, evaluation of units and demographics (see also Table 3.5 for a summary description of the variables).
There are three main factors related to learning dimensions – *nonlinear*, *learning control* and *multiple tools*. As can be seen from Figure 3.3, field independent (FI) students prefer a high nonlinear learning environment, whereas field dependent (FD) students prefer a low nonlinear learning environment. A high nonlinear learning environment encourages active or self-driven learning, whereas a low nonlinear learning (that is, linear learning) environment consists of passive or more focused guided learning.
A high learner control represents FI students who are generally more independent learners, with the ability to engage well using the control features in the hypermedia systems. A low learner control represents FD students who are less likely to engage with the control features in hypermedia systems and tend to be heavily dependent on guided learning. FI students tend to use indexes to find specific information in hypermedia learning systems whilst FD students tend to rely on maps to find specific information.

The high unit evaluation represents students who rated high satisfaction with a preference for structured learning in the unit and are classified as FD students. The low unit evaluation represents students who rated low satisfaction with a preference for flexible learning in the unit and are classified as FI students.

The culture dimensions of power distance (PD), individualism (IC), masculinity (MF), uncertainty avoidance (UA) and time orientation (TO) are described in detail in Section 2.3.1, 2.3.3 and Section 4.1. In this section, the relationships between culture dimensions and cognitive style are discussed.

A high PD score represents FD students who prefer the teacher-driven learning approach. Also, teachers are respected for their role and position. A low PD score represents FI students who prefer autonomy in their learning environment and perceived equality in the teacher and student relationship. A high IC score represents FI students who are generally self-directed learners. A low IC score represents FD students who prefer guided learning and relationships among peers are highly respected and valued. A high MF score represents FI students who are goal driven, competitive and ambitious to attain learning success. A low MF score represents FD students who are driven by cooperation and good working relationships among peers. A high UA score represents
FI students who demonstrate self-efficacy in their learning. A low UA score represents FD students who only learn within the scope of study. A high TO score represents FI students who are well disciplined, believing that time and effort will reap future rewards during their course of learning. A low TO score represents FD student who are likely to complete their assignments at the last minute.

Students’ demographic conditions, such as individual characteristics, course characteristics and computer skills, may provide added value in addition to the three main factors to predict cognitive style and learning pattern. The relationships of demographic conditions in this research model are assumed to be independent of each other and there are no higher order interactions among them.

3.3 The Survey

The survey is a common method of collecting primary data regarding a situation by questioning a representative sample of the appropriate population (Zikmund, 1997). Data are typically obtained through open-ended or closed-ended questions in surveys. Open-ended questions prompt respondents to provide answer in their own words and are frequently used for in-depth qualitative interviews. Closed-ended questions contain questions whereby respondents are asked to select an answer from a list provided (Babbie, 2010). The survey method is appropriate and useful in data collection under three conditions: “when the goals of the research call for quantitative data, when the information sought is reasonably specific and familiar to the respondents and when the researcher has prior knowledge of particular problems and the range of responses likely to emerge” (Bryman, 1984, p. 80-81). The task of writing a survey, determining the list
of questions and designing the exact format of the printed or written questionnaire, is an essential aspect of the development of a survey research design.

3.3.1 The Online Survey Method

Online or electronic surveys are now common techniques in survey methods. The rapid development of information and communication technologies (ICTs) in the globalised world has shaped the viability of this survey technique. An online survey is a computerised self-administered questionnaire. Information about the survey is transmitted to potential respondents either in the form of an email that contains an embedded link to the site of the survey or the survey itself is attached to an email for potential respondents to complete and return (Simsek & Veiga, 2000).

The quality of data collected pertaining to people and the social and cultural contexts obtained through online surveys (web or email) are similar to responses from conventional survey methods (Hamilton & Bowers, 2006; Simsek & Veiga, 2000). Online surveys facilitate survey processes particularly with access to specific groups of people. They also reduce research costs associated with time, travel, venue and data entry (Anderson & Gansneder, 1995; Hamilton & Bowers, 2006; Madge, 2007; Simsek & Veiga, 2000). The transfer of information has greater accuracy in machine-coded surveys, making data collection and analysis easier, integrated, and done in real time (Anderson & Gansneder, 1995; Hamilton & Bowers, 2006). A general disadvantage of online surveys is the restriction of data collection to populations with access to a computer and the Internet.
Considering the difficulties of sampling at two different locations and time periods, a web survey was used in this study and the web link was distributed via email. The web survey held considerable promise as an effective distribution and communication medium of collecting and analysing valuable data that minimised temporal and geographical constraints; in particular, the number of individuals reached, and the speed and the availability to individuals who use the media. It is possible that data collected from closed-ended questions may provide weaker reliability and validity of data compared to open-ended questions. This is because responses to closed questions are limited to response choices whereas responses to open-ended questions contain rich data content. Nevertheless, the online survey for this study mainly consisted of closed-ended questions since greater uniformity in responses simplifies the compilation, coding and analysis of data resulting in greater statistical reliability and measurement validity and are more easily processed than open-ended questions (Babbie, 2010). The section on students’ demographics contained open-ended questions due to the nature of possible responses.

3.3.2 Development of the Survey

The survey was based on the field dependence-independence (FDI) theoretical framework used in Lee et al. (2005) and adapted to incorporate Hofstede’s cultural dimensions, and unit evaluation and demographics (see Figure 3.3). Appendix C describes the improvements made to Lee et al.’s framework. The standardized tool (GEFT) by Witkin et al. (1977) was not used because the focus of this study was to examine FI/FD differences in various disciplines and the interdisciplinary connections.
The survey items were categorized according to the four variables investigated in this study (see Appendix A for the full survey) and the research model (Figure 3.3). Participants were asked to respond to all questions on a Likert scale of 1 to 5 (strongly agree to strongly disagree). The same types of questions were used in both semesters and research sites to gather longitudinal data. The items were as follows:

1. Cognitive Style (CS)
   - classified as FD or FI

2. Learning Dimensions
   - nonlinear learning approach (NL)
     - using a low nonlinear learning approach was classified as FD
     - using a high nonlinear learning approach was classified as FI
   - learner control (LC)
     - using fewer control features was classified as FD
     - using more control features was classified as FI
   - multiple tools (MT)
     - desiring greater navigation support was classified as FD
     - desiring less navigation support was classified as FI

3. Culture
   - Power distance (PD)
   - Individualism vs collectivism (IC)
   - Masculinity vs femininity (MF)
   - Uncertainty avoidance (UA)
   - Long term vs short term orientation (TO)
4. Unit Evaluation (EU)

- Satisfaction with unit of content and delivery
- Dissatisfaction with unit of content and delivery

In addition to questions about these four main variables, demographic questions were included. The number of questions for each variable and demographics is listed in Table 3.3.
Table 3.3 Number of Survey Questions for Each Variable

<table>
<thead>
<tr>
<th>Main Construct</th>
<th>Variable</th>
<th>Variable Code</th>
<th>Survey Question Number (number of sub-questions)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Style</td>
<td>Field Independent/Field Dependent</td>
<td>CS</td>
<td>1-4</td>
<td>4</td>
</tr>
<tr>
<td>Learning Dimension</td>
<td>Nonlinear</td>
<td>NL</td>
<td>12-20</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Learner control</td>
<td>LC</td>
<td>5-11</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Multiple tools</td>
<td>MT</td>
<td>21-28</td>
<td>8</td>
</tr>
<tr>
<td>Culture Dimension</td>
<td>Power distance</td>
<td>PD</td>
<td>29-31</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Individualism/collectivism</td>
<td>IC</td>
<td>38-40</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Masculine/feminine</td>
<td>MF</td>
<td>35-37</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Uncertainty avoidance</td>
<td>UA</td>
<td>32-34</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Short/long term orientation</td>
<td>TO</td>
<td>41-43</td>
<td>3</td>
</tr>
<tr>
<td>Evaluation of Units</td>
<td>Satisfaction with unit content</td>
<td>EU</td>
<td>44-49</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Dissatisfaction with unit content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demographics</td>
<td>Location</td>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gender, age, country of origin, nationality, ethnicity, first language, religion, marital status, employment status,</td>
<td>Individual Characteristics</td>
<td>7-8(4), 12, 13, 14, 15</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Course major, year of enrolment, enrolment type, residency status, financial situation,</td>
<td>Course Characteristics</td>
<td>8(2), 9, 10, 11, 12, 13, 14</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Computer experience introduction to computer, frequency use of computer</td>
<td>Computer Skills</td>
<td>16-18</td>
<td>3</td>
</tr>
</tbody>
</table>
3.3.3 Validity and Reliability of the Research

The greatest challenge faced by a researcher is to obtain or construct an unbiased, or at least a usable, sampling frame that allows probability sampling. It is essential that steps are taken to improve the validity (accuracy) and reliability (uncertainty) of the study involved in the sampling process as it determines the quality of the research. The use of analytical techniques can verify the effectiveness of sampling methods such as the surveys in finding a causal relationship amongst variables (Lucas, 1991), to shed light on complex situations and provide a useful description of a situation, (Shanks et al., 1993). A number of studies (e.g. Lockwood & McCaffrey, 2007; Ma, 2009; Mitra et al., 2001) that investigated the use of survey methods in cross-sectional and/or longitudinal studies have confirmed the internal validity of the instrument and the reliability of the research outcome. Detailed descriptions of cross-sectional and longitudinal studies are covered in depth in the data analysis section (Section 3.6.3). Nevertheless, a critical issue with surveys analysed quantitatively can sometimes give less insight into the processes underlying the situation under investigation than qualitative analyses, particularly if the results are to be generalized beyond the respondents surveyed. In this instance, the research design is said to lack external validity since the results cannot be generalized to groups other than those that participated in the original study. In selecting a research methodology, a trade-off is usually made between internal and external validity. This section discusses in detail the measures taken to ensure the validity and reliability of the survey and sampling procedures in this study.

Validity “refers to the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration” (Babbie, 2010, p. 153) and
reliability refers to “quality of measurement method that suggests that the same data would have been collected each time in repeated observations of the same phenomenon” (Babbie, 2010, p. 150). In other words, validity is the extent to which a measure accurately represents the concept it claims to measure and reliability is about replication or consistency of producing similar result in different circumstances. Validity can be affected by response and measurement errors; for example, a recall error can be a response error and the rounding of a measurement scale can be a measurement error.

There are three types of validity: internal (content) validity; external (criterion-related) validity; and construct validity (Maughan, 2009; Yin, 2009). According to Yin (2009, p. 40), internal validity attempts to “establish a caused relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationship”; external validity involves “defining the domain to which a study’s findings can be generalised”; and construct validity is about “identifying correct operational measures for the concept being studied”.

Reliability can be determined by three different approaches; that is, internal consistency, stability and equivalence. Internal consistency is determined by measuring variance of response in one item with the overall variance. A higher coefficient indicates a more reliable test. Stability is achieved when a test that was administered generates a similar result in a later test that measures a similar incidence. Reliability is based on the equivalence resulting from comparing the instruments used to measure the same thing (Maughan, 2009).

Measures taken to ensure the quality of this research is met are described in the following.
i) The use of multiple sources of evidence, such as quantitative and qualitative data from the survey and documentation from the unit guides, strengthens the construct validity of the research.

ii) The use of a pilot study to detect errors and limitation of the questions strengthens the construct validity of the study and enables refinements to the actual survey. A pilot study also determines the effective sample size of the study. Reliability is achieved when the sample size of the study is met.

iii) The use of pattern-matching logic strengthens the internal validity. The process involves comparing an empirically-based pattern with a predicted one and, if the patterns coincide, the internal validity is strengthened. This technique is effective for a descriptive case study only when the predicted pattern of specific variables is defined prior to the data collection (Yin, 2009). Pattern-matching logic has been applied to this study through targeting sample populations with similar traits (see Table 4.1). The greater the homogeneity of the selected sampling groups, the greater the internal validity and the lesser the measurement error.

iv) The use of the online survey software application at [http://www.SurveyMethods.com](http://www.SurveyMethods.com) is a simple procedure that does not require a software installation process. The process involves creating a monthly account for easy access and managing the subscription, creating and launching the surveys, conducting a simple analysis of the survey data, and exporting the data in Excel format via the web browser for more advanced analysis. The survey was configured with skip logic; that is, to either display or skip questions based on how previous questions were answered. Furthermore, the predefined colour palette
feature in the software application was used to configure the presentation of the survey. The Internet website link to the survey was distributed electronically via email by the course coordinators (see Section 3.4). The responses were recorded and stored in the database located at the site of the online survey and later transferred to the researcher’s database. This ensured that all participants responded in the same survey environment across both countries. These processes helped to strengthen the internal validity of this study.

v) The use of replication logic with a longitudinal study enhanced the external validity for multiple case investigations.

vi) The use of an incentive to encourage a high response rate and thus improve the reliability of the study.

vii) The use of a Likert scale of 1 to 5 for each question developed a reliable and valid scale of measure. This ensured that the estimation of the coefficient of correlation could be made among all variables. At least two replicated questions were used to determine the status of each variable. Both the reliability and validity of the study were estimated by the standard deviation between each set of replicated questions. This helped to improve the internal validity and reliability, which was achieved by increasing the sample size based on the replicates.

viii) The use of advanced statistical models (e.g. tree based regression and linear mixed effects models) extracted maximum information from the data. Tree-based regression improved the internal validity of the statistical analyses by inspecting all possible higher order interactions among all predictor variables with the response variable in a limited data survey, which multiple linear regressions
cannot do. Linear mixed effects models improved the reliability of the study through a repeated measure or a longitudinal study.

A summarized description of the measures taken to strengthen the robustness of this research is presented in Table 3.4
<table>
<thead>
<tr>
<th>Test criteria</th>
<th>Case study strategies</th>
<th>Research phase (strategies occurs)</th>
<th>Action taken in this research</th>
</tr>
</thead>
</table>
| Construct validity | - Use multiple sources of evidence  
- Establish chain of evidence  
- Have key informants review draft case study report | Data collection Composition | - Use of survey data (quantitative and qualitative) and documentation from unit guides and findings as sources of evidence  
- Conduct pilot study to detect survey errors and limitation |
| Internal validity | - Do pattern matching  
- Do explanation building  
- Address rival explanations  
- Use logic models | Data analysis | - Selection of sampling group based on similar characteristics (pattern matching)  
- Accuracy of data recording with the use of online survey  
- Longitudinal study  
- Use advanced statistical analysis to analyse data  
- Use of hypotheses to address rival explanations |
| External validity | - Use replication logic in multiple – case studies | Research design | - Multiple case investigation based on replication logic using longitudinal study |
| Reliability | - Use case study protocol  
- Develop case study database | Data collection | - Sample size determination  
- Use of a single online survey provider and same set of survey questions at both research sites ensures consistency in data collection procedure and minimize measurement errors  
- Incentives offered to improve response rate  
- Longitudinal study |

**Source:** Adapted from Yin (2009)
3.3.4 Pilot Study

A pilot study was conducted to accomplish two purposes. First, a pilot study provides the opportunity to refine the data collection by detecting errors and limitations of the questions prior to conducting the actual survey. Second, the number of responses from the pilot study was used to calculate and determine the desired sample size for the actual survey to detect an effect. The sample size determination for the actual survey is discussed in detail in Section 3.6.2.

The first half of the pilot study was conducted in May 2008 on six students at Murdoch University, Western Australia, based on cluster sampling. Similar sampling procedures were conducted on six students at the Curtin University, Sarawak, Malaysia in July 2008 for the second half of the pilot study using the same survey instrument. The cluster sampling approach was chosen to speed up the sample collection as well as to ensure that the required sample sizes for both groups were met given the project time constraints. To ensure sample collection consistency, this approach was also applied to the actual survey. Due to numerous incomplete responses in the demographic information section of the survey in Semester 1, this section underwent a minor restructure. The same types of questions were asked in a slightly different order to ease the answering process and encourage greater participant response in Semester 2. Based on the responses collected in the pilot study, a gender question was added to the demographic information section of the survey. Other than these minor changes, it was deemed that no further modification was necessary due to the usefulness of the data.
3.3.5 Timeline

Data collection commenced at Murdoch and Curtin Sarawak Universities near the conclusion of each semester and was completed during their semester break (Figure 3.4).

![Figure 3.4 Timeline of Data Collection Stages](image-url)
3.4 Participants

The participants were recruited from two universities in two countries: Murdoch University, Western Australia, and Curtin University, Sarawak, Malaysia. Students from both locations were contacted each semester by email from their respective course coordinators and invited to participate in the online survey. The email contained a web link to the online survey.

3.4.1 Murdoch University, Australia

Participants from Murdoch University were students enrolled in four different units in the School of Information Technology. The units covered the spectrum of course work within the school. Of the four units, two were first-year units (ICT105 Introduction to Information Technology and ICT108 Introduction to Multimedia and the Internet), one was a second-year unit (ICT231 Systems Analysis and Design), and one was a Masters level unit (ICT650 Information Technology Research Methodologies) in which students in their fourth year (Honours) could also enrol.

3.4.2 Curtin University, Malaysia

Participants from Curtin University Sarawak were students enrolled in Software Technology 151 and Engineering Programming 100. Both of these were first year units within the Bachelor of Technology (Computer Science) and Bachelor of Engineering programs. The students were mostly Malaysians, with a small number of international students. The entrance prerequisite for both programs was the Foundation Studies program in Engineering and Science at Curtin University, or other matriculation studies
such as General Certificate of Education (GCE) Advanced Levels from other institutions.

3.5 Ethical Considerations

Every step was taken to ensure that this study was carried out according to the institutional guidelines set by each university. The role of Murdoch University’s Human Research Ethics Committee (HREC) is to ensure that all Murdoch University research involving human participants complies with State and Federal Government standards and is conducted with the highest possible ethical integrity. This study was also carried out according to the ethical principles set by Curtin University Sarawak Ethics Committee, which also complies with Australian State and Federal Government standards since Curtin University Sarawak is affiliated to Curtin University based in Australia. Ethics applications were submitted to Murdoch HREC and Curtin Sarawak Ethics Committee on 10 September 2007 and 5 May 2008 respectively and approved on 14 December 2007 and 27 May 2008 respectively (see Appendix B).

Ethical issues associated with online surveys are similar to those of conventional survey methods (Flicker, Haans, & Skinner, 2004; Madge, 2007). Nevertheless, it is imperative for researchers conducting online surveys to be reflective in light of ethical principles as well as ethical consequences involved in human-based research by giving careful attention to the treatment and representation of research participants (Mortensen & Kirsch, 1996; Schneider, 2006). Researchers have an obligation to ensure that the knowledge acquired in such a data collection approach be guided by appropriate ethical considerations (Anderson, 1998). Ethics in research is described as a researcher’s
responsibility and accountability according to the guidelines of a set of principles and laws on how to carry out the study in an ethically responsible way (Bromseth, 2002). In short, the primary principle of ethics is to provide protection to people who participate in the research process, in terms of their rights, dignity and welfare. The main ethical issues involved in online surveys are: (i) obtaining informed consent, (ii) protection of participants’ anonymity and confidentiality, (iii) maintaining the security of the site, and (iv) incentives for participation in the survey.

3.5.1 Informed Consent

The purpose of informed consent is to treat potential participants in the study with respect and to ensure they are provided with a detailed explanation of the nature of the study and the meaning of participation to ensure that a level of common understanding has been reached (Madge, 2007; Varnhagen et al., 2005; Whitehead, 2007).

In this study, the important elements that were included in the information letter were: (i) a detailed explanation of the purpose of the study; (ii) the nature and voluntariness of participation; (iii) the participant’s right to withdraw at any time; (iv) the handling of data to avoid potential risks; (v) approximate time to complete; (vi) the contact information of the researcher and researcher’s supervisor; and (vii) the contact information of the relevant Ethics Committee in case the participants had any concerns about the project. This information was posted on the first page of the online survey website (see Figure 3.5).
The manner in which to gain consent varies with the nature of research. To address the consent issue in an online survey, it is important to question how informed is the consent obtained. The question arises whether clicking a ‘send’ button in an online survey can be considered a consent action. According to Whitehead (2007) and Varnhagen et al. (2005), as long as the required information about the survey is available on the website, the online consent does not differ from traditional survey methods of obtaining the participant’s signature on the returned consent form. Bruckman (2002, cited in Madge, 2007) suggested that participants’ consent can be obtained electronically if the risks to respondents are low; otherwise, consent must be obtained by a signature on paper and returned by mail or fax. A similar suggestion was
made by Madge (2007) who supported gaining virtual consent in an online survey by having participants download and return a signed consent form via email. However, she further argued that, in practice, this may discourage respondents and suggested an alternative way is to include a tick box ‘I accept’ on a survey webpage or an email attachment to the researcher. In this study, interested participants were directed to the consent form page when clicking on the ‘next’ button on the cover information letter page. Particular care was taken to obtain participant consent by asking respondents to click on a radio box to confirm that they had read the information sheet and agreed to participate (see Figure 3.6). Withdrawal from the online survey could be done by clicking the exit button on the web browser.
3.5.2 Protection of Participants’ Anonymity

It is a researcher’s responsibility to protect study participants from unintended harm resulting from the research. Data collected in online surveys can promote a certain degree of anonymity given that no face-to-face contact is made. However, there are some predicaments that arise and every attempt should be made to ensure participants’ protection from other users, limiting the use of the data for research purposes and ensuring that reported results do not breach confidentiality or unintentional harm to participants (Cho & LaRose, 1999; Flicker et al., 2004; Madge, 2007). In this study, efforts were made to address this issue. In addition to stating in the Information Letter
that the research project was approved and governed by the guidelines set by the universities’ Ethics Committees, it was emphasised that participants’ identification and responses would remain confidential throughout the process of the research even though this study included collecting identifiable information for the purpose of repeated measures in the research.

3.5.3 Security of the Site

Another ethical issue with online research is the security of the survey site as an online survey may contain undetected bugs or viruses. Efforts can be made to protect the site through encryption. This helps to assure participants that the information they provide will not be accessed from outside or within a site without authorization (Madge, 2007). In this study, the online survey located at SurveyMethods.com was extremely secure and guarded through encryption; for instance, the survey was launched with a URL that has a 14-digit encrypted suffix. This ensured that data collected, consisting of responses from participants, were protected and could not be located through search engines. Participants could only take the survey if the survey link was provided to them. Furthermore, access to the surveys and data were only accessible by the registered account holder. Likewise, the responses from the survey were securely stored on the server of SurveyMethods.com and were governed by their privacy policy.

3.5.4 Incentive in Participating in the Online Survey

There is considerable debate regarding the ethical appropriateness of using incentives in research with human subjects. It is important to determine whether incentives are
considered unethical. According to research by Grant and Sugarman (2004), the use of incentives to recruit and retain research subjects for the most part of research is innocuous. However, there are some instances when they are not. They claimed that incentives can become problematic “where the subject is in a dependency relationship with the researcher, where the risks are particularly high, where the research is degrading, where the participant will only consent if the incentive is relatively large because the participant’s aversion to the study is strong, and where the aversion is a principled one” (Grant & Sugarman, 2004, p. 717). In this study, two 8Gb Flash drive prize draws were used for each survey cycle as incentives. This type of incentive is considered innocuous since there was no dependency relationship between the participants and the researcher. Winners were randomly selected using a computer program. Prizes were given to the researcher’s supervisor to be handed to the winners at Murdoch University. For Curtin University, prizes were mailed to the course coordinator to be handed to the winners.

3.6 Statistical Analysis

Extensive statistical analyses were conducted on the survey data, which comprised various types of statistical methods ranging from elementary to advanced level. The first half of this section defines the response and predictor variables based on the factors investigated, and discusses the sample size determination for the survey. The second half of the section explains the cross-sectional and longitudinal study approaches, followed by description of the types of statistical tests and modelling used to analyse the survey data.
3.6.1 Definitions of the Response and Predictor Variables

This study classified the two types of variables investigated as response and predictor. An alternative terminology for a predictor variable is the independent variable and a response variable is the dependent variable. A predictor variable refers to a variable with values that are not problematic in an analysis but are taken as simply given. This variable is presumed to cause or determine a dependent variable (Babbie, 2010). A response variable is assumed to depend on or be caused by another (predictor variable).

The response variable for this study was cognitive style whilst the predictor variable consisted of five groups: (i) three learning dimensions; (ii) five culture dimensions; (iii) one unit evaluation; (iv) seventeen demographic characteristics; (v) two dimensions of time and locations. Classifications of scores for variables (i), (ii) and (ii) are presented in Table 3.6. On the Likert scale of 1 to 5, students’ response scores of >3 on the scale indicated FD characteristics and scores of <3 indicated FI characteristics. Once data were collected, standardization of the scale was adjusted according to the mean score to accurately classify students’ responses to each variable. The analyses of students’ demographic characteristics is presented as descriptive statistics, given the categorical state of the data, and excluded from the advanced statistical modelling used to predict students’ cognitive style in hypermedia learning systems. In addition, location (Australia and Malaysia) and time (first and second semesters) were considered as factor variables since this research was carried out in a cross-country setting and the surveys were conducted over two semesters.
Table 3.5 Summary of High and Low Scores of Each Variable

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>H (FD)</td>
<td>Prefers to be guided in their learning processes; employs a less analytic approach to learning; requires a more instructional guidance to assist in finding relevant and meaningful information to reduce disorientation.</td>
<td>&gt;3</td>
</tr>
<tr>
<td></td>
<td>L (FI)</td>
<td>Employs a less guided but a more analytical and autonomous approach to learning.</td>
<td>&lt;3</td>
</tr>
<tr>
<td>NL</td>
<td>H</td>
<td>Prefer linear learning structure (teacher-driven learning). Demonstrates greater social orientation.</td>
<td>&gt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Prefer nonlinear learning structure (student-driven learning). Enjoys working alone and prefers free navigation.</td>
<td>&lt;3</td>
</tr>
<tr>
<td>LC</td>
<td>H</td>
<td>Possesses a higher ability to engage in independent learning with analytical thought.</td>
<td>&lt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Relatively passive and less capable of learning independently.</td>
<td>&gt;3</td>
</tr>
<tr>
<td>MT</td>
<td>H</td>
<td>Require greater navigation support when utilising navigation tools provided.</td>
<td>&gt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Minimal navigation support when utilising navigation tools provided.</td>
<td>&lt;3</td>
</tr>
<tr>
<td>PD</td>
<td>H</td>
<td>Tightly-integrated society. Strong hierarchical order. Lecturer ranked higher than students based on knowledge and authority. Formal and passive learning environment.</td>
<td>&gt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Loosely-integrated society. Favour and practice of equality. Informal, direct and participative learning environment.</td>
<td>&lt;3</td>
</tr>
<tr>
<td>IC</td>
<td>H</td>
<td>Lacks interpersonal connection and shares little responsibility beyond family and perhaps a few close friends.</td>
<td>&lt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Students value relationship and respect their lecturers, friends and family. Prefer to work and take responsibility as a group</td>
<td>&gt;3</td>
</tr>
<tr>
<td>MF</td>
<td>H</td>
<td>Value competitiveness, assertiveness, ambition, and the accumulation of wealth and material possessions</td>
<td>&lt;3</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>Value on relationships and quality of life.</td>
<td>&gt;3</td>
</tr>
<tr>
<td>UA</td>
<td>L</td>
<td>Tolerate stress, different opinions from their own and are curious about differences and open-ended learning; prefer as few rules as possible, tend to be unemotional and contemplative.</td>
<td>&lt;3</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Does not tolerate well with stress, thus prefer rules and structured circumstances to minimise stress level, such as strict laws and rules, safety and security measures. Tend to be emotional, and are motivated by inner nervous energy.</td>
<td>&gt;3</td>
</tr>
</tbody>
</table>
### TO

<table>
<thead>
<tr>
<th>H</th>
<th>Long term oriented; looks to the future and value changes; thrift and persistence.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Short term oriented; values past and present; respect for traditions; fulfils social obligations.</td>
</tr>
</tbody>
</table>

### EU

<table>
<thead>
<tr>
<th>H</th>
<th>Indicates the objective of the unit is not clear and practical.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Indicates the unit is well-prepared and sufficient to motivate learning.</td>
</tr>
</tbody>
</table>

#### 3.6.2 Sample Size Determination

The results from the pilot study were used to estimate the required sample size for the survey. The required sample size depended on the following four factors (Zar, 1998, p. 33):

1. the minimum detectable difference;
2. the population variance;
3. the significance level of committing Type I error; and
4. the power of the test or the significance level of committing Type II error.

Both the minimum detectable difference (the difference between the two expected means from the two groups) and the population variance (the expected pooled variance from the two groups) can be estimated by determining the significant level of committing a Type I error (p=5% or less) and the significant level of committing a Type II error (p=1-20% or less implies the power of the test is 80% or more) from the pilot study results (Zar, 1998, p. 34).
3.6.3 Comparing Two Means from Two Samples

A comparison of two means from two samples can be determined by using the equations below. The purpose of comparing two means from two samples was to detect any differences within the two groups of sampled populations. In other words, if no differences were detected in the two samples, this indicates that both samples population were homogeneous.

Given two independent samples from normal distributions

\[ X_{1,i} \sim N(\mu_1, \sigma_i^2) \quad i = 1, \ldots, n_1 \]

\[ X_{2,j} \sim N(\mu_1, \sigma_j^2) \quad j = 1, \ldots, n_1 \]

where \( n_2 = kn_1 \), a two-sided test of equality of means is constructed

\[ H_0: \mu_1 = \mu_2 \]

\[ H_a: \mu_1 \neq \mu_2 \]

which is more conveniently written as

\[ H_0: \mu_2 - \mu_1 = 0 \]

\[ H_a: \mu_2 - \mu_1 \neq 0 \]

The difference of the sample means is normally distributed

\[ (\bar{X}_2 - \bar{X}_1) \sim N\left(\mu_2 - \mu_1, \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right) \sim N\left(\frac{\mu_2 - \mu_1}{n_1\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}\right) \]

which leads to the test statistics

\[ Z = \frac{\bar{X}_2 - \bar{X}_1}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \]
The derivation of the two-sample formulas proceeded along the same lines as the one-sample case, producing the following formulas:

\[ n_1 = \left( \sigma_1 + \frac{\sigma_2^2}{k} \right) \left( \frac{Z_{(\alpha/2)} + Z_{\text{Power}}}{|\mu_2 - \mu_1|} \right) \]

\[ n_2 = kn_1 \]

Table 3.6 presents a summary of means, standard deviations, p-value from two-tailed t-test, power of test, sample sizes estimated from power analysis on the students’ cognitive style (CS), three learning dimensions (NL, LC, MT), five culture dimensions (UA, PD, IC, MF, TO), and evaluation of unit (EU). The results were confirmed with p-values < 0.25 with the power of test 0.8.

**Table 3.6 Summary of Analyses**

<table>
<thead>
<tr>
<th>Name of variables</th>
<th>Mean (G1)</th>
<th>Mean (G2)</th>
<th>St. dev. (G1)</th>
<th>St. dev. (G2)</th>
<th>P-value</th>
<th>Power of test</th>
<th>Sample size of G1 (G1=G2)</th>
<th>Sample size of G1 (2xG1=G2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>2.63</td>
<td>3.25</td>
<td>0.34</td>
<td>0.35</td>
<td><strong>0.01</strong></td>
<td>0.87</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>LC</td>
<td>2.55</td>
<td>2.45</td>
<td>0.48</td>
<td>0.31</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NL</td>
<td>2.23</td>
<td>2.00</td>
<td>0.50</td>
<td>0.47</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>2.71</td>
<td>2.56</td>
<td>0.45</td>
<td>0.56</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UA</td>
<td>2.72</td>
<td>2.39</td>
<td>0.71</td>
<td>0.53</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>2.50</td>
<td>2.06</td>
<td>0.59</td>
<td>0.57</td>
<td><strong>0.21</strong></td>
<td>0.26</td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>IC</td>
<td>2.39</td>
<td>1.78</td>
<td>0.49</td>
<td>0.27</td>
<td><strong>0.02</strong></td>
<td>0.76</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>MF</td>
<td>1.78</td>
<td>1.83</td>
<td>0.46</td>
<td>0.62</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TO</td>
<td>2.28</td>
<td>2.00</td>
<td>0.44</td>
<td>0.30</td>
<td><strong>0.23</strong></td>
<td>0.25</td>
<td><strong>30</strong></td>
<td><strong>25</strong></td>
</tr>
<tr>
<td>EU</td>
<td>2.03</td>
<td>2.83</td>
<td>0.29</td>
<td>0.75</td>
<td><strong>0.03</strong></td>
<td>0.69</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

Based on the results from the pilot study, the estimated minimum number of students participation required for each group is 30 with a minimum response rate of completion from the survey of 60%. Alternatively the estimated minimum number of
students from both groups can be based on a ratio of $G_1/G_2=1/2$ with a minimum response rate of completion from the survey of 60%. Therefore, the estimated minimum number of students required in $G_1$ and $G_2$ is $25/0.6=42$ and $50/0.6=83$. It is important to note that if the rate of completion of the survey is greater than 60%, the estimated minimum number would be smaller.

In Semester 1 2008, a total of 97 students attempted the survey and the response rates of completed survey for $G_1$ (Australian) and $G_2$ (Malaysian) were $40/45=89\%$ and $37/52=71\%$ respectively. The overall response rate of the completed survey was $77/97=79\%$, which is higher than the assumed rate 60%. In addition, the number of completed surveys exceeds the overall effective sample size $25+50=75$. The effective sample size for this study was sufficient for estimation of the direct difference between two groups.

### 3.6.4 Cross-sectional and Longitudinal Studies

The quantitative element of this study was characterised by cross-sectional and longitudinal studies. A cross-sectional study is defined as “a study in which various segments of a population are sampled at a single point in time” (Zikmund, 1997, p. 215). The relationships among variables may be investigated by cross-tabulation. In general, the means of analysis is to divide the sample into appropriate subgroups. The data are analysed to see any similarities or differences occurring among the subgroups. A cross-sectional study (also known as cross-sectional analysis) forms a class of research methods that involves observation of all of a population, or a representative subset, at a defined time. They differ from case-control studies in that they aim to provide data on
the entire population under study, whereas case-control studies typically include only a sample of the population of individuals, often a tiny minority, with a specific characteristic.

A cross-sectional study additionally highlights methodological issues. It confirms, for example, the benefits of a comparative approach using equivalent samples and common data collection instruments. Most previous investigations in this area have been single nation studies between which direct comparisons are not really justified. The difficulties of comparative management research should not, however, be underestimated. As Ronen and Shenkar (1985) point out, obtaining a sample that represents the various groups, strata and organizations in a given country is almost impossible.

A longitudinal study is a survey of respondents at different points in time. The purpose is to examine continuity of responses and to observe changes that occur over time (Zikmund, 1997). An advantage of using this method is its very strong design as data are collected from a control group at different times. It addition, it provides “greater evidence of casualty, as one can measure changes in variables over time” (Lucas, 1991, p. 275). A longitudinal study that involves collecting data from the same sample of individuals over time is called a panel study (Zikmund, 1997).

3.6.5 Application of Elementary and Advanced Statistical Analyses

For the demographics section of the survey, descriptive statistics, represented by means and variances, were primarily used to interpret and summarise the participants’
characteristics. For the four main variables, a number of elementary and advanced statistical tests were used.

Elementary statistical tests, such as paired t-tests, were used to compare the means of two groups. Specifically, t-tests were used to determine any differences between Australian and Malaysian students’ cognitive style and detect any changes over time. Pearson’s product moment correlation coefficient was used to determine if the correlation between two groups of variables is either equal or not equal to zero by using a 5% significance level of committing a Type I error. In particular, Pearson correlation coefficient was used to determine the relationship of Australian and Malaysian students’ cognitive style with learning dimensions, culture dimensions and unit evaluation.

Advanced statistical models - multiple regression models (MLR), tree-based regression (TBR) and linear mixed effects (LME) - were carried out to model the relationships between the response and predictor variables. In particular, MLR were used to: determine the direct effect of all factors on Australian and Malaysian students’ cognitive style; investigate the interaction among all factors and their effect on students’ cognitive style; and investigate the effect of students’ demographic characteristics on students’ cognitive style. MLR was also used to analyse the cross-sectional study, specifically to investigate time and geographical location (Australia and Malaysia) effects on students’ cognitive style, on students’ learning dimensions, on culture dimensions and on unit evaluation in hypermedia learning. TBR were used to determine the direct effects of all factors according to their order of importance on Australian and Malaysian students’ cognitive style, and to investigate the interaction among all factors and their effect on students’ cognitive style. Lastly, the LME model was used to analyse
the longitudinal study in order to detect any changes over time and location in individual student’s cognitive style and interactions with learning dimensions, culture dimensions and unit evaluation. A detailed description of each advanced statistical model is presented in the following sub-sections.

### 3.6.5.1 Multiple Linear Regression (MLR)

In statistical modelling, the term linear model is used in different ways according to the context. The most common occurrence is in connection with regression models and the term is often expressed as a multiple linear regression (MLR) model. MLR models the relationship between the response variable, $y$, and one or several predictor variables, $x$, such that the model depends linearly on the unknown parameters, intercept and slope(s), to be estimated from the data. The random effects model, also known as mixed effects model, multilevel model and variance components model, is a kind of a hierarchical model.

Both Akaike Information Criteria (AIC) (Akaike, 1974) and Bayesian Information Criteria (BIC) (Schwarz, 1978) were used to select the best subset of predictor variables within the multiple regressions models. The predictor variable consisted of five groups as described in Section 3.6.1. The response variable was cognitive style. For the MLR model, the variables are assigned as follows:

- $y_i$ be the response variable of student $i$,
- $x_i$ be the predicted variable of student $i$, and
- $z_i$ be the covariate of student $i$ ($z_i = 0$ (Malaysia) or 1 (Australia)).
In this study, $y_i$ is the CS. $x_i$ can be one of the five culture dimensions, one of the three learning dimensions, the unit evaluation, or time when the survey was conducted.

The general trend of CS can be modeled as

$$y_i = \alpha_0 + \beta_0 x_i + \gamma_0 z_i + \epsilon_i,$$

where $\alpha_0, \beta_0, \gamma_0$ are the unknown intercept and slope of the regression, and unknown coefficient for the group effect, $\epsilon_i \sim \text{NID}(0, \sigma^2)$. NID stand for normally independently distributed.

### 3.6.5.2 Tree-based Regression (TBR)

In addition to the use of MLR, tree-based regression was used to study the effects of higher order interactions of the predictor variables on the response variable. The automatic construction of a decision tree was first used in the social sciences field by Morgan and Sonquist (1963). The tree-based method (Breiman, Friedman, Olshen, & Stone, 1984) is an alternative to generalized linear models and multiple regression models, linear logistic regression models and generalized additive models (Watters & Deriso, 2000). This model is also best suited to carry out statistical analyses on limited data. These types of models are fitted by binary recursive partitioning of a dataset into increasingly homogeneous subsets until it is infeasible to continue. Their use has been increasingly widespread in other fields such as the social sciences (Morgan & Sonquist, 1963), statistics (Breiman et al., 1984) and machine learning (Quinlan, 1979; 1983; 1986; 1993). The advantages of tree-based regression are:

- easier to interpret a set of predictor variables containing a mixture of numeric variables and factors in contrast to linear models;
• will not predict or grow nodes when there is insufficient data;
• robust and monotonic behaviour of predictor variables; and
• the standard linear model does not allow interactions between predictor variables unless they are of a multiplicative form.

3.6.5.3 Linear Mixed Effect (LME)

The linear mixed effects (LME) model is an extension to the linear model in which the linear predictor contains random effects in addition to the usual fixed effects. These random effects are usually assumed to have a normal distribution. A mixed-effects model (Laird & Wares, 1982; Pinheiro, 1994; Pinheiro & Bates, 2000) is a generalization of the standard linear model (a multiple regression model) and nonlinear models (a multiple nonlinear regression) that enables the analysis of data generated from several sources of variation instead of just one. It associates one continuous dependent variable (a response or an outcome) with several explanatory variables (categorical or continuous). The unique aspect of the mixed-effects model is the inclusion of both fixed and random factors. Fixed effects provide estimates of the average responses in the group, like in a common regression model, while random effects (e.g. subjects’ effects) account for the natural heterogeneity in the responses of different individuals and allow an estimation of responses for each individual in the study (Zieffler & Garfield, 2009). Since measurements done on the same subject are correlated, this correlation must be taken into account in modelling. The dependence among the repeated responses can be of different types, leading to specific covariance/correlation structures. The model allows the assumption of several covariance structures and enables estimation of the
effects as well as variance parameters. The number of observations per subject can be either the same (a balanced design) or different (an unbalanced design). The time points can be either identical across subjects or not. The time interval between repeated observations can vary across repetitions (Lindskey, 1993).

For the MLR model, the variables are assigned as follows:

\( y_i \) be the response variable of student \( i \),

\( x_i \) be the predicted variable of student \( i \), and

\( z_i \) be the covariate of student \( i \) \((z_i = 0 \text{ (Malaysia)}oor 1 \text{ (Australia)})\).

In this study, \( y_i \) is the CS. \( x_i \) can be one of the five culture dimensions, one of the three learning dimensions, the unit evaluation, or time when the survey was conducted.

The general trend of CS can be modeled as

\[
y_i = \alpha_0 + \beta_y x_i + \gamma z_i + \varepsilon_i,
\]

where \( \alpha_0, \beta_y, \gamma \) are the unknown intercept and slope of the regression, and unknown coefficient for the group effect, \( \varepsilon_i \sim \text{NID}(0, \sigma^2) \). NID stands for normally independently distributed.

For the LME model, the variables are assigned as follows:

\( y_{ij} \) be the response variable of student \( i \) at year \( j \),

\( x_{ij} \) be the predicted variable of student \( i \) at year \( j \), and

\( z_i \) be the covariate of student \( i \) \((z_i = 0 \text{ (Malaysia)}oor 1 \text{ (Australia)})\).

In this study, \( y_{ij} \) is the CS. \( x_{ij} \) can be one of the five culture dimensions, one of the three learning dimensions, the evaluation of unit, or the time of the survey.

The general trend of CS can be modeled as:
\[ y_{ij} = \alpha_i + \beta_i x_{ij} + \gamma z_i + \varepsilon_{ij}, \]

where \( \gamma \) is the unknown coefficient for the group effect.

The unknown \((\alpha_i, \beta_i)\) was modeled as a bivariate distribution with a mean \((\mu_\alpha, \mu_\beta)\) and variance-covariance matrix \(\Sigma\). By doing so, the intercept \(a_i\) is allowed to be correlated with the trend \(b_i\). The error vectors \(\varepsilon_i\) are assumed to be distributed as \(N(0, \sigma^2 I)\). The choice \(E_i = I\), where \(I\) is the identity matrix, corresponds to the case of no serial correlation.

Both Akaike’s Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Akaike, 1974; Schwarz, 1978) were used to select the best LME model. The best sub-model can be determined when all the estimated coefficients are significant \((p<0.05)\) with the minimum information value from all above information criteria. In addition, a comparison of the fitting results of both LME and MLR models with the information criteria is essential to determine the best model in representing the data.

3.7 Conclusion

This chapter discussed various research methodologies to determine the most appropriate method to conduct this study. A mixed method design, specifically case study and survey methods, was considered to be the most appropriate to address the multiple case study and cross-disciplinary inquiry. This chapter detailed the development and process of the research design, including ethical considerations. Finally, the statistical methods used to analyse the survey data were discussed. The use of rigorous statistical analyses helps to enrich the interpretive process in case study
research as well as to enhance the validity and reliability of the findings. The next chapter will discuss the method and criteria used for selecting cases.
Chapter 4

CASE STUDIES

The first section of this chapter describes the selection method and criteria used to determine the appropriate research sites for the case study. The remaining sections are overviews of the two case studies with detailed descriptions of the embedded cases (units sampled from both research sites).

4.1 Case Study Selection Method and Criteria

Early selection of research sites helps to facilitate both the design and implementation of the case study. The selection of research sites for this multiple-case study was carried out according to a pattern-matching logic technique. It involved selecting sampling groups that possessed similar characteristics. Pattern matching logic is effective for descriptive case studies only when the predicted pattern of specific variables is defined prior to the data collection (Yin, 2009). This technique helps to strengthen a case study’s internal validity. Recruitment of participants based on pattern matching logic can be conducted through cluster sampling. The preference for carrying out cluster sampling rather than random sampling was due to the constraint of selecting groups of populations with similar characteristics. Hence, the greater the homogeneity of the selected sampling groups, the greater the internal validity of this study would be (see Section 3.3.3 for a more detailed discussion of the validity and reliability of case studies). The following sections discuss in detail the pattern matching process and the justification of the research sites selected for this study. The process is summarized in Table 4.1.
Table 4.1 Summary of Research Criteria and Research Sites Selected

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cross-country setting</td>
<td>Australia</td>
<td>Malaysia</td>
</tr>
<tr>
<td>2. Hypermedia learning environment (partly or entirely delivered through the Internet)</td>
<td>Use of hypermedia (WebCT later transferred to Blackboard)</td>
<td>Use of hypermedia (WebCT later transferred to Moodle)</td>
</tr>
<tr>
<td>3. Homogeneous target sampling group</td>
<td>Students enrolled in IT related units</td>
<td>Students enrolled in IT related units</td>
</tr>
<tr>
<td>4. Academic program</td>
<td>Awarded degrees are accredited by the Australian education system</td>
<td>Awarded degrees are accredited by the Australia education system</td>
</tr>
<tr>
<td>5. Proportion of resident students</td>
<td>Approximately 85%</td>
<td>Approximately 84%</td>
</tr>
</tbody>
</table>

i) **Cross-country research setting.** Murdoch University and Curtin University Sarawak were ideal research settings as they were situated in two contrasting countries: Australia and Malaysia.

ii) **Hypermedia (LMS).** Both universities used the same hypermedia system (WebCT) for managing and delivering their instructional and learning materials to students with a combination of face-to-face educational environments. Due to unforeseen circumstances, after the research proposal and research site selections were confirmed, WebCT was acquired by Blackboard. When Curtin University Sarawak’s license agreement expired with WebCT (now Blackboard), they decided to use Moodle, which was an open-source application of a hypermedia system. Murdoch University, however, decided to use Blackboard, a commercial hypermedia system. Nevertheless, both universities still relied on hypermedia to supplement their face-to-face educational environment.
iii) *Homogeneous target sampling group.* The target sampling groups comprised of students enrolled in IT-related units. The homogenous disciplines facilitated a comparative study between the two case studies.

iv) *Academic program.* Although the universities were situated in two different countries, their programs were similar as Curtin University Sarawak is an Australian accredited university located in Malaysia.

v) *Student ratio.* Both universities had similar proportions of non-resident versus resident students. The proportions of resident (domestic) students from both universities were fairly close (84% for Murdoch University and 85% for Curtin University Sarawak), which was ideal to make a comparative study.

Although both research sites were selected on similar characteristics, it is important to note that the students differed greatly in cultural background. Cultural differences at the research sites were intended to be studied as independent variables and thus would not impede the internal validity of this study. However, while there were wide cultural differences in the students’ background, both universities used similar tertiary curricula since they were Australian accredited. Hence, both universities were ideal research sites to investigate cultural differences. This section describes the national cultural differences of the research sites based on Hofstede’s five dimensions (Figure 4.1) (see also Sections 2.3.1, 2.3.3 and 3.2).

i) *Power Distance (PDI).* Malaysia’s PDI score (104) is considered high and Australia’s PDI score (36) is considered low when compared to the world average score (55). Malaysia’s score indicates a tightly integrated society that accepts a
hierarchical order in which inequalities among people is acceptable. Centralisation of power is commonly practised in the government, organizations and the family. Australia’s score, on the other hand, indicates greater equality at a loosely integrated societal level, including the government, organizations and the family. Communication between superiors and subordinates are commonly informal, direct and participative.

ii) *Individualism (IDV).* Australia has a remarkably high IDV score (90) that is well above the world average (40) while Malaysia has a relatively low IDV score (26). Australia’s score indicates a highly individualistic culture suggesting a loose-knit society where people are self-reliant and display initiative. In contrast, Malaysia’s score indicates a strong collectivistic culture, promoting a close-knit society based on long-term that can include family, extended family and extended relationships.

iii) *Masculinity (MAS).* Australia’s MAS score (61) is a little higher than Malaysia’s score (50) and the world average score (50). This indicates that Australians are driven by competition, ambition, achievement, success, assertiveness and accumulation of wealth and material possessions. The lower masculinity score in Malaysia indicates a society in which achievement is attained based on close relationships rather than tangible success (Manikutty et al., 2007); a value system that typically begins in school and continues throughout life.

iv) *Uncertainty Avoidance (UAI).* Australia’s UAI score (51) and Malaysia’s UAI score (36) are well below the world average (63). Although Australia’s score is relatively higher in this dimension, it does indicate a fairly pragmatic culture in which people in general are fairly relaxed in terms of accepting new ideas and a
willingness to try different things. The surprisingly low score for Malaysia may be attributed to a high PDI in which inequalities of power with a strongly based ruled-oriented governance system enable people to tolerate uncertainty.

v) **Long Term Orientation (LTO).** Australia’s LTO score (31) is below the world average (45), which suggests that Australians value traditions and fulfilling social obligations. No score is available for Malaysia’s LTO.

![Figure 4.1 Hofstede’s (2009) Cultural Dimensions in Australia and Malaysia Compared to World Average Scores](image)

**Figure 4.1** Hofstede’s (2009) Cultural Dimensions in Australia and Malaysia Compared to World Average Scores

### 4.2 Overview of Case Studies

As mentioned previously, the two research sites were Murdoch University, Australia and Curtin University Sarawak, Malaysia. Accessibility to both sites was possible due to the willingness and cooperation of the lecturers to approach and encourage their students.
to take part in the survey. Each case study consisted of a number of embedded cases (Figure 4.2). At Murdoch University, the embedded cases were units offered by the School of Engineering and Information Technology. There were two first-year units (ICT105 Introduction to Information Technology and ICT108 Introduction to Multimedia and the Internet), one second-year unit (ICT231 Systems Analysis and Design), and one Masters level unit (ICT650 Information Technology Research Methodologies). The latter unit is also one in which students in their fourth year (Honours) could enrol. At Curtin University Sarawak, the embedded cases were units offered by the School of Engineering. There were two first-year units (Software Technology 151 and Engineering Programming 100). Information about these units is provided after a brief introduction to each university.

![Diagram of case studies](image)

**Figure 4.2** Case Studies Featured in this Study

### 4.3 Murdoch University

Murdoch University is a public university in Perth, Western Australia. The main campus is located on South Street in the suburb of Murdoch. It commenced operations as the state's second university in 1973, and accepted its first students in 1975. Murdoch
University is a research intensive institution and a member of Innovative Research Universities Australia. Murdoch University is nationally recognised for its learning and teaching excellence and is therefore ranked as one of Australia’s top learning and teaching universities. It is one of only 12 universities to have received funding through the Learning and Teaching Performance Fund (LTPF), an Australian Government initiative to recognize and support excellence in universities. In 2008, Murdoch University had 16,770 enrolled students. In the same year, the university received a four-star rating in graduate outcomes, indicating that graduates from Murdoch University are attractive to prospective employers. Murdoch University has also received a five-star rating from the Good Universities Guide for graduate satisfaction 13 times in 16 years. Murdoch University has a number of off-shore campuses including Dubai, Malaysia, Singapore and Japan. Students from these campuses receive identical degrees to those from the main campus in Australia. Assignments are set and moderated by academic staff in Perth to ensure that they meet and fulfill the academic standards required for completion of a Murdoch University qualification. Academics from Perth visit the off-shore campuses on a regular basis for quality audit and for consultations on various academic and administrative issues. The school offers excellent undergraduate and postgraduate programs in Computer Science and Information Systems in which students can pursue in a variety of specialised and cross-disciplinary areas (Murdoch University, 2008).
4.3.1 Hypermedia Learning System at Murdoch University

Murdoch University used a hypermedia learning system known as Blackboard to supplement the students’ face-to-face educational environment. It was a licensed internet-based education software developed by Blackboard Inc., an enterprise software company based in Washington, DC, USA. When students logged on to MyUnits, they were presented with a list of units in which they were enrolled for the semester. Students could then select an individual unit to gain access to the unit course materials including unit information, learning guide, readings and audio recordings of lectures via Lectopia. This hypermedia learning system not only provided students with secure access to a range of online learning resources on and off campus, it also enabled the unit coordinator and IT technicians to directly administer, manage and support student education and services. Table 4.2 summarises the characteristics of Murdoch University’s hypermedia learning system.

Table 4.2 Characteristics of Murdoch University’s Hypermedia Learning System

<table>
<thead>
<tr>
<th>Features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course content</td>
<td>Electronically available and downloadable unit information, learning guides, lecture notes, audio recordings of lectures (via Lectopia), assessment policy, laboratory materials, assignment instructions and other learning materials accessible on and off campus via the internet.</td>
</tr>
<tr>
<td>Announcement</td>
<td>View latest announcement posted by unit coordinator/lecturer/tutor in electronic form.</td>
</tr>
<tr>
<td>Assignments</td>
<td>A tool used to submit assignments electronically.</td>
</tr>
<tr>
<td>Calendar</td>
<td>Serves as a notification tool to students regarding important information and dates relating to coursework.</td>
</tr>
<tr>
<td>Discussions</td>
<td>Forums for online discussions.</td>
</tr>
<tr>
<td>Search</td>
<td>A navigation tool to search within the unit website.</td>
</tr>
<tr>
<td>Web Links</td>
<td>List of recommended online resources with links to assist student learning.</td>
</tr>
</tbody>
</table>

The following sections describe the four units surveyed at Murdoch University.
4.3.2 ICT105 Introduction to Information Technology

ICT105 Introduction to Information Technology was a core unit for students enrolled in the following Bachelor degrees:

- Accounting (BCom)
- Cyber Forensic (BSc)
- Information Security and Management (BSc)
- Environmental Science (BEnvSc, BSc)

The number of students enrolled in this unit in Semester 1, 2008 was 174 of whom 165 were internal and 9 external students. Internal students refer to students studying on-campus whereas external students refer to students studying off-campus. In Semester 2 the enrolment was 31, all of whom were external students. This unit introduced students to information technology focusing on the fundamentals of computer technologies and their importance for information processing applications in a wide range of disciplines. Students gained practical skills through laboratory sessions using Microsoft Office software including word processing, spreadsheets, databases and presentation graphics. In addition to the generic information provided on Blackboard (see Section 4.3.1), there were relevant materials such as practical manuals and practical data files (Figure 4.3).
Students were expected to attend a 2-hour lecture and a 1-hour laboratory each teaching week, read and review the recommended textbook and other suggested reading materials, and submit all assignments to the Blackboard site using the in-built assignment tool. Assignments, practical tests and the exam were based on unit material as detailed in Table 4.3.

Table 4.3 Assessment Components of ICT105

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Description</th>
<th>Marks</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Choice Test</td>
<td>Test topic of 1-4</td>
<td>10%</td>
<td>During Week 5</td>
</tr>
<tr>
<td>Assignment 1</td>
<td>Questions and cases from Topic 1-4</td>
<td></td>
<td>End of Week 5</td>
</tr>
<tr>
<td>Pratical Test 1</td>
<td>Complete tasks using MS Word and PowerPoint</td>
<td>15%</td>
<td>At your normal practical session in Week 7</td>
</tr>
<tr>
<td>Practical Assignment 1</td>
<td></td>
<td></td>
<td>End of Week 7</td>
</tr>
<tr>
<td>Assignment</td>
<td>Excel problem</td>
<td>10%</td>
<td>Wednesday Week 12</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------</td>
<td>-----</td>
<td>-------------------</td>
</tr>
<tr>
<td>Assignment 2</td>
<td></td>
<td></td>
<td>Wednesday Week 12</td>
</tr>
<tr>
<td>Practical Test 2</td>
<td>Complete tasks using MS Excel and Access</td>
<td>15%</td>
<td>At your normal practical session in Week 14</td>
</tr>
<tr>
<td>Practical Assignment 2</td>
<td></td>
<td></td>
<td>End of Week 14</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Multiple choice and short answer</td>
<td>50%</td>
<td>University examination period</td>
</tr>
</tbody>
</table>

### 4.3.3 ICT108 Introduction to Multimedia and the Internet

ICT108 Introduction to Multimedia and the Internet was a core unit for students enrolled in the following Bachelor degrees:

- Business Informatics (BBusInformatics)
- Business Information Systems (BSc)
- Cyber Forensic, Information Security and Management (BSc)
- Internet Software Management (BSc)

ICT108 was also an elective unit for students undertaking Graduate Diploma in Education Studies minor in:

- Digital Marketing
- Internet and Multimedia Computing
- Internet Computing
- Science Communication

The number of students enrolled in this unit in Semester 1, 2008 was 65 of whom 54 were internal and 9 were external students. In Semester 2, the enrolment was 54 of whom 42 were internal and 12 were external students. This unit introduced students to the concept of multimedia and its role on the Internet. Specific topics included the nature of multimedia and types of multimedia objects, components of multimedia systems, web
authoring, multimedia delivery tools, multimedia applications and societal implications of multimedia. Students enrolled in this unit were expected to gain practical skills by developing multimedia applications using XHTML/HTML, CSS, JavaScript, animation, sound and video. In addition to the generic information provided on Blackboard (see Section 4.3.1), there were lecture notes, laboratory materials, and additional resources (see Figure 4.4).

Figure 4.4 ICT108 Introduction to Multimedia and the Internet Homepage (Blackboard)

The estimated time to study for this unit was 10-12 hours per week, which included lecture/tutorial attendance, reading from the recommended textbook, suggested reading materials and supplementary reading from other sources and assignment preparation. Students were expected to attend a 2-hour lecture and a 2-hour tutorial session each week, and submit all assignments to the Blackboard site using the in-built assignment tool. Assignments, practical tests and the exam were based on unit material
and students participated in online discussions on two relevant topics using the Blackboard forum (Table 4.4).

Table 4.4 Assessment Components of ICT108

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Description</th>
<th>Marks</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>XHTML homepage</td>
<td>15%</td>
<td>Submit and upload to LMS by 12 pm, Monday 7 April (Week 8)</td>
</tr>
<tr>
<td>Topic exercises</td>
<td>Lab exercises</td>
<td>5%</td>
<td>The tutorial session in the following week.</td>
</tr>
<tr>
<td>Online forum</td>
<td>Online forum participation on two topics</td>
<td>10%</td>
<td>Week 8 and 9</td>
</tr>
<tr>
<td>Project</td>
<td>XHTML homepages on your selected topic</td>
<td>30%</td>
<td>Submit by 12pm and upload to LMS by 8pm Friday May 28 (Week14)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Multiple choice and short answer</td>
<td>40%</td>
<td>University examination period.</td>
</tr>
</tbody>
</table>

4.3.4 ICT231 Systems Analysis and Design

ICT231 System Analysis and Design was a second year core unit for students enrolled in the following Bachelor degrees:

- Business Informatics (BBusInformatics)
- Business Information Systems (BSc)
- Computer Science (BSc)
- Cyber Forensic, Information Security and Management (BSc)
- Internet Computing (BSc)

ICT231 was also an elective unit for students undertaking Graduate Diploma in Information Systems or Graduate Diploma in Computer Studies minor in:

- Computer Science
- Foundations of Information Systems
- Software Quality and Reliability
The prerequisites for this unit were successful completion of ICT105 Introduction to Information Technology or ICT102 Introduction to Computer Science or ICT108 Introduction to Multimedia and the Internet.

The number of students enrolled in this unit in Semester 1, 2008 was 98 of whom 75 were internal and 13 external students. In Semester 2, the enrolment was 11, all of whom were external students. This unit introduced the fundamentals of system analysis and design with the focus on understanding the processes involved in solving information systems issues in organisations. Specific topics covered in the unit included systems analysis and design, project management, data and process modelling, object oriented modelling and design, user interface design, and system construction and implementation. In addition to the generic information provided on Blackboard (see Section 4.3.1), there was the study schedule, lecture materials, and tutorial information (see Figure 4.5).

![Figure 4.5 ICT231 Systems Analysis and Design Homepage (Blackboard)](image-url)
The estimated time to study for this unit was 10-12 hours per week, which included lecture/tutorial attendance, reading from the recommended textbook, supplementary reading from other sources and assignment preparation. Students were expected to attend a 2-hour lecture and a 2-hour tutorial session each week, and submit all assignments to the unit’s Blackboard site using the in-built assignment tool. Assignments, practical tests and the exam were based on unit material and the students were also expected to participate in tutorial discussions or submit tutorial solutions (Table 4.5).

**Table 4.5 Assessment Components of ICT231**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Description</th>
<th>Marks</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>Extended response questions</td>
<td>20%</td>
<td>Week 8 - Friday 11 April</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>Extended response questions</td>
<td>20%</td>
<td>Week 14 - Monday 9 May</td>
</tr>
<tr>
<td>Tutorial participation (internal student) OR (internal and external student) who could not attend tutorial class.</td>
<td>Submission 1 Tutorial 1-5 Submission 2 Tutorial 6-11</td>
<td>10%</td>
<td>Submission 1: Monday 31 March (Week 7) Submission 2: Friday 23 May (Week 14)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Multiple choice, short answer, extended response</td>
<td>50%</td>
<td>Assessment period</td>
</tr>
</tbody>
</table>

**4.3.5 ICT650 Information Technology Research Methodologies**

ICT650 Information Technology Research Methodologies was core unit for students enrolled in the following degrees:

- Honours in Information Systems (BSc(Hons))
- Honours in Computer Science (BSc(Hons))
- Honours in Games Software Design and Production (BSc(Hons))
- Honours in Games Technology (BSc(Hons))
The number of students enrolled in this unit in Semester 1, 2008 was 20, all of whom were internal students. This unit was not offered in Semester 2, 2008. The unit introduced various types of research approaches and methods used in the field of Information Technology with the focus on issues such as problem formulation, theory construction, research design, measurement and validity. In addition to the generic information provided on Blackboard (see Section 4.3.1), there was the study schedule, lecture materials and tutorials (see Figure 4.6).

![Figure 4.6 ICT650 Information Technology Research Methodologies Homepage (Blackboard)](image)

Each week, students were expected to attend a 3-hour class session, read chapters from the textbook, supplementary reading in the reserve section of the library and use
the library’s database to search for journal articles and conference papers. Students were expected to submit all assignments to the unit’s Blackboard site using the in-built assignment tool. Assignments and the exam were based on unit material and the students were also assessed on participation and weekly exercises (Table 4.6).

**Table 4.6 Assessment Component of ICT650**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>10%</td>
<td>Week 5 - Thursday 20 March</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>20%</td>
<td>Week 9 - Friday 18 April</td>
</tr>
<tr>
<td>Research project</td>
<td>20%</td>
<td>Week 14 - Friday 23 May</td>
</tr>
<tr>
<td>Participation and weekly exercises</td>
<td>10%</td>
<td>Weekly</td>
</tr>
<tr>
<td>Final Exam</td>
<td>40%</td>
<td>Examination period</td>
</tr>
</tbody>
</table>

**4.4 Curtin University Sarawak**

Curtin University of Technology is also a public university in Perth, Western Australia. In 1999, the university, in a joint venture with the Sarawak State Government, set up a campus in Miri, Sarawak, Malaysia. Curtin University Sarawak is owned and managed by Curtin (Malaysia) Sdn Bhd of which 90% is owned by Sarawak State Government agencies. Curtin University Sarawak offers identical degree courses to those at the Curtin University’s main campus in Perth. The establishment of the university in Malaysia was the Sarawak State Government’s initiative to provide local and international students the opportunity to receive excellent yet affordable higher education. The awarded degrees are accredited by the Australian education system. Every aspect of the academic programs, including course materials and examinations, is identical to the Curtin University’s programs in Perth. Examinations are set and moderated at Curtin's main campus to ensure that they meet and fulfill the academic
standards required for completion of a Curtin qualification. Like Murdoch University, academics from Curtin University visit the Sarawak campus on a regular basis for quality audit and consultations on various issues. In 2002, Curtin University Sarawak moved into their Lutong Campus and was recognised as the first and largest international campus in Malaysia. It is also well known particularly for its world-class facility with stylish architecturally-designed buildings equipped with state-of-the-art equipment and facilities and sophisticated IT linkages to provide student access to the resources of the main campus in Perth. It had 2434 students enrolled in 2008 of whom 339 students were international students representing approximately 40 countries.

The students surveyed in this research were those enrolled in the units Software Technology 151 and Engineering Programming 100 which were offered by the School of Engineering.

4.4.1 Hypermedia Learning System in Curtin University Sarawak, Malaysia

Curtin University Sarawak used Moodle as their hypermedia learning system to supplement students’ face-to-face educational environment. Moodle was an open source Internet-based educational learning software platform. Moodle stands for Modular Object Oriented Dynamic Learning Environment (Module, 2008). However, Curtin University in Perth used Blackboard. Although the campuses used different hypermedia learning systems, they still served their purpose as an online delivery tool for students. When students logged on to Moodle, they were presented with a list of units in which they were enrolled for the semester. Students could then select an individual unit to gain access to the unit course materials including unit information, learning guide, and other
sources of learning materials and links. This hypermedia learning system not only provided students with secure access to a range of online learning resources on and off campus, it also enabled the unit coordinator and IT technicians to directly administer, manage and support student education and services. Table 4.7 summarises the characteristics of Curtin University Sarawak’s hypermedia learning system.

Table 4.7 Characteristics of Curtin University Sarawak’s Hypermedia Learning System

<table>
<thead>
<tr>
<th>Main Features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>My Courses</td>
<td>Electronically available and downloadable unit information, learning guides, lecture notes, tutorial, assignments, weekly learning materials and other learning resources accessible on and off campus via the internet.</td>
</tr>
<tr>
<td>Blog Menu</td>
<td>Allow student to access blog and post entry.</td>
</tr>
<tr>
<td>Discussion</td>
<td>Forum for online discussions.</td>
</tr>
<tr>
<td>Messages</td>
<td>Allow student to send and exchange messages to lecturers and other students enrolled in the unit.</td>
</tr>
<tr>
<td>Useful Reminder</td>
<td>General information on how to login Moodle Curtin.</td>
</tr>
<tr>
<td>Calender</td>
<td>Fast and convenient reference to dates.</td>
</tr>
<tr>
<td>Search For</td>
<td>Search engine customised to search for keywords related to Curtin Sarawak Malaysia.</td>
</tr>
<tr>
<td>Blackboard</td>
<td>Link to Curtin’s blackboard portal.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual Unit Home Page Features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>My Courses</td>
<td>Access to the learning materials from teaching week 1-14: - Unit outline - Lecture notes - Laboratory materials - Assignments (information/tools for online submission)</td>
</tr>
<tr>
<td>News Forum</td>
<td>View latest announcement posted by unit coordinator/lecturer/tutor in electronic form.</td>
</tr>
<tr>
<td>Forum Search Engine</td>
<td>A navigation tool to search within forum discussion.</td>
</tr>
<tr>
<td>Grades</td>
<td>View grades on assignments and mid-year exams.</td>
</tr>
<tr>
<td>User Profile</td>
<td>Allows users to: - edit profile - edit post and discussion on forum - create a blog entry - activity reports</td>
</tr>
<tr>
<td>Resources</td>
<td>Quick overview and access to course learning materials</td>
</tr>
<tr>
<td>Participants</td>
<td>View participants enrolled in the unit.</td>
</tr>
</tbody>
</table>

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The following sections describe the two units surveyed at Curtin University Sarawak.

4.4.2 Software Technology 151

Software Technology 151 was core unit for students enrolled in the following degrees:

- Information Systems (BSc)
- Computer Science (BSc)
- Software Engineering (BSc)

The number of students enrolled in this unit in Semester 1, 2008 was 21, all of whom were internal students. It was not offered in Semester 2. This unit introduced students to Unix and Java programming. The learning outcomes on completion of the unit include:

(i) apply the knowledge of basic science and engineering fundamentals; (ii) demonstrate in-depth competence in the discipline of software engineering; (iii) identification of problem and solution formulation; (iv) understand and apply professional and ethical responsibilities; (v) in-depth technical knowledge of computer science; and (iv) awareness of the issues associated with changes in technology as well as the ability to adapt to those changes. In addition to the generic information provided on Moodle (see Section 4.4.1), students were expected to access unit materials such as lecture notes and other important announcement on a regular basis (see Figure 4.7).
Students were expected to attend a 2-hour lecture and a 3-hour tutorial/laboratory session each week and submit all assignments to the unit’s Moodle website using the in-built assignment tool. They were also expected to independently read and study supplementary material widely available information on the internet. Detailed assessment components are listed in Table 4.8.

**Table 4.8 Assessment Components for Software Technology 151**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheet Test 1</td>
<td>7.5%</td>
<td>3rd April</td>
</tr>
<tr>
<td>Worksheet Test 2</td>
<td>7.5%</td>
<td>1st May</td>
</tr>
<tr>
<td>Worksheet Test 3</td>
<td>7.5%</td>
<td>15th May</td>
</tr>
<tr>
<td>Worksheet Test 4</td>
<td>7.5%</td>
<td>22nd May</td>
</tr>
<tr>
<td>Final Exam</td>
<td>70%</td>
<td>Exam period</td>
</tr>
</tbody>
</table>
4.3.2 Engineering Programming 100

Engineering Programming 100 was a core unit for the Bachelor of Engineering Pre-major. The Bachelor of Engineering pre-major prepares students for the entry to the second year of any engineering disciplines, including:

- Chemical Engineering
- Petroleum Engineering
- Electronic and Communication Engineering
- Electrical Power Engineering
- Computer System Engineering
- Software Engineering
- Mechanical Engineering
- Mechatronic Engineering
- Civil and Construction Engineering

The number of students enrolled in this unit in Semester 1, 2008 was 60, all of whom were internal students. In Semester 2, the enrolment was 138 all of whom were internal students. This unit introduced students to computer programming and its relevance to the engineering field. The learning outcomes on completion of the unit include: (i) ability to articulate the relevance of computer programming for all engineers; (ii) apply logic, rigour and discipline in writing the solution to a problem as a sequence of distinct and unambiguous instructions; (iii) translate the solution sequence of a problem into a set of commands to create a simple program; (iv) compile, debug, run and validate simple computer programs; and (v) identify and explain in which situations it is beneficial to write a computer program to generate the solution to a given problem. In addition to the generic information provided on Moodle (see Section 4.4.1), students were expected to access unit materials such as lecture notes and other important announcement on a regular basis (see Figure 4.8).
Students were expected to attend a 1-hour lecture and a 2-hour laboratory session each week and submit all assignments to the unit’s Moodle website using the in-built assignment tool. The detailed assessment components are listed in Table 4.9.

Table 4.9 Assessment Components for Engineering Programming 100

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>20%</td>
</tr>
<tr>
<td>Mid Semester Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>60%</td>
</tr>
</tbody>
</table>

4.5 Conclusion

Murdoch University and Curtin University Sarawak were the two case studies selected as research sites for this study. The Murdoch University case study comprised four embedded cases (ICT105, ICT108, ICT231 and ICT650) and Curtin University Sarawak comprised two embedded cases (Software Technology 151 and Engineering Programming 100). The process of pattern-matching logic technique was used in the
selection of research sites and assessed according to five criteria; specifically, cross-
country setting, hypermedia learning systems, homogenous target sampling group, 
academic program and proportion of resident students. The hypermedia learning 
systems used in the case studies were outlined, accompanied by a detailed description of 
each embedded case. The case studies were selected based on similar characteristics but 
different cultures so that the impact of culture on cognitive style and hypermedia could 
be investigated. The next chapter reports the demographics of the participants in both 
case studies.
5.1 The Survey

The number of students who participated in the online surveys was 187, of whom 97 students took part in the Semester 1 survey and 99 students took part in the Semester 2 (Table 5.1). Among them, a total of 22 students were repeated survey participants.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Australia</td>
<td>15 Male</td>
<td>25 Female</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>13 Male</td>
<td>24 Female</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>21 Male</td>
<td>24 Female</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>23 Male</td>
<td>18 Female</td>
</tr>
<tr>
<td>Repeated</td>
<td>Australia</td>
<td>6 Male</td>
<td>5 Female</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>7 Male</td>
<td>4 Female</td>
</tr>
</tbody>
</table>

The time spent completing the survey ranged from 12 to 90 minutes with the average being 25 minutes. It is inevitable that there would be missing responses when conducting a survey. In this study, missing responses were detected in all categories of
survey questions. The incomplete responses from participants were dealt with by assuming that the responses were randomly missed. For example, among the missing responses in the gender variable, 5 Australian students and 15 Malaysian students provided incomplete responses in the Semester 1 survey and 18 Australian students and 10 Malaysian students provided incomplete responses in the Semester 2 survey. Hence, the statistical figures of all participants from the survey were reported in proportion.

In the following sections, the detailed demographic responses are summarised under three broad categories: individual characteristics, course characteristics and computer skills.

5.2 Individual Characteristics

This section describes the individual characteristics of survey participants in Australia and Malaysia; specifically, gender, age, country of origin, nationality, ethnicity, first language, religion, marital status and employment status. The purpose of including these characteristics is that they reflected fundamental cultural elements and aspects that were relevant to the nature of this case study, particularly when it involved the comparison of two countries. National cultures vary because people’s values, beliefs and the pattern of life represent the culture of a region or country. Within each country, individuals vary in characteristics such as country of origin and nationality. Country of origin refers to the country in which a person was born and obviously does not change over time; however, a person’s nationality may be subject to change. Therefore, both variables played an important role in accurately representing migration changes among students in this study.
5.2.1 Gender

In the Australian Semester 1 survey, approximately two thirds of the participants were female (62.5%) and one third were male (37.5%). In Semester 2, the opposite trend was evident. There were more than twice as many males (70%) as females (30%) (Figure 5.1). However, over the two semesters, the average proportion of male participants (54%) was a little higher than the average proportion of female participants (46%) (Figure 5.2).

In the Malaysian Semester 1 survey, approximately two thirds of the participants were female (65%) and one third were male (35%). In Semester 2, there was a more balanced sample with a few more male (56%) than female participants (44%) (Figure 5.1). However, over the two semesters, the average proportion of each gender was the same as for the Australian site (54% male and 46% female) (Figure 5.2).

![Figure 5.1 Proportion of Participants by Gender in Each Survey](image)
5.2.2 Age

Figure 5.3 presents the distribution of the survey population according to selected age categories in the Semester 1 and Semester 2 surveys. In both surveys, the typical age of Australian students ranges from 18 to 22 years old and represented the majority of participants. The older Australian students’ age ranges from 38 to 42. Data from the Malaysian surveys indicated that there were an exceptionally high proportion of 18 to 22 year old students (89% in Semester 1 and 96% in Semester 2) fewer mature aged students than in the Australian survey.
When combining the figures for both semesters (Figure 5.4), the trend of more mature age students in Australia is even more obvious. Malaysia has almost double the number of young students (18-22 years) than Australia.
5.2.3 Country of Origin

In Semester 1, approximately one quarter (24%) of the participants in the Australian survey were born in Australia while three quarters were born elsewhere. Those born overseas originated from diverse countries such as Malaysia, Singapore, Indonesia, China, India, Sri Lanka, Mauritius, Britain, France, Germany and Yugoslavia. The relatively high proportion of Australian students born overseas is not surprising since Australia has experienced successive waves of migration in the past century (Australian Bureau Statistics, 2011). In contrast, in Semester 2, four of every five Australian students were born in Australia (Figure 5.5). On the other hand, the majority of participants in the Malaysian survey in both Semester 1 (81%) and Semester 2 (88%) were born in Malaysia. Malaysian students born overseas in Semester 1 mainly originated from Indonesia while those in Semester 2 were from China and Indonesia.
Across both semesters, the average proportion of Australian students born in Australia was a little more than half (52%) compared with the very high proportion of Malaysian students born in Malaysia (85%). The data demonstrates the highly diverse community of students in Australia (Figure 5.6).
5.2.4 Nationality

The number of participants in the Semester 1 Australian survey who were of Australian nationality was about three times less than those in Semester 2 (28% vs 83%). A higher number of international students at Australian universities are more likely because their main intake takes place in February each year (Semester 1) and not all faculties offer a Semester 2 intake. Other countries such as USA and Europe are also popular destinations for international higher education but their main intake is in September, which is another possible explanation of a significantly lower proportion of international students at Australian universities in Semester 2. Students of non-Australian citizenship in Semester 1 represented Asian (China, India, Indonesia, Malaysia, Singapore and Sri Lanka), European (France, Germany, Yugoslavia) and African (Mauritius) countries. However, in Semester 2, non-Australian citizens were from Asian countries (Figure 5.7).

In the Malaysian survey, students who were Malaysian citizens in both Semester 1 and 2 represented more than three quarters of the participants (Figure 5.7). However, in Semester 1, there were more students who were Indonesian citizens (22%) than in Semester 2 (4%). The rest of the non-Malaysian citizens were Chinese (15%).
Across both semesters, about half (55%) the participants of the Australian survey were Australian citizens. The majority of non-Australian citizens were Asian with a small number of European and African. In the Malaysian survey, the average proportion of Malaysian citizens (80%) was similar in each semester. Of the non-Malaysian citizens, the majority were Chinese citizens (13%) (Figure 5.8).
5.2.5 Ethnicity

Table 5.2 presents the ethnic background of participants in each survey. In Semester 1, about half (51%) of the Australian students were Caucasian and about a third (35%) were Asian. The remaining students were of African and unspecified ethnicity. The breakdown of ethnic backgrounds in Semester 2 was similar to Semester 1 except for one Hispanic student. Malaysian students in Semester 1 consisted mainly of Asian ethnicity (97%) with just one African student; however, in Semester 2, all of the survey participants were of Asian ethnicity.

Table 5.2 Proportions of Participants by Ethnicity in Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>African</td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>3%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>0%</td>
</tr>
</tbody>
</table>

Across both semesters, the ethnic landscape is similar (Table 5.3). In the Australian survey, over half (55%) were Caucasian and a third (33.5%) were Asian.
There were a small number of students of other ethnic backgrounds. In contrast, in the Malaysian survey, almost all students (98.5%) were of Asian ethnicity.

**Table 5.3 Average Proportions of Participants by Ethnicity in Each Survey**

<table>
<thead>
<tr>
<th>Country</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>African</td>
</tr>
<tr>
<td>Australia</td>
<td>3%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

### 5.2.6 First Language

In the Australian survey, the data indicated a variation in the proportion of students speaking English as their first language. In Semester 1, there were a little more than two thirds (69%) whereas in Semester 2 almost all students (98%) were native English speakers. The other most common languages spoken by students in Semester 1 were Chinese and Bahasa.

In the Semester 1 Malaysian survey, approximately half (49%) of the participants spoke Chinese and about a third (31%) spoke English as their first language. The other most common language was Bahasa (20%). It is interesting to note that, in Semester 2, there were considerably fewer (6%) native Bahasa speakers with increased proportions of Chinese and English speakers (Figure 5.9).
A similar pattern is found across both semesters. Not surprisingly, the most common language spoken by Australian students is English (83%) followed by small proportions of Chinese, Bahasa, French and German. When combining both Malaysian surveys, a similar pattern was found as for the two semesters. The first languages for Malaysian students were Chinese (50%), English (36%) and Bahasa (14%).
5.2.7 Religion

According to the Australian Bureau of Statistics (2011), Christianity is still a predominant religion in Australia; however, the number has declined by 30% in the last 100 years. Correspondingly, increases have been reported in non-Christian religions and ‘no religion’, so it was not surprising that more than a third (41%) of Australian students were not affiliated with any religion in Semester 1 and almost half (49%) in Semester 2. Students having Christian affiliation represented only one third (33%) of the survey population in both Semesters 1 and 2 (Table 5.4).

Malaysia is regarded as a Muslim country; however, the religion with the largest proportion (35%) in Semester 1 was Christianity and, in Semester 2, the largest proportion (44%) was Buddhist. The Islamic faith only represented approximately one fifth (19%) of the survey participants in Semester 1 and one tenth (11%) in Semester 2.
Students with no religion were approximately three times less than in Australia in both Semesters (Table 5.4).

**Table 5.4 Proportion of Students by Religion in Each Survey**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Religion</th>
<th>No religion</th>
<th>Buddhist</th>
<th>Christian</th>
<th>Hindu</th>
<th>Muslim</th>
<th>Unspecified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Australia</td>
<td>41%</td>
<td>8%</td>
<td>33%</td>
<td>0%</td>
<td>5%</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>14%</td>
<td>27%</td>
<td>35%</td>
<td>5%</td>
<td>19%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>49%</td>
<td>14%</td>
<td>33%</td>
<td>0.00%</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>15%</td>
<td>44%</td>
<td>30%</td>
<td>0%</td>
<td>11%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

On average, Australian students with no religion represented the highest overall percentage of participants, followed by Christianity. There were three times as many Muslim students in Malaysia than in Australia. The average proportions of Buddhists (36%) and Christians (32%) among Malaysian students are fairly close (Table 5.5).

**Table 5.5 Average Proportion of Students by Religion in Both Surveys**

<table>
<thead>
<tr>
<th>Country</th>
<th>Religion</th>
<th>No religion</th>
<th>Buddhist</th>
<th>Christian</th>
<th>Hindu</th>
<th>Muslim</th>
<th>Unspecific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>45%</td>
<td>11%</td>
<td>33%</td>
<td>0%</td>
<td>4%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>14%</td>
<td>36%</td>
<td>32%</td>
<td>3%</td>
<td>15%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

### 5.2.8 Marital Status

In the Australian survey, the number of students who were single in Semester 1 (56%) was slightly less than in Semester 2 (64%). The number of students who were married represented nearly half of the participants (44%) in Semester 1 whereas a decrease was evident among survey participants (36%) in Semester 2. There was a very small proportion (3%) of married Malaysian students in Semester 1 and there were no married participants in Semester 2 (Table 5.6). Across both semesters, 60% of Australian survey
participants were single and 40% were married but there was only one Malaysian student who was married (Table 5.7).

**Table 5.6** Proportions of Participants by Marital Status in Each Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Marital status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>97%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>64%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 5.7** Average Proportions of Participants by Marital Status in Both Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>Marital status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
</tr>
<tr>
<td>Australia</td>
<td>60%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>99%</td>
</tr>
</tbody>
</table>

**5.2.9 Employment Status**

Australian students who had a job represented more than half of the survey participants in Semester 1 and there was an even higher proportion in Semester 2. Unlike Australian students, nine out of ten Malaysian participants in both semesters were non-working students (Table 5.8). Across both semesters, two thirds of Australian students (66%) were working. Data from the Malaysian surveys indicated that there was an exceptionally high proportion of non-working students (92%). Australian students were therefore more likely to be employed while at university (Table 5.9).
Table 5.8 Proportion of Participants by Employment Status in Each Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>62%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>8%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 5.9 Average Proportion of Participants by Employment Status in Both Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Australia</td>
<td>66%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>8%</td>
</tr>
</tbody>
</table>

5.2.10 Summary

In relation to individual characteristics, differences were found in gender and age. Overall, there were more male students in the Australian than the Malaysian sample, although this trend differed in each semester. The Malaysian students were younger than the Australian students.

The two countries portrayed very different cultural elements in most categories. Australia had a more culturally diverse community of students than Malaysia. The pattern of migration was evident among students in both countries, with migrants mainly from Europe and Asia in the Australian survey and a very small proportion of migrants from other Asian countries in the Malaysian survey. Interestingly, a small proportion of students who were Indonesian citizens were born in Malaysia. Not surprisingly, Malaysian students’ ethnicity was predominantly Asian whereas the majority of Australian students were Caucasian. English was the most common native language spoken among Australian students, whereas Chinese was commonly spoken among Malaysian students.
Other differences in background were in religion, marital status and employment. Australia and Malaysia had similar average proportions of Christian students but, overall, more Australians were not religious. Unlike Malaysian students, it is not unusual for Australian students to be married while studying at University. It is common for Australian students to work while at university.

On the basis of the demographic information presented in this section, it is evident that individual characteristics were rooted in certain types of culture that shape how they think, perceive and behave, subsequently affecting their values and beliefs. Such valuable information indicates that culture and learning are closely tied together in a complex manner in a way that cognitive processing cannot be separated from the cultural context (Bryne et al., 2004; Hofstede & Minkov, 2010; Tomasello, 2000).

5.3 Course Characteristics

This section describes the course characteristics of Australian and Malaysian students who participated in the two surveys, specifically their course major, year of enrolment, enrolment type, student type and education funding. Enrolment type and year of enrolment were particularly included in this study in order to identify part-time and full-time students as well as to categorise students according to their stage of studies.

5.3.1 Course Major

In the Australian survey, the proportion of course majors of the participants varied over the two semesters (Figure 5.11). Although the majority of students were majoring in Information Systems, the proportion was higher in Semester 1 (61%) compared to Semester 2 (46%). There were more students enrolled in Engineering, Education and
other disciplines in Semester 2 (54%) than in Semester 1 (39%). The proportion of students enrolled in Business was similar for both semesters (approximately one quarter).

Figure 5.11 Proportion of Participants by Course Major in Each Survey

In Malaysia, the largest proportion of participants was enrolled in an Engineering major (Figure 5.11). Those majoring in Information Systems in Semester 2 (12%) were approximately half as many as in Semester 1 (22%). There was a small number of students majoring in Business and other disciplines in Semester 1 only.

Figure 5.12 shows the average proportion of Australian and Malaysian students enrolled in different majors over the two semesters. In Australia, Information Systems accounted for more than half (54%) and Business accounted for more than a quarter (29%). In Malaysia, on the other hand, only about one fifth (17%) were majoring in
Information Systems and more than three quarters (79%) were in Engineering with very few in Business.

![Pie chart showing course major distribution in Australia and Malaysia.](image)

**Figure 5.12** Average Proportions of Participants by Course Major in Both Surveys

### 5.3.2 Year of Enrolment

As four of the seven cases surveyed were first year units, it would have been expected that the majority of students would be in their first year of university studies. Surprisingly, in both the Australian and Malaysian surveys, the highest proportions of students were in their second year (Figure 5.13). In the Australian survey, the next most common group in Semester 1 was first year students and in Semester 2 third year students. Approximately one tenth of Australian students had spent more than three years in their studies at the time of the survey. The data were similar for the Malaysian students, except that the second most common group was students in their first year for both Semester 1 and Semester 2 surveys. Figure 5.14 confirms that, over the two semesters, the majority of Australian and Malaysian students were in their second year of studies; however, there were comparatively more Malaysian students.
5.3.3 Enrolment Type

In the Semester 1 Australian survey, the majority (85%) of students were studying full-time. By Semester 2, this proportion had declined to 70%. On the contrary, all of Malaysian students in both semesters were studying full time (Figure 5.15). Over both
semesters, more than three quarters of Australian survey participants were full time students (Figure 5.16).

**Figure 5.15** Proportions of Participants by Enrolment Type in Each Survey

**Figure 5.16** Average Proportions of Participants by Enrolment Type in Both Surveys
5.3.4 Residency Status

In Figure 5.17, among the Australian students who participated in the survey, two thirds (68%) were Australian residents in Semester 1 and about three quarters (74%) in Semester 2. In the Malaysian survey, there was little difference in residency between the two semesters; however, Malaysia had a higher average proportion of resident students compared to Australia (Figure 5.18).

![Figure 5.17 Proportions of Participants by Student Type in Each Survey](image-url)
5.3.5 Financial Situation

Survey data from Semesters 1 and 2 indicate two in five Australian students were financially dependent on their family to support their education (Table 5.10). There were a higher proportion of students who were financially independent in Semester 2 compared with Semester 1. In Semester 1, there were more than double the students who had an education loan than in Semester 2. This was probably because most of the students on loans were married (refer to Table 5.6 in Section 5.2.8) and, although they had employment, the income earned was likely insufficient in funding both family and education expenses.

Among the Malaysian students in Semester 1 and Semester 2, three in five were financially dependent on their family to support their education; one in five had an education loan; one in ten was funded by a scholarship; and only a small proportion was financially independent.
Table 5.10 Proportions of Participants by Education Funding in Each Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Financial situation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scholarship</td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>15%</td>
</tr>
</tbody>
</table>

It is apparent that Malaysia had a relatively higher average proportion of students who were financially dependent on their family to support their education compared to Australia (Table 5.11). Similar average proportions were seen in Australian and Malaysian students who had loans to support their education. Australian students were seven times more likely to be financially independent than Malaysian students. In contrast, there were many more Malaysian students who had a scholarship.

Table 5.11 Average Proportions of Participants by Education Funding in Both Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>Financial situation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scholarship</td>
</tr>
<tr>
<td>Australia</td>
<td>1%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>15%</td>
</tr>
</tbody>
</table>

5.3.6 Summary

Universities in Australia generally cater to both full-time and part-time students whereas universities in Malaysia generally cater to full-time students. Students’ age could be the main driving force and reason behind the demand (see Section 5.2.2).

Australia had an exceptionally higher number of students who were financially independent and supported their own education than Malaysia. The most probable explanation was the relatively large proportion of Chinese Malaysian students (Section 5.2.6) whose cultural values may be traced back to Confucianism. ‘Confucian
dynamism’ later known as ‘long term orientation’ is the hope of a brighter future through the act of persistence effort and thrift in the long run (Goh, 2009; Hofstede & Minkov, 2010; Mitsis & Foley, 2009; Sugahara & Boland, 2010). Asian parents are generally long-term oriented and place high value on their children’s education. They tend to associate educational success with opportunity and a successful career in the future and would go to any lengths to support their children’s education to the highest level. Therefore, Asian students’ learning orientation is strongly connected to the perceived financial and social advancement through higher education (Lim, 2004). In return, their children are expected to excel in their studies and secure a good job and eventually become care providers for their aging parents.

Interestingly, approximately the same proportion of Australian and Malaysian students took loans to support their education. Over the past decade, the Malaysian government has allocated a quarter of its country’s budget to education, which is an enormous amount compared to other countries. Malaysia was placed 11 out of 137 nations in terms of their education budget in 2009 (Yong, 2010). In 2010, apart from numerous scholarship programs offered by large private companies in Malaysia, the Public Service Department (PDA) scholarship program, run by the Malaysian government, awarded 1500 scholarships worth RM1.24 billion to top achieving high school graduates (Yong, 2010).

Other course characteristics, such as enrolment year and residency status were similar for both groups.
5.4 Computer Skills

The last section of this chapter describes the Australian and Malaysian students’ computer competency based on Semester 1 and Semester 2 data. Students’ computer competency may vary depending on their computer experience, how early they were first introduced to the technology and the frequency of use. The purpose of gathering this information helped to unveil the various levels of computer competency among survey respondents.

5.4.1 Computer Experience

Figure 5.19 shows that, in the Australian survey, there were more students (59%) who were highly competent computer users (over 8 years of computer experience) than in Semester 2 (46%). Students with 4-5 years of computer experience represented the smallest proportion of survey participants in Semester 2 whereas students with less than a year’s experience represented the smallest proportion in Semester 1.

In the Malaysian survey, the students’ computer experience commonly ranges from 6 to 7 years in both Semester 1 and 2. Students with the highest computer competency (greater than 10 years) only represented a quarter of participants in both semesters. A small proportion of students had 3 years or less computer experience.
Averaging across both semesters, it was found that there were twice as many highly competent (10+ years) Australian than Malaysian students. Malaysian students’ computer competency typically ranged from 6 to 7 years (32%) (Figure 5.20).

5.4.2 Introduction to Computers

In the Semester 1 survey, more than half of Australian students indicated that they were first introduced to the computer at home whereas, in the Semester 2 survey, more students were first introduced to the computer in primary school. The data for both
surveys show that there were slightly more Malaysian students who were first introduced to the computer at home than in primary school.

Table 5.12 Proportions of Participants by First Introduction to Computer in Each Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>First introduced to computer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Home</td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>46%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>48%</td>
</tr>
</tbody>
</table>

The number of Malaysian students who first experienced the computer at home was slightly higher than Australian students. This is surprising since Malaysia is a less economically developed country. There is also evidence that the use of the computer is slowly gaining pace in preschool settings. Not surprisingly, only a few survey respondents from Australia reported that they were first introduced to the computer at their workplace or at the university.

Table 5.13 Average Proportions of Participants by First Introduction to Computer in Both Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>First introduced to computer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home</td>
</tr>
<tr>
<td>Australia</td>
<td>43%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>47%</td>
</tr>
</tbody>
</table>

5.4.3 Frequency Use of Computer

The Semester 1 data revealed that Australia and Malaysia have identical proportions of respondents reporting frequent use of the computer; specifically, 95% use the computer
every day (Table 5.14). On the other hand, Semester 2 data revealed that all of the Malaysian students used a computer on a daily basis whereas slightly fewer Australian students indicated daily use of computer. However, the difference represents just one Australian student. Over both semesters, Australia and Malaysia share exceptionally high proportions of students who used a computer on a daily basis (Table 5.15).

Table 5.14 Proportions of Participants by Frequency Use of Computer in Each Survey

<table>
<thead>
<tr>
<th>Semester</th>
<th>Country</th>
<th>Computer use</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Everyday</td>
<td>A few times a week</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>95%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>95%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>98%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>100%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.15 Average Proportion of Participants by Frequency Use of Computer in Both Surveys

<table>
<thead>
<tr>
<th>Country</th>
<th>Computer use</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Everyday</td>
<td>A few times a week</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>96%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>97%</td>
<td>3%</td>
<td></td>
</tr>
</tbody>
</table>

5.4.4 Summary

The steady and growing trend of computer technology diffusing into homes and schools was evident in the survey data from both groups. It can be inferred that both Australian and Malaysian schools are assimilating computer technology with learning and instruction given that close to half of the survey respondents indicated their first computer experience began in school. In general, Australian and Malaysian students share similar attributes associated with the frequency use of computer. This indicates that computer use is very much integrated into students’ everyday life. However,
Australian students may be perceived as more competent users than Malaysian students since computer competency are developed and learned through experience over time (Schumacher & Morahan-Martin, 2001).

5.5 Conclusion

Survey participants’ demographic characteristics were reported in three major categories: individual characteristics, course characteristics and computer skills. Strong differences in Australia and Malaysia were particularly evident in individual characteristics such as age, nationality, marital status and employment status; course characteristics such as enrolment type and financial situation; and computer skills such as computer experience. Specifically, Malaysian students were generally young, study full time, single, and financially dependent. In contrast, Australian students were more culturally diverse than Malaysian students. It is not unusual for Australian students to be married, working and financially independent while studying at university. Part-time studies are offered by universities in Australia to cater for mature age students. The exceptionally high number of Australian students who had more than 10 years of computer experience suggests that they possessed higher computer competencies than Malaysian students.
Chapter 6

RESULTS

The previous chapter described the demographic information of the survey participants. In this chapter, the hypotheses (as stated in Chapter 3) are reiterated and the results are discussed in three major sections: cross-sectional results; longitudinal results; and a comparison of cross-sectional and longitudinal results. The cross-sectional and longitudinal results are reported in the order of elementary to advanced statistical analyses. Statistical analyses were used to test the hypotheses and advanced statistical modelling was used to determine the relationship among the investigated predictor and response variables. The results from the elementary statistical analyses are the means, standard deviations, Pearson correlation coefficients and t-tests. The results from the advanced statistical analyses report the application of multiple linear regressions (parametric), tree-based regressions (non-parametric) and linear mixed effects statistical modelling on the relationship between cognitive style (CS) and all predictor variables. Akaike information criteria were used to select the best sub-model. Residual plots were used to verify where the residuals follow the normality assumption.

6.1 Hypotheses

In this study, hypotheses were necessary to facilitate in answering the two main research questions listed in Section 1.3. For this case study, alternative hypotheses were used to conclude whether the hypotheses were supported or not supported. Statistically supporting an alternative hypothesis indicates that there is a relationship among the
variables under study. Part I hypotheses mainly focus on answering the first research question; specifically, investigating the properties of the response variable and all the predictor variables. Part II hypotheses mainly focus on answering the second research question, which investigated the change in all the variables with time and location. Part I hypotheses and the first three hypotheses of Part II are related to the cross-sectional study. The remaining hypothesis is related to the longitudinal study.

Research Question 1: What are the factors that affect CS?

H1.1: There is a difference between Australian and Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation.

H1.2: Australian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

H1.3 Malaysian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

H1.4: Students’ approaches to learning, culture dimensions and unit evaluation affect their cognitive style.

H1.5: Higher order interactions among students’ learning dimensions, culture dimensions and unit evaluation affect their cognitive style.

H1.6: Students’ demographic characteristics affect their cognitive style.

Research Question 2: Does CS and all predictor variables change over time?

H2.1: Students’ cognitive style changes with time in the development of hypermedia learning.
H2.2: Time and location affect the students’ cognitive style in hypermedia learning.
H2.3: Time and location affect the students’ learning dimensions, culture dimensions and unit evaluation.
H2.4: Individual students’ cognitive style varies with changes in their learning dimensions, culture dimensions or unit evaluation.

The hypotheses testing results are categorised into two sections. Section 6.2 presents the results of the cross-sectional studies for both Semester 1 and Semester 2 data. A comparison is made between Semester 1 results and the combined Semesters 1 and 2 MLR results. In addition, the robustness of the MLR results is reported. Additional variables, specifically time and location, were investigated to determine if it led to a change in the mean of response and predictor variables from Semester 1 to Semester 2. Section 6.3 presents the results of the relationship of all variables over time (longitudinal), using data from students who participated in both Semester 1 and Semester 2 surveys.

**6.2 Cross-sectional Results**

Many research projects involve studying a certain population by assessing a cross-section of the group at a single point in time. Cross-sectional studies require a researcher to take a “snapshot” of a population at single point in time and analyze it carefully. Cross-sectional analysis is a useful approach for descriptive studies of a certain phenomenon or population. However, because of the limited time frame, this type of analysis requires cautious interpretation. On the other hand, longitudinal studies provide the most reliable characterization of the temporal progression of an individual so the
true predictors are best identified with a longitudinal design (García-Alberca et al., 2011; Mega, Cummings, Fiorello, & Gornbein, 1996). There were several controlled factors in the cross-section part of the study; for instance, all participating students were enrolled in units that had a similar curriculum from a cross-country perspective as well as a similar proportion of international overseas students.

The results from elementary statistical analyses (t-tests and Pearson correlation coefficients) are presented in Sections 6.2.1 to 6.2.6. The results from advanced statistical analyses (MLR and TBR) are reported in Sections 6.2.3 and 6.2.4. The comparison results of both MLR and TBR analyses are reported in Section 6.2.5. Section 6.2.6 presents the relationships among each variable recorded, the location effect, and the cross-sectional time series effect. The purpose of conducting cross-sectional time series studies was to determine and understand which variables were likely to change with time.

6.2.1 Mean and Standard Deviation

Means and standard deviations are considered elementary statistical analysis methods, commonly used to describe a set of collected survey data. The mean is generally known as the arithmetic average of a sample and is commonly used to measure the central tendency of a sample (Zikmund, 1997). Standard deviation refers to the distribution spread or the variation that exists from the mean. A low standard deviation indicates a close distribution (low dispersion) of data points to the mean and a high standard deviation indicates a large distribution (high dispersion) of data points to the mean (Zikmund, 1997). The magnitude of the standard deviations and the means both affect
the statistical tests for comparison. The same means but larger standard deviations will increase the p-value.

The mean score and standard deviation of each variable in Semesters 1 and 2 are summarised in Tables 6.1 and 6.2 respectively and described in the following sections. The representation of each mean score was determined according to the classification for each variable’s score as described in Section 3.6.2. Students’ t-tests were used to compare the means of two groups and the p-values are listed in the last column of both tables.

**Table 6.1** Mean, SD and P-values of Australian and Malaysian Students’ T-test (Semester 1)

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Australia Mean (SD)</th>
<th>Malaysia Mean (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>CS</td>
<td>2.702 (0.577)[n=40]</td>
<td>2.939 (0.457)[n=41]</td>
<td>0.043</td>
</tr>
<tr>
<td>Predictors-Learning</td>
<td>NL</td>
<td>2.846 (0.435)[n=41]</td>
<td>3.122 (0.0.394)[n=40]</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>3.236 (0.401)[41]</td>
<td>3.371 (0.329)[40]</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>3.542 (0.319)[n=41]</td>
<td>3.695 (0.314)[n=40]</td>
<td>0.033</td>
</tr>
<tr>
<td>Predictors-Culture</td>
<td>PD</td>
<td>2.825 (0.599)[n=40]</td>
<td>2.912 (0.578)[n=38]</td>
<td>0.515</td>
</tr>
<tr>
<td></td>
<td>IC</td>
<td>2.642 (0.552)[n=40]</td>
<td>3.052 (0.468)[n=38]</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>MF</td>
<td>2.650 (0.459)[n=40]</td>
<td>2.456 (0.359)[n=38]</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>UA</td>
<td>3.083 (0.617)[n=40]</td>
<td>2.746 (0.517)[n=38]</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>TO</td>
<td>2.875 (0.493)[n=40]</td>
<td>2.623 (0.591)[n=38]</td>
<td>0.044</td>
</tr>
<tr>
<td>Predictors – Evaluation</td>
<td>EU</td>
<td>2.179 (0.784)[n=40]</td>
<td>2.622 (0.541)[n=37]</td>
<td>0.006</td>
</tr>
</tbody>
</table>
Table 6.2 Mean, SD and P-values of Australian and Malaysian Students’ T-test (Semester 2)

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Australia Mean (SD)</th>
<th>Malaysia Mean (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>CS</td>
<td>2.590 (0.602)[n=47]</td>
<td>2.867 (0.313)[n=30]</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictors-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td>NL</td>
<td>2.789 (0.460)[n=47]</td>
<td>3.045 (0.348)[n=30]</td>
<td>0.011</td>
</tr>
<tr>
<td>dimensions</td>
<td>LC</td>
<td>3.128 (0.392)[n=47]</td>
<td>3.339 (0.313)[n=30]</td>
<td>0.0155</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>2.983 (0.360)[n=47]</td>
<td>3.326 (0.292)[n=30]</td>
<td>0.000</td>
</tr>
<tr>
<td>Predictors-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture</td>
<td>PD</td>
<td>2.598 (0.621)[n=44]</td>
<td>3.012 (0.519)[n=27]</td>
<td>0.005</td>
</tr>
<tr>
<td>dimensions</td>
<td>UA</td>
<td>2.902 (0.673)[n=44]</td>
<td>2.667 (0.585)[n=27]</td>
<td>0.139</td>
</tr>
<tr>
<td></td>
<td>MF</td>
<td>2.712 (0.637)[n=44]</td>
<td>2.525 (0.280)[n=27]</td>
<td>0.153</td>
</tr>
<tr>
<td></td>
<td>IC</td>
<td>2.583 (0.744)[n=44]</td>
<td>3.704 (0.580)[n=27]</td>
<td>0.0047</td>
</tr>
<tr>
<td></td>
<td>TO</td>
<td>2.689 (0.428)[n=44]</td>
<td>2.691 (0.332)[n=27]</td>
<td>0.984</td>
</tr>
<tr>
<td>Predictors-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>EU</td>
<td>1.928 (0.580)[n=44]</td>
<td>2.364 (0.543)[n=27]</td>
<td>0.002</td>
</tr>
</tbody>
</table>

6.2.1.1 Cognitive Style (Response Variable)

In Semester 1, the mean score of Australian students’ CS was 2.702 and the mean score of Malaysian students’ CS was 2.939. These scores indicate that Malaysian students possess significantly (p=0.043) less field independent (FI) characteristics compared to Australian students so are therefore likely to be more field dependent (FD) (Table 6.1). Similarly, in Semester 2, the mean score of Australian students’ CS was 2.590, which suggests significantly (p=0.023) strong FI characteristics compared to Malaysian students’ CS of 2.867 (Table 6.2).
6.2.1.2 Learning Dimensions (Predictor Variable)

Non-linear Learning (NL)

There was a significant difference (p=0.004) in the nonlinear learning (NL) mean score between Australian (2.846) and Malaysian (3.122) students in Semester 1 (Table 6.1), and a considerable significant difference (p=0.011) in Australian students’ NL (2.789) and Malaysian students’ NL (3.045) in Semester 2 (Table 6.2). These scores characterise Australian students as enjoying working alone and preferring free navigation or using a discovery approach to generate ideas based on the meaning and understanding of the topic of interest, whereas Malaysian students are socially oriented, preferring a structured learning environment and tending to be dependent on guided learning.

Learner Control (LC)

The mean score (3.236) of Australian students’ learner control (LC) was slightly less than Malaysian students’ LC (3.371) in Semester 1. The scores suggest that both Australian and Malaysian students’ LC share similar characteristics (p=0.10) as to the extent of learner control and pace as well as utilising hypermedia learning system features according to their learning needs (Table 6.1). However, a significant difference (p=0.0155) was evident between Australian students’ LC mean score (3.128) and Malaysian students’ LC mean score (3.339) in Semester 2 (Table 6.2). This indicates that Australian students in Semester 2 were more capable of engaging in independent learning. On the other hand, Malaysian students’ LC mean scores were relatively consistent across Semesters 1 and 2 indicating they were less able to learn independently. A possible reason behind the insignificant difference (p=0.10) between
Australian and Malaysian LC mean scores in Semester 1 could be insufficient sample size.

*Multiple Tools (MT)*

Australian students’ mean score (3.542) on multiple tools (MT) implies that they were significantly (p=0.033) less dependent on navigation support in hypermedia learning systems compared to Malaysian students (3.695) (Table 6.1). Similarly, a highly significant (p=0.000) difference was evident between Australian students’ MT mean score (2.983) and Malaysian students’ MT mean score (3.326) in Semester 2 (Table 6.2).

**6.2.1.3 Culture Dimensions (Predictor Variables)**

*Power Distance (PD)*

The Australian students’ power distance (PD) mean score (2.825) was relatively low and corresponds with Hofstede’s (2007) PD score for Australia as described in Section 4.1. The Malaysian students’ PD mean score (2.912) was surprisingly low as Hofstede found that Malaysia has a relatively high PD. Therefore there was no significant (p=0.515) difference between Australian and Malaysian PD scores in Semester 1 (Table 6.1). While there was a highly significant difference (p=0.005) between Australian students’ PD mean score (2.598) and Malaysian students’ PD mean score (3.012) in Semester 2 (Table 6.2), the mean scores for both groups were inconsistent across Semesters 1 and 2. The lower PD score of Malaysian students in Semester 1 compared to Hofstede’s may possibly be due to the influence of the Australian teaching culture and its infusion in the Malaysian teaching culture at Curtin University Sarawak. Foreign employed lecturers...
could also be a contributing factor to the classroom culture. Another possibility could be
due to the insufficient sample size or large standard deviations in both Australian and
Malaysian students’ PD.

*Individualism vs. collectivism (IC)*

Australian students’ IC mean score (2.642) was more significantly (p=0.001) individualistic compared to Malaysian students’ IC mean score (3.052) in Semester 1 (Table 6.1). There was also a highly significant difference (p=0.0047) between Australian students’ IC mean score (2.583) and Malaysian students’ IC mean score (3.704) in Semester 2 (Table 6.2). It could be concluded that Australian students lack interpersonal connection and share little responsibility beyond family, while Malaysian students demonstrate more respect to their teachers and family members.

*Masculinity vs. Femininity (MF)*

In Semester 1, Australian students’ masculinity (MF) mean score (2.650) was significantly (p=0.04) higher than Malaysian students’ mean score (2.456) (Table 6.1). However, in Semester 2, no significant difference (p=0.153) existed between Australian students’ MF mean score (2.712) and Malaysian students’ MF mean score (2.525) (Table 6.2). This may be due to insufficient sample size or large standard deviations of both Australian and Malaysian students’ MF. Nevertheless, Australian students’ MF mean scores were consistently higher than Malaysian students’ MF mean scores in both Semester 1 and 2. The results drawn from both semesters may indicate that Australian and Malaysian students value material things and are driven by competition, ambition,
achievement, success, assertiveness and accumulation of wealth and material possessions. The difference between these two scores is that Malaysian students may have a tendency to place greater value on relationships over material things.

*Uncertainty Avoidance (UA)*

Australian and Malaysian students’ mean scores of uncertainty avoidance (UA) correspond with Hofstede’s UA scores for this cultural dimension. There was a higher significant uncertainty avoidance (p=0.011) in Australian students compared to Malaysian students (Table 6.1). The mean score of Australian students (3.083) indicates that they are relatively relaxed and tend to tolerate anxiety and stress in their studies. The mean score of Malaysian students (2.746) indicates that they are unlikely to tolerate anxiety and stress in their studies very well; however, these problems can be overcome if driven by ambition and competitiveness. In Semester 2, the mean score of Australian students’ UA (2.902) was insignificantly (p=0.139) higher than the mean score of Malaysian students’ UA (2.667). Although, the mean scores of Australian students’ UA were consistently higher than Malaysian students’ UA across both semesters, the insignificant result from Semester 2 may be due to insufficient sample size or large standard deviations in both Australian and Malaysian students’ UA.

*Short vs Long Term Orientation (TO)*

According to the mean scores of both Australian and Malaysian students’ time orientation (TO) in Semester 1 (Table 6.1), Australian students (2.179) were significantly (p=0.044) more short term oriented than Malaysian students (2.622). This
indicates that Australian students tend to enjoy the present due to their carefree attitude toward their studies whereas Malaysian students face challenges in their studies through perseverance in the hope of successfully completing their studies. However, in Semester 2, there was no significant difference (p=0.984) between Australian students’ TO mean score (2.689) and Malaysian students’ TO mean score (2.691). Considering that the mean scores of Australian students’ TO was consistently lower than the Malaysian students’ TO, the insignificant (p=0.984) difference in Semester 2 may be due to insufficient sample size or large standard deviations in both Australian and Malaysian students’ UA.

6.2.1.4 Evaluation of Unit (Predictor variables)

In Semester 1, the mean scores of both Australian and Malaysian students’ evaluation of unit (EU) suggest that Australian students (2.179) were significantly (p<0.01) more satisfied with their learning outcome compared with Malaysian students (2.622) (Table 6.1). In Semester 2, higher satisfaction was significantly (p=0.002) evident among Australian students (1.928) compared with Malaysian students (2.364) (Table 6.2). This indicates that Australian students are generally more satisfied than Malaysian students with their learning outcomes.

Overall, there were significant differences when comparing the mean scores of Australian and Malaysian students’ CS, learning dimensions, culture dimensions and EU. Therefore, correlation tests were conducted to investigate further the relationships among all the variables.
6.2.2 Correlations Among All Variables

A Pearson correlation coefficient can be estimated with real-value continuous variables but not with categorical variables. As all 18 demographic characteristics were categorical variables, correlation coefficients cannot be estimated for them. The correlation coefficients ($\rho$) between all variables (excluding demographic data) of the two case studies (Australia and Malaysia) are summarised for Semester 1 in Tables 6.3 and 6.4 and for Semester 2 in Tables 6.5 and 6.6. A significant correlation was consistently found between CS and NL in both Semester 1 ($\rho=0.34$) and Semester 2 ($\rho=0.36$) for the Australian case study. However, in the Malaysian case study, the correlation coefficients between CS and NL in both semesters were not consistently significant.

<table>
<thead>
<tr>
<th></th>
<th>LC</th>
<th>MT</th>
<th>NL</th>
<th>PD</th>
<th>UA</th>
<th>MF</th>
<th>IC</th>
<th>TO</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>0.21</td>
<td>0.01</td>
<td><strong>0.34</strong></td>
<td>0.05</td>
<td>0.04</td>
<td>0.09</td>
<td><strong>0.34</strong></td>
<td>0.12</td>
<td><strong>0.48</strong></td>
</tr>
<tr>
<td>LC</td>
<td>0.23</td>
<td>-0.01</td>
<td>-0.29</td>
<td>0.08</td>
<td>-0.23</td>
<td>-0.03</td>
<td>0.1</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>0.13</td>
<td>-0.17</td>
<td>0.09</td>
<td>-0.07</td>
<td><strong>0.45</strong></td>
<td><strong>0.34</strong></td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NL</td>
<td>0.13</td>
<td>0.23</td>
<td>-0.06</td>
<td><strong>0.31</strong></td>
<td>0.16</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>0.03</td>
<td>0.2</td>
<td>0.04</td>
<td>-0.05</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UA</td>
<td>-0.09</td>
<td>0.01</td>
<td>0.23</td>
<td>0.06</td>
<td></td>
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</tr>
<tr>
<td>MF</td>
<td>-0.04</td>
<td><strong>0.31</strong></td>
<td>0.13</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC</td>
<td>-0.02</td>
<td>-0.01</td>
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<tr>
<td>TO</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Bold indicates it is significant with 5% of Type I errors
Table 6.4 Malaysian Students’ Correlation Coefficients of All Variables (Semester 1)

<table>
<thead>
<tr>
<th></th>
<th>LC</th>
<th>MT</th>
<th>NL</th>
<th>PD</th>
<th>UA</th>
<th>MF</th>
<th>IC</th>
<th>TO</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
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<td>0.06</td>
<td>0.23</td>
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<td>0.2</td>
<td>-0.17</td>
<td>-0.2</td>
<td>0.17</td>
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<td>0.26</td>
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<td></td>
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</tr>
<tr>
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<td>0.25</td>
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</tr>
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<td>0.21</td>
<td>0.27</td>
<td>-0.02</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>UA</td>
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<td>0.34</td>
<td>-0.01</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MF</td>
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<td>-0.19</td>
<td>0.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>IC</td>
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<td></td>
<td></td>
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<tr>
<td>TO</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>-0.37</td>
</tr>
</tbody>
</table>

Note: Bold indicates it is significant with 5% of Type I errors

Table 6.5 Australian Students’ Correlation Coefficients of All Variables (Semester 2)

<table>
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<th>LC</th>
<th>MT</th>
<th>NL</th>
<th>PD</th>
<th>UA</th>
<th>MF</th>
<th>IC</th>
<th>TO</th>
<th>EU</th>
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</thead>
<tbody>
<tr>
<td>CS</td>
<td>-0.01</td>
<td>-0.06</td>
<td>0.36</td>
<td>-0.11</td>
<td>-0.45</td>
<td>0.45</td>
<td>-0.13</td>
<td>0.34</td>
<td>-0.08</td>
</tr>
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<td>LC</td>
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<td>0.22</td>
<td>0.2</td>
<td>0.55</td>
<td>0.05</td>
<td>-0.18</td>
<td>0.4</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
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<td>0.4</td>
<td>0.36</td>
<td>-0.14</td>
<td>0.29</td>
<td>-0.21</td>
<td>0.23</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.02</td>
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<td>-0.07</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
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<td>-0.56</td>
<td>0.57</td>
<td>0.01</td>
<td>0.25</td>
<td></td>
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</tr>
<tr>
<td>UA</td>
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<td>0.46</td>
<td>0.28</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>MF</td>
<td>-0.66</td>
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<td>-0.41</td>
<td></td>
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<tr>
<td>IC</td>
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<td>-0.11</td>
<td>0.35</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>0.3</td>
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<td></td>
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</table>

Note: Bold indicates it is significant with 5% of Type I errors

Table 6.6 Malaysian Students’ Correlation Coefficients of All Variables of (Semester 2)

<table>
<thead>
<tr>
<th></th>
<th>LC</th>
<th>MT</th>
<th>NL</th>
<th>PD</th>
<th>UA</th>
<th>MF</th>
<th>IC</th>
<th>TO</th>
<th>EU</th>
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</thead>
<tbody>
<tr>
<td>CS</td>
<td>0.17</td>
<td>0</td>
<td>-0.42</td>
<td>0.12</td>
<td>-0.26</td>
<td>-0.27</td>
<td>-0.28</td>
<td>-0.18</td>
<td>0.44</td>
</tr>
<tr>
<td>LC</td>
<td>0.29</td>
<td>0.13</td>
<td>0.08</td>
<td>-0.14</td>
<td>-0.44</td>
<td>0.36</td>
<td>-0.14</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>0.06</td>
<td>0.28</td>
<td>-0.09</td>
<td>-0.53</td>
<td>-0.13</td>
<td>-0.04</td>
<td>-0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NL</td>
<td>-0.19</td>
<td>0.14</td>
<td>-0.17</td>
<td>0.32</td>
<td>0.09</td>
<td>-0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>-0.05</td>
<td>-0.37</td>
<td>0.26</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td>-0.49</td>
<td></td>
</tr>
<tr>
<td>UA</td>
<td>0.3</td>
<td>-0.06</td>
<td>0.42</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>0.11</td>
</tr>
<tr>
<td>MF</td>
<td>0.03</td>
<td>-0.28</td>
<td>-0.27</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>IC</td>
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<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Note: Bold indicates it is significant with 5% of Type I errors
In general, the estimated correlation coefficient in both case studies indicated that students’ CS was only correlated with NL in the learning dimension (Tables 6.5 and 6.6). Although correlation is the foundation for advanced modelling between one predictor variable and one response variable in simple linear regression, it may not be an appropriate tool to model the multiple variables in this study. All the estimated correlations were between -0.7 to 0.7, which were not highly significant. Instead, the application of multiple linear regressions was used in this study in order to determine whether the inclusion of additional predictor variables would lead to increased prediction of the outcome of the response variable. The process involved at least two predictor variables to determine their relationship with the response variable.

6.2.3 Multiple Linear Regression Results

Multiple linear regression (MLR) is essentially a two-step process model. The first step involves determining and selecting the significance of the estimated coefficient predictor variables with direct effect. The second step involves testing all significances of estimated coefficients of predictor variables with direct effect in order to determine their interaction terms (indicated by * in between two variables). In this study, MLR models were used to analyse the possible relationships and interaction terms between CS and all predictor variables; specifically, three learning dimensions, five culture dimensions, evaluation of unit and eighteen demographic characteristics which are presented as Semester 1 results. Confirmation of the robustness of MLR statistical model and overall results are presented in combined Semester 1 and 2 results.
6.2.3.1 MLR Semester 1 Results

The results from the first MLR modelling process on CS (the response variable) and the predictor variables revealed that all 18 demographic characteristics were not significant (p> 0.20). Of all the estimated coefficients of the predictor variables analysed using the students’ t-test, the estimated coefficient of EU represented the most significant (p=0.015) variable affecting students’ CS. The next step was to determine the interaction terms among all significance of estimated coefficients of predictor variables. Very often, it is likely that these interaction terms exist within each type of predictor variable. For example, the fixed effect variables for three learning dimensions included LC, ML, NL, and the interaction terms existed as LC*ML, LC*NL, ML*NL and LC*ML*NL.

Ultimately, Akaike Information Criteria (AIC) (see Section 3.6.5) were used to select the best sub-model from all the fixed effects variables and their interaction terms. The results generated by MLR models selected by AIC in this study have categorised EU (p=0.03), LC (p=0.05) and NL (p=0.02) as significant predictor variables (p<0.05), and intercept (p=0.14) PD (p=0.11), TO (p=0.15) and PD*TO (p=0.09) interaction terms as marginally significant predictor variables (p>0.10) (Table 6.7). It appeared that PD*TO was the only interaction term that was present in this study. Although PD*TO was only marginally significant, it was still counted since it may have become significant when correct moderation effects were tested. The following simulated analyses demonstrate that the results are sufficient to show the effects that are often excluded for further analysis because they were considered as not significant enough to determine the effect but, in fact, significance for interesting moderation effects did exist.
Table 6.7 Estimated p-value of the Estimated Coefficient of Insignificant (p>0.05) Predictor Variables from the T-test of MLR Model Fits (the significant predictors are reported in Sections 6.2.3 and 6.2.4)

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Semester</th>
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<tr>
<td></td>
<td>S1</td>
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<tr>
<td>MT</td>
<td>0.129</td>
</tr>
<tr>
<td>LC</td>
<td>0.157</td>
</tr>
<tr>
<td>UA</td>
<td>0.075</td>
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<tr>
<td>MF</td>
<td>0.089</td>
</tr>
<tr>
<td>IC</td>
<td>0.075</td>
</tr>
<tr>
<td>PD</td>
<td></td>
</tr>
<tr>
<td>Time (levels, semester 1 and 2)</td>
<td>(Not applicable)</td>
</tr>
<tr>
<td>Location</td>
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<tr>
<td>Gender</td>
<td>0.517</td>
</tr>
<tr>
<td>Age</td>
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</tr>
<tr>
<td>Country of origin</td>
<td>0.435</td>
</tr>
<tr>
<td>Nationality</td>
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</tr>
<tr>
<td>Ethnicity</td>
<td>0.681</td>
</tr>
<tr>
<td>First language</td>
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</tr>
<tr>
<td>Religion</td>
<td>0.956</td>
</tr>
<tr>
<td>Marital status</td>
<td>0.481</td>
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<tr>
<td>Employment status</td>
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<tr>
<td>Course major</td>
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</tr>
<tr>
<td>Year of employment</td>
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<tr>
<td>Enrolment type</td>
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<td>Financial situation</td>
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</tr>
<tr>
<td>Computer experience</td>
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</tr>
<tr>
<td>Introduction to computer</td>
<td>0.322</td>
</tr>
<tr>
<td>Frequency use of computer</td>
<td>0.477</td>
</tr>
</tbody>
</table>

The estimated coefficients of intercepts EU, LC, NL, PD, TO and PD*TO were 2.35, 0.31, 0.33, -0.80, -0.76, 0.18 and 0.31 respectively. A lower LC, NL or EU represents students who are FI. Students with high PD or TO are considered FI whereas students with low PD or TO are FD. The interaction term of PO*TO can be simulated by assuming a student’s PD and TO scores are each 2 units on the Likert scale in the survey. The student response may then change to 3 units for PD and TO in the second survey. The change would be reflected as PD+TO = CS (-0.80-0.76=-1.56) units on the
CS score. This implies the student’s CS had changed from FD to FI due to the predicted score decreasing by 1.56 units. However, the actual change was calculated as $-1.56+0.31*(3*3-2*2) = -0.01$ unit, which means only a slight insignificant change occurred in the direction of FD to FI due to the interaction term PD*TO. This further implies that there was no change in students’ CS. The estimated mean residual standard errors and mean residual deviances were 0.47 and 0.22 respectively with 70 degrees of freedom. Six residual diagnosis plots are commonly used to check the MLR model assumptions. Figure 6.1 is the residual against fitted values and Figure 6.2 is the square of the absolute value of residuals. Figure 6.3 is the observed and fitted values of CS. Figure 6.4 is the quantile-quantile (Q-Q) residual plot. Figure 6.5 is the standardized CS against standardized fitted values and residuals. Figure 6.6 is the Cook’s distance of each residual. From the six regression residual diagnosis plots, the fitted regression model is not against the assumption that the residuals are independently normally distributed. In Figures 6.1, 6.2 and 6.3, all the residuals showed no pattern of increase, decrease or correlation with the fitted values. This implies all the residuals were independently distributed. In Figures 6.4 and 6.5, all the residuals are normally distributed as observed by the standardization of CS, residuals and fitted values. Only three residuals in the order of 12, 33 and 39 were larger than others but they were acceptable with $3/77$ (Figure 6.6).
Figure 6.1 Plot of Residuals Against the Fitted Values

Figure 6.2 Plot of the Square Root of Absolute Residuals Against Fitted Values
Figure 6.3 Plot of the Observed and Fitted Values of CS

Figure 6.4 All the Residuals in Quantile – Quantile (Q-Q) Plot
Figure 6.5 Plot of the Standardized CS against Standardized Fitted Values and Residuals

Figure 6.6 Plot of the Cook’s Distance of Each Residual
6.2.3.2 MLR Combined Semesters Data (Semesters 1 and 2 Results)

Replication of similar research outcomes indicates valid and reliable findings as well as confirmation of an effective sample size. This section reports on the validity and reliability of the survey results tested through a replication process in Semester 2 that involved conducting an additional survey using the same survey instrument. In addition, the combination of the data from both semesters is an alternative method to increase the sampling size and power analysis to detect relationships between the response variable and all the predictor variables. Therefore, it justifies additional statistical analyses using MLR modelling on the data from the combined semesters.

In the Semester 1 results, all 18 coefficients of demographic characteristics were insignificant (p>0.10) (Table 6.7). Therefore, the demographic characteristics were discounted from the list of predictor variables in the MLR models. The following section presents the results from the combined data and refitted all the significant predictor variables with their interactions. The final sub-model selected by AIC consisted of the following predictor variables: EU, NL and TO. The final sub-model selected by AIC with all the higher order interaction terms among all the predictor variables (estimated coefficient, p-value) were intercept (9.242, p=0.041), EU (-3.567, p=0.079), NL (-2.356, p=0.134), TO (-3.591, p=0.020), TO*NL (1.212, p=0.025), EU*NL (1.212, p=0.079), TO*EU (1.709, p=0.014) and TO*EU*NL (-0.551, p=0.019). This implies that there are significant higher order interaction terms in predicting students’ CS. The estimated residual standard errors of fit was 0.47 (df=140) and the estimated mean residual deviance was 0.22. The results based on the combined data resulted in the same conclusions as the Semester 1 results – that EU, NL and TO are key
predictor variables to predict students’ CS, but they do not indicate which predictor variable is more important. As discussed in Section 6.2.3, it is very difficult to interpret higher order interaction terms from MLR results. In addition, it is very difficult to identify the most important predictor variable in the final selected sub-model. In this situation, nonparametric statistical modelling - tree-based regression - was used to model the collected data in the next section.

### 6.2.4 Tree-based Regression Results

Tree-based regression (TBR) was used to study the effect of higher order interactions of the predictor variables on the response variable. The response variable is the students’ CS and the predictor variables are the three learning dimensions, five culture dimensions, evaluation of unit and location. This model is best suited to carry out statistical analysis on limited data and higher order interaction among predictor variables. Firstly, the TBR was used to model the Semester 1 data set. Confirmation of the robustness of the TBR statistical model and overall results of the combined semesters’ data are presented in Section 6.2.4.2.

#### 6.2.4.1 TBR Semester 1 Results

The top-most predictor variable (EU) prior to the first split in the tree regression represented the most important variable to determine students’ CS in comparison with other predictor variables such as learning and culture dimensions (Figure 6.7). The first split on the left side of EU (<2.417) and NL (<2.315) represents students who are FI. The second splits consist of the learning dimensions of NL and LC. The third splits
consist of the culture dimensions of IC, PD and TO. Hence, the order of importance in determining CS was unit evaluation followed by learning dimensions and then culture dimensions. Predictor variables such as MT, UA, MF, location and demographic characteristics were not present in the TBR, indicating the insignificance of these variables to determine the effect of direct and higher order interaction on CS.

Students with IC<2.667 tend to be more individualistic, have responses of NL<2.813 and EU<2.417 and tend to be FI (CS=2.15<2.819, n=10). Students with responses of NL<2.813 and EU<2.417 tend to be FI (CS=2.347<2.819, n=18); students with responses of PD<3.167, NL>=2.813 and EU<2.417 tend to be FI (CS=2.724<2.819, n=16); students with responses of PD>=3.167 and NL>=2.813 and EU<2.417 tend to be FD (3.094 >2.819, n=8); students with lower learning control (LC<3.155) and higher unit evaluation (EU>2.417) tend to be FI (CS=2.659 <2.819, n=11); and students with higher learning control (LC>=3.155) and higher unit evaluation (EU>2.417) tend to be FD (3.406 >2.819, n=8).
evaluation (EU>2.417) tend to be FD (CS=3.219>2.819, n=24). Also, students tend to be FD with a response of cognitive style (CS=3.406>>2.819) and long-term orientation (TO>2.5, n=24).

6.2.4.2 TBR Combined Semesters Data (Semesters 1 and 2 Results)

Like MLR combined Semesters 1 and 2 results (Section 6.2.3.2), a TBR was used to model the combined semesters data. This replication process enabled verification of the robustness of the results. The most important predictor variable was EU (unit evaluation) and the second most important predictor variables were NL and LC (learning dimensions). The third most important predictor variables were PD and IC (culture dimensions). Although the Semester 1 TBR results presented TO as one of the third most important culture predictor variables, it was not presented in the analyses of the combined data sets. The reason for this outcome is unknown. In general, TBR modelling should be very robust when adding the second set of data (Semester 2).

The overall mean of students’ CS score is 2.762. As indicated in Figure 6.8, students with NL<2.80357 and EU<2.25 tend to be FI (2.347 <2.762, n=36); students with IC>2.5, NL>2.80537 and EU<2.25 tend to be FI (2.750 <2.762, n=39); students with PD<3.5, LC<3.53571 and EU >2.25 tend to be FI (2.750 <2.762, n=37); students with IC<2.5, NL>2.80537 and EU<2.25 tend to be FD (3.143>2.762, n=7); students with PD>3.5, LC<3.53571 and EU >2.25 tend to be FD (3.25 <2.762, n=6); and students with LC>3.5351 and EU >2.25 tend to be FD (3.199>2.762, n=23). Most importantly, TBR analyses of the combination of the two sets of data (Figure 6.8)
resulted in a similar outcome to just one set (Semester 1) (Figure 6.7). This is a good indication that the model produced valid and reliable results.

**Figure 6.8** Tree-based Regression Results of Semesters 1 and 2 based on Response Variable CS and the Predictor Variables. The Tile Plot is the Distribution of the Residuals in Each Terminal Node (mean residual deviance= 0.21)

### 6.2.5 MLR Results Compared to TBR Results

The overall results from MLR and TBR indicated that students’ CS was affected by evaluation of unit, learning dimensions and culture dimensions. In addition, students’ CS was affected by higher order interaction among learning dimensions, culture dimensions and unit evaluation. In addition, both statistical models concluded that students’ demographic characteristics did not affect their CS. On the other hand, the TBR provided more detailed information about the relationship between the response variable, CS, and predictor variables and their interaction terms, compared with the MLR. As shown on the tile plot (lower portion of Figure 6.7), only the means CS=2.15 and CS=3.406 had larger differences in residuals within the same node. In addition, the TBR
estimated mean residual deviance in Semester 1 was 0.15 with 70 degrees of freedom; a smaller residual deviance compared to the MLR estimated mean residual deviance of 0.22 in Semester 1. Similarly, the TBR estimated mean residual deviance in combined Semesters 1 and 2 was 0.21 with 142 degree of freedom (as listed in Figure 6.8), a smaller mean residual deviance compared to the MLR estimated mean residual deviance of 0.22 in the combined data. The residual deviance results for both Semester 1 and combined Semesters 1 and 2 reconfirmed that TBR outperforms MLR in fitting the relationships between students’ CS and all other predictor variables. Drawing from these comparisons, both MLR and TBR models provided similar results; however, TBR model outperformed the MLR due to its better fit with a smaller deviance and a lower assumption. The results based on MLR models are very difficult to interpret and could not further explain the interactions of all variables given the limited data. TBR models are easier to be interpreted and discussed when analysing a set of independent variables that contain a mixture of numeric variables and factors. They do not predict or grow nodes when there are insufficient data and they are robust to monotonic behaviour of independent variables, so that the precise form in which these appear in the model is irrelevant. MLR models do not allow interactions between predictor variables unless they are in multiplicative form. TBR models can detect interactions between several levels or parts of the numeric range of predictor variables. Thus, the TBR method was mainly employed to determine cognitive style by analysing the relationships among learning and culture dimensions, unit evaluation and demographic characteristics.
6.2.6 Cross-sectional Results of Time and Location

T-tests and MLR were used for the cross-sectional study of time and/or location and the results are presented in this section. The first section presents results from the t-tests used to detect changes in the means of response and predictor variables from one location to another location or one time to another time. MLR was used to investigate the effect of location (two levels: Australia (control) and Malaysia) and time (two levels: Semester 1 and Semester 2) for each of the studied variables and the results are presented in Section 6.2.6.2.

6.2.6.1 T-test Time and Location Results

Time Effect on All Variables

The time effect between Semester 1 and Semester 2 based on the t-tests revealed that there was no significant difference in Malaysian (p=0.38) and Australian students (p=0.43) CS.

Location Effect on All Variables

T-test results for Semester 1 revealed that there was a significant difference (p=0.043) between Australian (2.70) and Malaysian (2.93) students’ CS. This indicated that Malaysian students are likely to be FD whilst Australian students tend to be FI. The survey results in Semester 2 were similar with a significant difference (p=0.02) between Australian (2.56) and Malaysian (2.87) students’ CS. Based on this pattern, it can be inferred that Malaysian students tend to be FD whereas Australian students tend to be FI.
6.2.6.2 MLR Time and Location Results

The MLR analysis results of cross-sectional studies on time (Semesters 1 and 2) and location (Australia and Malaysia) with all variables are listed in Table 6.8. The time difference between the commencement of each semester is six months. From the F-statistics, all the estimated linear regression lines were significant (p<0.05) except for TO. Likewise, CS, NL, LC, PD, IC, UA and MF had a significant (p<=0.02) linear trend with location but not with time. In addition, EU and MT had a significant (p<=0.02) linear trend with time and location effects.

<table>
<thead>
<tr>
<th>Estimated Coefficient (P-value)</th>
<th>Response variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS</td>
</tr>
<tr>
<td>Intercept</td>
<td>191.92 (P = 0.25)</td>
</tr>
<tr>
<td>Time (S1/2008,S2/2008)</td>
<td>-0.09 (P = 0.25)</td>
</tr>
<tr>
<td>Location (level-Australia, Malaysia)</td>
<td>0.13 (P = 0.002)</td>
</tr>
<tr>
<td>F-statistics (p-value)</td>
<td>5.93 (P = 0.003)</td>
</tr>
</tbody>
</table>

Note: Bold indicates significant (P<0.05)
Time Effect on All Variables

The estimated time coefficients of CS, NL, LC, PD, IC, MF and UA were not significant (p>0.05). Among the three learning dimensions, NL and LC did not change with time. Among the culture dimensions, PD, IC, MF and UA did not change with time. On the other hand, students’ EU scores changed over the two time periods (-0.25). The change in score indicates that students were increasingly satisfied with their overall learning experience over time. Students’ MT score also changed over the two time periods (-0.47). This change in score indicates that students became more proficient in navigating the hypermedia system with experience. In other words, over time, students became less passive and learned to approach a problem in an analytical way. This suggest that, at the beginning of the course, FD students were less likely to utilise all the navigation tools provided in the hypermedia learning environment when carrying out an assigned task. As students gained more learning experience, they became more confident in navigating.

Location Effect on All Variables

The location effect of all estimated significant trends of all variables were significant (p<0.05). The Malaysian students’ CS score was 0.13 higher than the Australian students’ CS score. This implies that Malaysian students have a greater preference in being guided in their learning process; such a characteristic can be classified as FD. On the other hand, the Malaysian students’ EU score was 0.22 higher than the Australian students’ EU score. This indicates that Malaysian students have a greater demand on their lecturer in terms of providing additional learning materials.
In the learning dimensions, the Malaysian students’ NL score was 0.13 higher than the Australian students’ NL score, which indicates that Malaysian students enjoy working in a group while Australian students prefer to work alone. The Malaysian students’ LC score was 0.086 higher than the Australian students’ LC score, which implies that they are relatively passive and are less capable of learning independently. This further suggests that Malaysian students are less likely motivated to learn if they are allowed to have greater control in their learning. The Malaysian students’ MT score was 0.12 higher than the Australian students’ MT score, implying that they approach a problem in a global way or accept ideas as presented, whereas Australian students are more analytic in their approach. In other words, Australian students are able to control their own learning paths of complex subject matter independently, while Malaysian students have the tendency to become lost or disoriented in a hypermedia learning environment that has too many links and navigation tools.

In the culture dimensions, there was a significant (p<0.05) difference between Australian and Malaysian students. Malaysian students are likely to accept the hierarchical order between lecturers and student, value relationships and respect their lecturers, friends and family members. They may not tolerate anxiety and stress but will persevere when face with challenges. In contrast, Australian students favour equality between lecturers and students, lack interpersonal connections in which little responsibility is shared beyond family, and their carefree attitude enables them to tolerate anxiety and stress in their studies. These findings are consistent with Hofstede (2009) cultural framework as described in Section 4.1.
Using the same survey to collect additional data in Semester 2 strengthened the power of the analysis in this study due to the process of replication. In addition, the effect of time on all response and predictor variables can now be investigated.

6.3 Longitudinal Studies

One of the advantages of a longitudinal study is that it can prevent sampling errors between students. In this study, the longitudinal investigation involved detecting any changes in students’ responses. Although there were 99 students participating in the Semester 2 survey, only 22 of those had participated in Semester 1. These 22 students, therefore, were regarded as longitudinal students. The longitudinal students were extracted by matching the student numbers.

6.3.1 Linear Mixed Effects Models and Multiple Linear Regression Results

This study uses both multiple linear regression (MLR) and linear mixed effects models (LME) to model the relationships among CS and four groups of variables (learning styles, culture dimensions and unit evaluation) as well as time and location (Section 3.6.5).

The LME outperformed the MLR when modeling the relationships of the predictor variables EU, LC, PD and TO based on both AIC and BIC information criteria presented in Table 6.9. In addition, the outcome of analyses based on the LME model generated smaller residual standard errors (sigma values in Table 6.9) compared with the MLR model. All estimated parameters, including both slope and intercepts of the MLR and LME models, were highly significant (p<0.01). The estimated slope and intercepts
of the MLR were similar in values to the estimated slope and intercept of the LME model. The LME model is another powerful statistical model that takes into account the random effects of individual students on the response variable (cognitive style) in hypermedia learning systems. The longitudinal study is a more powerful tool compared with the cross-sectional study in detecting the relationships between cognitive style and predictor variables despite the small sample size. In addition, the model can be used to detect individual changes with time. This enables the detection of change in the relationship of individual cognitive style and its significant predictor variable(s).

**Table 6.9 LME and MLR fits with CS as the Response Variable and EU, LC, PD and TO as the Predictor Variables**

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Model (p-value of likelihood ratio test between LME and MLR results)</th>
<th>Estimated Intercept (st.error)</th>
<th>Slope (st.error)</th>
<th>SD of intercept</th>
<th>SD of slope</th>
<th>Correlation between random slopes and random intercepts</th>
<th>AIC</th>
<th>BIC</th>
<th>Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>LME (p=0.01)</td>
<td>1.83 (0.40)</td>
<td>0.46 (0.16)</td>
<td>1.19</td>
<td>0.45</td>
<td>-1</td>
<td>72.17</td>
<td>82.59</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>MLR</td>
<td>1.99 (0.31)</td>
<td>0.40 (0.14)</td>
<td></td>
<td></td>
<td></td>
<td>78.42</td>
<td>83.64</td>
<td>0.53</td>
</tr>
<tr>
<td>LC</td>
<td>LME (p=0.03)</td>
<td>0.86 (0.03)</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
<td>79.67</td>
<td>90.09</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>MLR</td>
<td>0.85 (0.03)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>87.61</td>
<td>91.13</td>
<td>0.60</td>
</tr>
<tr>
<td>PD</td>
<td>LME (p=0.02)</td>
<td>1.76 (0.50)</td>
<td>0.36 (0.16)</td>
<td>1.52</td>
<td>0.47</td>
<td>-1</td>
<td>79.45</td>
<td>89.87</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>MLR</td>
<td>2.24 (0.14)</td>
<td>0.21</td>
<td></td>
<td></td>
<td></td>
<td>83.70</td>
<td>88.91</td>
<td>0.56</td>
</tr>
<tr>
<td>TO</td>
<td>LME (p=0.009)</td>
<td>1.50 (0.59)</td>
<td>0.49 (0.23)</td>
<td>1.64</td>
<td>0.66</td>
<td>-0.986</td>
<td>79.67</td>
<td>90.09</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>MLR</td>
<td>2.60 (0.48)</td>
<td>0.08 (0.17)</td>
<td></td>
<td></td>
<td></td>
<td>85.20</td>
<td>90.41</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**6.3.1.1 The Effect of EU on CS**

Figure 6.9 illustrates plots of observed data and fitted results of the LME models on 22 students based on both surveys. The assigned response variable is CS and the predictor...
variable is EU. The estimated linear regression relationship indicates students with no expectations of course materials (low EU score) are FI students (low CS score). Students with high expectations of well-prepared lectures (high EU score) are FD students (high CS score). The estimated correlation between the random effects of slope and intercept is -1. This indicates that the estimated individual student regression line with a smaller intercept would have a greater slope. In other words, FD students are not likely to change their expectations in EU even though there is a random change in the course preparation from the first to the second semester. In contrast, FI students are likely to change their expectations in EU when there is a random change in the course materials.

Figure 6.9 Plots of LME Model on 22 Longitudinal Students with Response Variable CS and Predictor Variable EU
6.3.1.2 The Effect of LC on CS

Figure 6.10 illustrates plots of observed data and fitted results of the LME models on the 22 longitudinal students. The assigned response variable is CS and the predictor variable is LC. The estimated intercept of the LME model fitted was not significant (p>0.20). The best fitted model of LME illustrated a slope that only began from the origin. The estimated slope of the LME model was 0.86. In addition, this slope was similar to the estimated slope of the MLR model, which was 0.85. Thus, it is apparent that the LME model resulted in a better fit compared with the MLR model. The coefficient of variation of random effects was 0.13/0.86=15%. A lower LC score relates to a lower CS score. This implies that students with a lower LC score are likely to be FI as they tend to have a higher ability to engage in independent learning with analytical thought. A higher LC score is related to a higher CS score. This implies that students with a higher LC score are likely to be FD as they tend to be relatively passive and less capable of learning independently. Students’ LC is likely to change with time; this change also affects the variation of individual CS.
6.3.1.3 The Effect of PD on CS

Figure 6.11 illustrates plots of observed data and fitted results of the LME models on the 22 longitudinal students. The assigned response variable was CS and the predictor variable was PD. The estimated slope and intercept from the LME model were highly significant (p<0.01). The estimated slope from the MLR model was not significant (p>0.05). It is apparent that the LME model resulted in a better fit than the MLR model when comparing the standard residual errors of both models. Based on the fitted results from the LME model, students who prefer equal distribution of power (low PD score) are likely to be FI students. On the other hand, students who accept unequal distribution of power (high PD score) are likely to be FD students. The estimated correlation between the random effects of slope and intercept was -1. This indicates that the
estimated individual student regression line with a smaller intercept would have a greater slope or a bigger change in CS. Hence, FD students are not likely to change their view of power distance randomly with time; FI students are likely to change their view of power distance randomly with time.

Figure 6.11 Plots of LME Models Predicted Results of 22 Longitudinal Students with Response Variable CS and Predictor Variable PD

6.3.1.4 The Effect of TO on CS

Figure 6.12 illustrates plots of observed data and fitted results of the LME models on the 22 longitudinal students. The assigned response variable was CS and the predictor variable was TO. The estimated linear regression relationship suggests that students with short term orientation (low TO score) are FI students (low CS score). However, students with long-term orientation (high TO score) are FD students (high CS score). The
estimated correlation between the random effects of slope and intercept was -0.986. The estimated individual student regression line with a smaller intercept would have a greater slope or a bigger change in CS. FD students are likely to change their term of orientation randomly with time. FI students are likely to change their term of orientation from short term orientation to long term orientation.

![Graph of LME Models Predicted Results](image)

**Figure 6.12** Plots of LME Models Predicted Results of 22 Longitudinal Students with Response Variable CS and Predictor Variable TO

### 6.4 Comparison of Results (Cross-sectional and Longitudinal Studies)

In this study, both MLR and LME were used to model the relationships among CS and three groups of variables (learning dimensions, culture dimensions and unit evaluation) as well as time and location. The principles of a longitudinal study have provided
additional support for the finding that variation of individual CS is affected by changes in EU, LC, PD and TO with time.

6.5 Summary of Results

Cross-sectional Results

Based on the elementary and advanced statistical analyses results for both case studies (Section 6.2), it is now possible to evaluate the hypotheses as described in Section 6.1. Findings which did or did not support the hypotheses are summarised in Table 6.10.

Table 6.10 Summary of Cross-sectional Hypotheses Results

<table>
<thead>
<tr>
<th>Alternative Hypotheses</th>
<th>Findings</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1.1: There is a difference between Australian and Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation.</td>
<td>Supported</td>
<td>There was a significant difference between Australian and Malaysian students’ CS, learning dimensions, culture dimensions and unit evaluation.</td>
</tr>
<tr>
<td>H1.2: Australian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation are correlated.</td>
<td>Not supported</td>
<td>Australian students’ CS was only correlated with NL in learning dimensions.</td>
</tr>
<tr>
<td>H1.3: Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation are correlated.</td>
<td>Not supported</td>
<td>Malaysian students’ CS was not correlated with learning dimensions, culture dimensions and EU.</td>
</tr>
<tr>
<td>H1.4: Students’ learning dimensions, culture dimensions and unit evaluation affect their cognitive style.</td>
<td>Supported</td>
<td>Multiple linear regressions results: EU, LC and NL in the learning dimensions, and PD and TO in the culture dimensions affected CS. Tree based regressions results: EU, LC and NL in the learning dimensions, and IC, PD and TO in the culture dimensions affected CS.</td>
</tr>
<tr>
<td>H1.5: Higher order interactions among students’</td>
<td>Supported</td>
<td>Multiple linear regressions results: PD*TO interaction term affected CS in Semester 1.</td>
</tr>
</tbody>
</table>
learning dimensions, culture dimensions and unit evaluation affect their cognitive style. | NL*EU*TO interaction term affected CS in Semesters 1 and 2. Tree based regressions result: higher order interaction terms from EU, LC, NL, IC, PD and TO affected CS in both Semesters 1 and 2.

**H1.6:** Students’ demographic characteristics affect their cognitive style. | Not supported | All students’ demographic characteristics did not affect their cognitive style compared with the predictor variables, unit evaluation, learning dimensions and culture dimensions.

**H2.1:** Students’ cognitive style changes with time in the development of hypermedia learning. | Not supported | There was no significant difference in Malaysian students’ CS between Semester 1 and Semester 2. Similarly, it was observed that there was no significant difference in Australian students’ CS between Semester 1 and Semester 2.

**H2.2:** Time and location affect the students’ cognitive style in hypermedia learning. | Partially supported | The MLR test results revealed that time did not affect students’ CS but location did affect students’ CS in hypermedia learning.

**H2.3:** Time and location affect the students’ learning dimensions, culture dimensions and unit evaluation. | Supported | The MLR test results revealed that all variables with the exception to TO, EU and MT had linear trend with time and location. NL, LC, PD, UA, IC and MF had linear trend with location.

**Longitudinal Results**

The predictor variables of EU, LC, PD and TO were significant in determining students’ CS. These results corresponded with the findings of the cross-sectional study presented in Section 6.2.4. The longitudinal study provided further findings that facilitate educators to understand that variation of individual CS is affected by changes of EU, LC, PD and TO with time. Nevertheless, one of the limitations of this study is that it can only investigate one predictor variable with CS in the LME model. This limitation was caused by the data; that is, having only one repeated measure of 22 students. If the data contained more repeated measures, it would have allowed the LME model to investigate
the correlation of the estimated random slopes and the random intercept among the predictor variables (Cheng & Kuk, 2002). The use of the LME model with repeated measures data enables the variation of CS with time to be understood. This variation is a combination of measurement errors, sampling errors and random errors. It is distributed with a constant mean and unknown variation. This implies that the measurement of CS should be conducted several times due to variation errors. However, the variation of CS can also be understood with the predictor variables, EU, LC, PD and TO.

The elementary and advanced statistical analyses results for the combined (longitudinal) data reported in Section 6.3 helped determine if the hypotheses were supported or not supported (Table 6.11).

<table>
<thead>
<tr>
<th>Alternative Hypothesis</th>
<th>Findings</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2.4: An individual student’s cognitive style varies with changes in their learning dimensions, culture dimensions or unit evaluation.</td>
<td>Supported</td>
<td>The LME results revealed that each individual student’s CS varied with the changes in EU, LC, PD and TO.</td>
</tr>
</tbody>
</table>

6.6 Conclusion

This research conducted vigorous statistical analyses consisting of effective statistical sample size determination, hypotheses testing and application of advanced statistical models (MLR, TBR and LME) to extract maximum information from the survey data. The significant findings in this study are:

(i) Unit evaluation is the primary variable to determine students’ CS.
(ii) Learning dimensions, particularly nonlinear learning and learner control dimensions, are considered as secondary variables that affect students’ CS.

(iii) Culture, in particular power distance, long term orientation, and individualism, are tertiary variables that affect students’ CS.

(iv) Neither demographic characteristics nor time affect students’ CS.

The following chapter discusses the implications of the study based on the findings reported in this chapter. The various applications of advanced statistical methods used in this study and its appeals in CS research are also discussed.
This chapter discusses the implications of the results reported in the previous chapter by addressing the two main research questions. The significant and non-significant factors that affect students’ cognitive style in hypermedia learning environment, their interrelationships and important patterns of order, and the efficacy of different statistical models are discussed.

7.1 Research Question 1: What are the Factors that Affect Cognitive Style?

There were six hypotheses tested to determine the factors affecting cognitive style, of which three (H1.1, H1.4 and H1.5) were supported. The implications of the results for these three hypotheses are discussed in detail. The three hypotheses that were not supported (H1.2, H1.3 and H1.6) are discussed briefly.

7.1.1 Supported Hypotheses

H1.1: There is a difference between Australian and Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation.

Based on the t-test results in both Semester 1 and Semester 2 surveys (Section 6.2.1), there is a significant difference between Australian and Malaysian students’ cognitive style, learning dimensions, culture dimensions and unit evaluation. The overall results suggest that Malaysian students’ cognitive style is more likely to fall within the field
dependent (FD) spectrum and Australian students’ cognitive style is more likely fall within the field independent (FI) spectrum (Section 6.2.1, Tables 6.1 and 6.2).

The significant difference in mean scores in the Australian and Malaysian students’ nonlinear learning (NL) dimension suggests that a hypermedia learning system is less likely to cause learning difficulties among Australian students since most Australian learners prefer working alone and use a discovery approach in their learning. On the contrary, hypermedia learning systems may not benefit Malaysian students since they are likely to be FD learners. This discovery further validates findings from earlier studies (Chen et al., 2000; Moos, 2009; Seufert et al., 2007) that found FD learners are more likely to experience greater learning difficulties in a nonlinear presentation of course content as they depend on structured and guided learning.

The significant difference in mean scores in the Australian and Malaysian students’ learner control (LC) dimension indicated that Australian students favour the greater degree of learner control experienced in hypermedia learning systems compared to Malaysian students. This has a positive implication for Australian students since previous studies (Chen & Macredie, 2002; Guthrie, 2010; Weller et al., 1994; Yoon, 1994) confirmed that FI students learn more effectively than FD students in high LC environments. In other words, it is expected that the flexibility and high interactivity of hypermedia learning environments are more likely to stimulate, motivate and accommodate Australian students’ learning interests and their preference for independent and self-regulated learning. A study by Lee et al. (2005) also supported this finding in which the extent of control in students’ learning supported by hypermedia learning environments plays a vital role in determining their cognitive style. This further
suggests that a hypermedia learning system that supports and caters to different cognitive styles provides students with greater control over their learning process. The flexibility and high interactivity of hypermedia learning environments can be a deterrent for FD students to perform well in their learning; however, a study by Yoon (1994) discovered that FD students were found to perform equally well compared to their FI counterpart when provided with ample learning support. Other studies (Fitzgerald, 1998; Ford & Chen, 2000; Liu & Reed, 1995) also found that, although FD and FI students used different navigation patterns, types of media and learning aids, their learning performances were similar.

The significant difference in mean scores in Australian and Malaysian students’ multiple tools (MT) dimension indicate that Malaysian students tend to be more dependent on navigational support than Australian students. The result could be associated with FD students being more inclined to browse and follow the sequence (linear way) of the program in contrast to FI students who tend to jump freely from one point to another using the index tool (see also Lee et al., 2005). Thus, compared to Australian students, Malaysian students are more susceptible to confusion and disorientation in the nonlinear structure of hypermedia learning environments. This supports past research (Chen et al., 2000; Chen & Macredie, 2004) that confirmed the connection between students’ cognitive style and the MT dimension, particularly how students’ cognitive style influence their choice of tools and navigation path. Interestingly, it was reported in Section 5.4.1 that there was a higher proportion of Australian students who were considered highly experienced computer users than Malaysian students. The smaller proportion of experienced computer users among
Malaysian students may further explain their greater dependency on navigational support and their tendency to have more difficulties in hypermedia navigation. Similar cases were confirmed in which effectiveness of hypermedia navigation is not only related to choice of tools and navigation pattern but is also related to computer experience and prior knowledge. For instance, Palmquist and Kim (2000) discovered that FD students with little or no experience in hypermedia navigation preferred a linear representation of content. Other studies (Chen et al., 2006; Fiorina et al., 2007; Moo & Azevedo, 2008; Rezende & de Souza, 2008) claimed that students’ computer experience affects hypermedia navigation with more experienced users spending less time navigating than less experienced users. However, this finding is qualified by Reed et al. (2000) who claim that navigation improves over time.

All the culture dimensions of Australian and Malaysian students are significantly different. Both Australian and Malaysian students’ power distance (PD), individualism vs collectivism (IC), masculinity vs femininity (MF), uncertainty avoidance (UA), and time orientation (TO) concurred with Hofstede (1980) culture dimension scores.

Australian students scored low in PD. This indicates Australian students learn in a highly interactive and very much student-driven learning environment. Two-way informal communication is commonly witnessed between Australian students and their lecturers whereby Australian students are not afraid to confront their lecturers with questions. The informal, direct and participative learning environment not only encourages analytical thoughts and independent learning among students but also stimulates effective learning. It is no surprise that Malaysian students, who come from a tightly integrated society, scored high on PD. The learning environment is expected to be
strongly hierarchical and teacher-driven. Lecturers are ranked higher than students on the basis of knowledge and authority and therefore contribute to students being apprehensive about questioning and challenging their lecturers. This result supports Keng (2010) study in which he found a high PD score for Malaysian students and described them as passive learners who strongly depend on their lecturer to pass on the knowledge, dictate the learning path and initiate communication. These characteristics contradict the features of online learning, which contributed to less positive perception of learning effectiveness. Malaysian students’ FD characteristics, to a certain extent, share similar characteristics associated with a high PD score, which further explained the implication that Malaysian students are prone to learning difficulties in a nonlinear presentation of information.

The present finding indicating that Australian students were strongly individualistic is consistent with Sugahara and Boland (2010). This indicates that Australian students prefer to work individually whereas Malaysian students prefer to work and take responsibility as a group. The individualistic characteristics of Australian students are consistent with the FI individualistic characteristics and therefore support the independent and self-regulated learning required in hypermedia environments. Malaysian students’ low individualistic characteristics may be a disadvantage for them in learning effectively due to a mismatch of the learning approach and learning environment. This supports Oyserman and Lee’s (2008) finding that individualism and collectivism produce different shifts in cognitive procedures, suggesting that the cultural spectrum influences information processing and thoughts.

Australian students’ MF scores were higher than their Malaysian counterparts. The results indicate that Australian students tend to be driven by competition, ambition,
achievement, success, assertiveness and accumulation of wealth and material possessions (Hofstede, 1986). On the other hand, Malaysian students’ lower score on the masculinity dimension may possibly be attributed to their modest, humble and nurturing characteristics (Manikutty et al., 2007). This implies that Malaysian students associate achievement with the establishment of close human relationship and Australian students are driven by competition and tangible success in the learning environment. Malaysian students’ femininity characteristic is similar to FD’s social orientation whereas Australian students’ strong masculinity trait is similar to FI’s characteristic of being internally directed.

Several studies have supported that a high UA score is associated with students’ preference for teacher-driven learning environment (Goh, 2009; Keng, 2010; Mitsis & Foley, 2009; Sugahara & Boland, 2010). However, findings from this study seemed to contradict such claims. Australian students in this study had a higher UA score compared to Malaysian students. In addition, students’ UA scores from both countries correspond with Hofstede (1980) UA scores (see Section 4.1). Australian students’ higher UA score may suggest their awareness of the risks associated with failure in adapting to hypermedia learning technology and implies that Australian students have a lower tolerance for stress and anxiety compared to their Malaysian counterparts. Nevertheless, the fact that Australian students have strong individualistic characteristics (proactive learning behaviour and strategic choices) would possibly minimise their stress, anxiety and risk of failure in hypermedia learning environments. This subsequently helps increase their learning confidence and optimise their chances of achieving their learning goals in a less predictable condition. On the other hand,
Malaysian students’ lower UA score may be attributed to their strong PD characteristics where acceptance of hypermedia learning technology is due to their high expectation of learning support provided by their lecturer. This subsequently leads to a lack of awareness of the risks associated with failure in adapting to the learning technology. Thus, they are likely to accept the uncertain conditions and risks related to their studies.

Malaysian students’ high TO score implies that long-term effort and exercise of perseverance are necessary for them in order to acquire the necessary skills and knowledge in the hope of successfully completing their studies and increase career opportunities (Goh, 2009; Hofstede & Minkov, 2010; Lim, 2004; Mitsis & Foley, 2009; Sugahara & Boland, 2010). The significant difference between the Australian and Malaysian students’ TO scores was obviously due to the ethnicity landscape across Australia and Malaysia. This is attributed to the relatively large proportion of Malaysian students of Chinese descent with strong Confucianism traditions (see Section 5.3.6).

Australian students’ low TO means that they value freedom, rights and achievement. Nevertheless, their strong masculinity traits of ambition and competition would lead them to focus on achieving immediate goals and quick tangible success (Hofstede & Minkov, 2010; Sugahara & Boland, 2010).

According to the evaluation of unit (EU) results, Australian students provided more positive learning feedback about the unit content and delivery compared to Malaysian students. A likely explanation is due to the nature of hypermedia learning systems in which the learning structure is inherently flexible and high interactive. This corresponds with the learning characteristics of Australian students who are FI. Another possible explanation is the influence of age ($p<0.134$, see p.189), since a larger
proportion of older or mature students were evident in the Australian cohort (see Section 5.2.2). Lee et al. (2005) discovered that demographic characteristics, particularly age, appeared to have significant interaction terms with other predictor variables to determine students’ cognitive style in hypermedia learning; older students fall within the FI continuum and younger students in the FD continuum. Other past studies have discovered that younger students’ perception of course evaluation was significantly different from older students; in particular, older students were highly motivated learners, achievement oriented and relatively independent and favour flexible learning instruction (Bentley & Selassie, 2010; Haan et al., 2010; McKenzie & Gow, 2004).

H1.4: Students’ learning dimensions, culture dimensions and unit evaluation affect their cognitive style.

The primary purpose of this hypothesis was to determine the direct effect of all predictor variables on cognitive style based on multiple linear regression (MLR) and tree-based regression (TBR) modelling. In addition, TBR modelling can detect the order of importance among significant predictor variables. The results from MLR modelling indicated that EU, LC and NL in the learning dimensions, and PD and TO in the culture dimensions, are significant predictor variables and thus affect cognitive style. In other words, students’ cognitive style is directly influenced by EU, LC, NL, PD and TO. Similarly, results generated by TBR modelling revealed that predictor variables EU, LC, NL, IC, PD and TO have a direct effect on cognitive style. EU is the most important variable to predict students’ cognitive style. The second most important predictor variables are the learning dimensions NL and LC, and third most important are the
culture dimensions IC, PD and TO. Findings from this study confirmed the results of the Lee et al. (2005) study, which indicated the importance of learning dimensions in predicting students’ cognitive style, particularly NL. Both MLR and TBR resulted in similar outcomes and reconfirmed the direct effect of the relationships between the predictor and response variables. However, the TBR model had a smaller mean residual compared to MLR model in this study. A smaller mean residual deviance indicates that TBR is a better fit of the statistical model. A drawback of MLR is that it can only detect linear relationships on multiple predictor variables whereas TBR can detect linear and nonlinear relationships on multiple predictor variables.

H1.5 *Higher order interactions among students’ learning dimensions, culture dimensions and unit evaluation affect their cognitive style.*

This hypothesis examined the effect of all possible interaction terms among all predictor variables on cognitive style. The MLR results imply that there are significant interaction terms in predicting students’ cognitive style but there is no indication of which predictor variable is more important. The results generated by TBR illustrate EU as the most important predictor variable to determine cognitive style, followed by LC and NL in the learning dimensions and PD and IC in the culture dimensions. In other words, EU is the key predictor variable in the construction of every interaction term. Students who fall within the FI continuum have low EU and NL scores whereas students who fall within the FD continuum have high EU and LC scores, or high EU, low LC and high PD scores. This implies that FI students are more satisfied with the unit content and delivery than FD students, particularly the nonlinear structure of the hypermedia learning system.
In other words, the flexibility and high interactivity of hypermedia learning environments hinder FD students in their learning.

7.1.2 Non-supported Hypotheses

The results from the Pearson correlation coefficient in determining the direct linear dependence between two variables were too weak to support the following hypotheses:

\( H1.2: \) Australian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

\( H1.3: \) Malaysian students’ cognitive style is correlated with learning dimensions, culture dimensions and unit evaluation.

A possible reason for the lack of support for these hypotheses may be the relatively small sample size. In addition, Pearson correlation coefficient is an elementary statistical method; a common standard measurement to conduct simply statistical analysis in quantitative research. In particular, Pearson correlation is bivariate in nature, which means that it is only capable of investigating direct relationships between two variables and is incapable of investigating multiple relationships. Analysis of multiple relationships can be accomplished by advanced statistical analysis such as multiple linear regression analysis.

\( H1.6: \) Students’ demographic characteristics affect their cognitive style.

The statistical analyses from the first MLR modeling process were extremely insignificant and thus provided no support for this hypothesis. The lack of differences in demographic effects on students’ cognitive style for both case studies may possibly be
due to a relatively large number of Malaysian students who speak English as their first language (Section 5.2.6). This can be for historical reasons because Malaysia was previously part of the British Empire, and English remained the *de facto* administrative language after independence in 1957. It was only in the early 1970s that Malay became a predominant language. This suggests that the use of English as the language of instruction in hypermedia systems does not pose a learning issue for Malaysian students.

### 7.2 Research Question 2: Does Cognitive Style Change Over Time?

Four hypotheses were tested to address the second research question, of which two (H2.3 and H2.4) were supported, one (H2.2) had partial support and another (H2.1) was not supported. The implications of the results for the hypotheses are discussed. The time effects in hypotheses H2.2 and H2.3 differ since predictor variables and the response variable were investigated separately.

#### 7.2.1 Supported Hypotheses

*H2.3 Time and location affect students’ learning dimensions, culture dimensions and unit evaluation.*

The MLR results revealed that there were differences between Australian and Malaysian students’ learning dimensions, culture dimensions and unit evaluation; however, the cultural dimension TO was found to be not significant. This signifies that NL, LC, PD, IC, UA and MF have a significant linear trend with location but not with time. It is therefore important that precautionary steps be taken into consideration when applying results from this study since it is only applicable to Australia and Malaysia.
EU and MT were the only predictor variables that varied with both time and location. Given the fact that MT constantly changes with advances in educational technologies over time, and students would have to learn new navigation strategies anyway, the MT result for time would not affect students’ cognitive style (refer to H.1.4). Therefore, researchers should only rely on the latest EU data for precise predictions of students’ cognitive style.

Interestingly, the insignificant effect of time on the Australian and Malaysian students’ culture dimensions (PD, IC, MF and UA) correspond with the majority of cross-cultural research findings (e.g. Gaspy et al., 2008; Hofstede, 1999; Hofstede, Neuijen, Ohayv, & Sanders, 1990; House, Hanges, Javidan, Dorfman, & Gupta, 2004; Smith, 2010) that culture is relatively static. In other words, cultural values differ across nations and influence how people respond to their environments.

\textit{H2.4: Individual students’ cognitive style varies with the changes in their learning dimensions, culture dimensions or unit evaluation.}

The LME results from the longitudinal study indicated that individual students’ cognitive style varies with changes in EU, LC, PD and TO (Table 6.9). Variations in EU (Figure 6.9) suggest that FD students are not likely to change their expectations of the unit content. This may be due to their expectation of a highly structured learning content. FI students’ satisfaction with EU, on the other hand, will vary depending on the unit content from semester to semester.

Cognitive style varying with changes in LC (Figure 6.10) implies that the high learner control featured in hypermedia learning systems is more suited to students with
FI characteristics who have the ability to engage in independent learning and that FD students tend to face learning difficulties and challenges due to their inclination to guided learning.

Cognitive style varying with a change in PD (Figure 6.11) indicates that FI students are likely to change their view of PD randomly over time whereas FD students are not likely to change their view of PD. That is, FI students’ PD orientation will likely change and vary from low to high PD and high to low over time while FD students will remain relatively stable.

As for PD, cognitive style varying with the change in TO (Figure 6.12) suggests that FI students are more likely to change from short term to long term orientation and that FD students will remain relatively stable.

7.2.2 Partially Supported Hypothesis

_H2.2 Time and location affect students’ cognitive style in hypermedia learning._

The results showed that time does not affect students’ CS in hypermedia learning but location does. The MLR results revealed there was a significant difference between Australian and Malaysian students’ cognitive style scores; in particular, Australian students’ CS scores were lower than Malaysian students’ CS scores. This confirms that Malaysian students tend to be FD whereas Australian students tend to be FI. However, the effect of time does not affect students’ cognitive style. This concurred with earlier findings (Messick, 1984; Peterson et al., 2009; Witkin et al., 1977) that students’ cognitive style is relatively stable over time or is a consistent characteristic within students’ cognitive processing. In other words, cognitive style does not change but may
vary randomly over time with a constant mean. Variations in cognitive style may be the result of measurement errors and/or sampling errors.

7.2.3 Non-supported Hypothesis

H2.1: Students’ cognitive style changes with time in the development of hypermedia learning.

There was no significant difference in both Australian and Malaysian students’ CS scores between Semester 1 and Semester 2. This result is consistent with the conclusion of H2.2, in that time did not affect CS scores. It is also consistent with earlier research (Messick, 1984; Peterson et al., 2009; Witkin et al., 1977) that found cognitive style is a constant characteristic.

7.3 Summary of Significant Findings

A summary of the significant factors that affect students’ cognitive style in hypermedia learning environment, their interrelationships and important patterns of order based on the hypotheses tested is represented in Figure 7.1. A key factor in predicting students’ cognitive style in hypermedia learning systems is students’ satisfaction with the content and delivery of the unit. Identification of FI students is based on their preference for flexible unit content as opposed to FD students who tend to be more comfortable with a structured unit content. In addition, it appears that students’ preference for the type of structural content and delivery of the unit corresponds with age.

Secondary factors such as learning dimensions and culture dimensions are also important considerations since it was confirmed that cognitive style is a stable and
consistent characteristic. This further implies that students’ ability to structure their cognitive overview in a hypermedia learning system depends on a learning setting in which the learning dimensions match their cognitive style. A learning environment with a nonlinear presentation of course content that offers a high degree of learner control is more suited to FI students while FD students will experience greater learning difficulties. Also, FI students are more commonly more experienced computer users than FD students.

Another significant aspect of this study is the confirmation that culture is relatively static. A learning environment in which the cultural dimensions contradict students’ cultural values can pose serious learning problems. In particular, FD students from highly hierarchical and collectivistic societies are likely to experience learning difficulties and fail to adapt if they are unable to overcome their apprehensive attitudes and interactions in class. Ethnicity and nationality also play a role in cultural values, particularly when comparing two different countries, which is evident in how the students responded to the different types of learning environments.
Figure 7.1 Patterns and Interrelationships of Variables based on Significant Findings with Demographic Effects.

7.4 Conclusion

In general, there was a significant difference in students’ cognitive style across the two countries investigated in this study. Australian students are more likely to be FI and Malaysian students are more likely to be FD. This implies that Australian students have a preference for a student-driven learning environment and Malaysian students have a preference for a teacher-driven learning environment. Fundamentally, the order of
importance among significant predictor variables with direct effect on cognitive style were EU, NL and LC in the learning dimension and IC, PD and TO the culture dimensions. This indicates that EU is a vital predictor variable for students’ cognitive style. The significance of the cross-sectional study indicated that students’ cognitive style is a relatively stable variable. The most important implication of the longitudinal study is that FD students’ EU, LC, PD and TO are not likely to change with time whereas FI students’ EU, PD and TO will change with time.
Chapter 8

CONCLUSION

The aim of this thesis was to identify the key factors that affect students’ cognitive style in educational environments supported by hypermedia systems. This final chapter summarises the importance of hypermedia systems as cognitive tools in promoting student learning in higher education and the main findings in relation to the research questions. The significance of this study, and its contribution to cognitive style in educational technology research, is also discussed, followed by recommendations as possible solutions to the research problems. The last section critically addresses the limitation of this study and provides avenues for future research.

8.1 Hypermedia as Cognitive Tool

The use of hypermedia as an instructional medium has grown rapidly with developments in ICTs. The more recent advancement of multimedia and software technologies enhanced with networking facilities have led to exciting opportunities for hypermedia learning system development. As a result, hypermedia has gained attention nationally and internationally in the field of education. Much of the popularity of the medium is derived from its capacity to convey large amounts of non-structured information to learners that parallels the way the human brain and memory work. This feature makes a hypermedia learning system an ideal tool for supporting multilineal thinking and facilitating self-directed learning (independent learning). Hypermedia learning systems alleviate time constraints and the place of learning; they support advanced interactivity
and communication between tutors and learners as well as one-stop maintenance and reusability of resources. In addition, the new technologies act as a tool for educators with few skills and experience in computer-based teaching to become developers and publishers of their own materials and systems in contrast to earlier years where hypermedia development required specific skills in software authoring.

8.2 Research Questions

This research began with two research questions:

1. What are the factors that affect cognitive style?

2. Does cognitive style change over time?

Hypotheses were developed from these questions and the findings discussed in Chapter 7. This section reports the progress made towards answering the research questions.

1. **What are the Factors that Affect Cognitive Style?**

The main findings of this study have indicated that unit evaluation is the key factor in predicting students’ cognitive style and is an important variable in determining students’ cognitive style in hypermedia learning systems. Furthermore, variation in learning dimensions and culture dimensions, to a certain extent, are interconnected to students’ evaluation of unit content and delivery. These interconnections indicate a learner’s ability to structure a cognitive overview in a hypermedia learning system and should also be taken into consideration when designing the system in order to enrich the learning experience for students. This is particularly important for field dependent learners, as they may not have the knowledge and experience to select the right path to understand what meaningful constructions of knowledge to master in
connection to curricular material (Chen et al., 2006; Moo & Azevedo, 2008; Rezende & de Souza, 2008).

2. *Does Cognitive Style Change Over Time?*

It was found that Malaysian students tend to be field dependent (FD) whereas Australian students tend to be field independent (FI) and that the students’ cognitive style does not change over time. This implies that cognitive style is a stable and consistent characteristic in the cognitive process. This supports past research findings that cognitive styles are relatively stable and closely linked to fundamental information processing mechanisms (Papanikolaou et al., 2006; Peterson et al., 2009; Witkin et al., 1967). It is important to note that, although the overall mean measurement or value did not change over time, variation in cognitive style is still possible when it is quantified by measurement or scale due to measurement errors. Measurement errors commonly occurred because of different measurement tools. Another possible source of variation in cognitive style is due to variation of individual students with time. This was evident in the longitudinal study where FI students’ EU, PD and TO changed with time. Nevertheless, compared to FI students, FD students are more likely to have greater difficulty learning in a nonlinear environment (Chen et al., 2000). This further implicates the importance of an emerging research concept known as adaptive hypermedia (Lo et al., 2012; Mampadi et al., 2011) in which learning effectiveness can be achieved when considering various perspectives or factors to match various learner characteristics.
and preferences when designing a hypermedia system. This issue will be discussed further in Section 8.3.

Overall, the cognitive tools in hypermedia learning systems support effective learning in higher education, particularly for students who possess FI learning characteristics. Although FD students may encounter some learning difficulties due to the nonlinear learning nature of hypermedia learning system, they can still be accomplished learners if adequate teaching and learning support is provided.

8.3 Recommendations

As discussed above, unit evaluation is the key variable in predicting students’ cognitive style. Therefore, prior to developing hypermedia learning content, educators should consider surveying the student cohort about their expectations of the unit content and delivery. Being aware of students’ particular learning needs and preferences according to their learning characteristics and cognitive styles provides valuable information to guide educators in tailoring teaching and learning materials to create a conducive and supportive learning environment that cultivates a positive learning attitude among all students.

It is suggested that student surveys should be conducted at both the beginning and the end of each semester. The pre-semester survey would facilitate identification of the cognitive styles in the student cohort, which would enable the unit coordinators to design their hypermedia system more effectively and the tutors and lecturers to adjust their teaching styles accordingly. The post-semester survey would elicit students’
feedback on learning content and delivery and facilitate the unit being adjusted for the following semester.

Modification of instructional content and navigation in hypermedia learning systems is ideally aligned more closely to various learner characteristics and preferences. However, in most instances, this is not a feasible option since university approval would have to be sought on the unit content well before the unit commences. Nevertheless, identification of students’ cognitive style at the beginning of the semester is still a vital process in collecting information in relation to students’ attitudes towards learning as it provides fundamental information for coordinators, lecturers and tutors in order to determine the necessary level of scaffolding required throughout the semester. For instance, if the evaluation indicates that students enrolled in the unit have predominantly FD characteristics, the unit coordinator can decide on the extent of additional teaching and learning resources and services to be delivered on the hypermedia system. Information in relation to students’ cognitive style collected at the beginning of the unit would not only help coordinators, lecturers and tutors to set the right balance of intervention or instructional help in hypermedia learning environments, but the appropriate navigation support in the structure of the content may compensate for FD students’ lack of conceptual structure of hypermedia learning (Azevedo & Hadwin, 2005; Chen et al., 2006; Schnotz, 2010; Schnotz & Heiß, 2009).

Verification of students’ learning needs is usually assessed through students’ satisfaction with the teaching and learning instruction and acquired knowledge delivered through the hypermedia learning system. In other words, positive or negative feedback gathered from evaluation of the course content of the unit at the end of the semester...
reveals the scope in which students’ learning needs are met or not met. Students’ satisfaction with the course content gives an indication that the instructional content and teaching style matches the students’ cognitive style whereas students’ dissatisfaction may strongly suggest a mismatch. Hence, students’ feedback at the end of a unit provides pragmatic information and awareness for course coordinators to improve next semester’s course content.

It is proposed that the two-stage student evaluation process would provide vital information to improve teaching effectiveness as the unit coordinator would be able accommodate the learning needs of different students and encourage students to use learning strategies effectively in a learning environment that requires extensive use of hypermedia learning systems. This can then be used to improve the planning, production and implementation of educational experiences, particularly in adaptable hypermedia learning systems.

8.4 Significance of the Research

The present study has made significant contributions to the research of cognitive style in hypermedia learning systems in a broad disciplinary area that incorporates multiple factors with supported evidence of their interconnections and patterns of order represented in a model (Figure 7.1).

The most important finding of this research is that it confirmed that students’ cognitive style is a stable and consistent characteristic and that it influences students’ overall learning responses to different structural content and delivery of the unit. Specifically, students’ cognitive style can be estimated based on students’ satisfaction
with the structural content and delivery of the unit. Taking this step enables the unit coordinator to develop and tailor the structure and delivery of the unit content as closely as possible to students’ cognitive style.

Another significant discovery was that culture is a relatively stable element and it has a substantial effect on students’ cognitive style in hypermedia learning. Interestingly, participants’ demographic results such as age, computer skills, ethnicity and nationality (Chapter 5) suggested feasible interconnections with the significant variables (Figure 7.1).

The detailed aspects of the case studies were supported by extensive quantitative analyses to justify the validity and reliability of the research finding. In particular, the hypotheses in the present findings were validated from basic to advanced applications of statistical modelling. The extraction of maximum information from both cross-sectional and longitudinal (repeated measures) surveys also attests to the validity of the results. Both methods enabled the investigation of predictor variables with time and location effects on students’ cognitive style from individual and group perspectives. In addition, the repeated measures design (using the same survey instrument in two semesters over a six-month period) supported the effectiveness of sample size determination and minimised bias in the present study.

8.5 Limitation of the Research

Despite the significance of this research, there are some limitations; in particular, the results from this study are only applicable to Australian and Malaysian students. Another limitation is the cluster sampling because of the possibility of producing biased
results. Ideally, empirical research should use random sampling with an equal number of samples within each group. However, it was not the case for this study, since in practice it is extremely difficult to accomplish a study that requires a large sampling size and the cooperation of a large number of academic faculty in both universities. This study has attempted to minimize bias or sampling errors using the repeated measures design, administering the same survey instrument in two semesters over a six-month period. Although the study of students who participated in both surveys (longitudinal students) has proven its effectiveness in testing the direct effect of predictor variables without the influence of variation among students, ideally more surveys are preferred over longer periods.

The number of voluntary participants is also an issue since only 22 students of the 99 students were identified as repeat survey participants. In addition, the recruitment of survey participants through conventional approaches such as paper surveys has been found to be easier and yield higher response rates compared to online surveys (Ballantyne, 2003). This has been reported and is confirmed by comparing the 93-97% survey response rate of Lee et al. (2005) study with the 71-89% survey response rate of this study. The difference in the minimum and maximum response range in both studies is also an indicator of the reliability of the data. However, a contributing factor to a lower response rate in this study compared to Lee et al. (2005) may be the length of the survey. The average survey completion time for this study was 25 minutes.
8.6 Future Research

An interesting area for future research in the interaction of cognitive style and hypermedia would be to carry out longitudinal data collection on individual students throughout the duration of their study program. The collection of two or more replications of survey data would enable the investigation of the response variable with bivariate and trivariate random effects among predictor variables.

The use of a longitudinal study to investigate the relationships between predictor variables and the response variable has proven to be an effective tool to avoid sampling errors. In this study, data were collected from two time snapshots due to limited time restriction. Ideally, data should be collected from three or more time snapshots.

Due to the difficulty of collecting longitudinal data, the survey should be redesigned and shortened to collect the necessary information as this would encourage more students to participate.

Further research using a survey instrument should be guided by the survey developed for this study and ideally standardise it for future use. This would facilitate direct comparison results and validate the reliability associated with similar research.

The cross-countries design in this study only surveyed Australian and Malaysian undergraduate students. Both countries are in the south-west Pacific region. Ideally, future studies should include countries in Africa, the Middle East, Europe and America in order to make comparisons more valid.
8.6 Conclusion

This study has contributed to a deeper understanding of the potential of hypermedia technologies as tools in supporting teaching and learning in the higher education environment as well as greater comprehension of the cognitive mechanisms underpinning hypermedia learning. In particular, it has contributed to an understanding of individual differences and factors that have an impact on individuals’ cognitive style in hypermedia learning environments. The findings of the potential of hypermedia learning systems in this study supported findings from earlier studies in which it was found that hypermedia learning systems promote self-directed and independent learning, especially among field independent students. In other words, hypermedia learning environments may not suit students with field dependent characteristics due to the nature in which learning materials and resources are presented. To accommodate field dependent learners in hypermedia learning environments, it is suggested that greater learning support and resources are provided to help reduce the discrepancy between the two types of learners.

The application of rigorous statistical analysis in this study has uncovered the interdisciplinary connection between hypermedia, cognitive style, culture dimensions and unit evaluation. Results from statistical analyses suggested some key areas that need to be addressed when designing and developing effective hypermedia learning materials. Of particular importance is the identification of students’ cognitive style through the evaluation survey, which provides the necessary information to correlate hypermedia design and teaching style with students’ cognitive style. This has a strong connection to learning effectiveness as learners’ performance could decline if a representational
approach that contradicts their cognitive style is used. In conclusion, the significance of this study has promoted ideas for the implementation of efficient hypermedia instructions to accommodate different learner groups and to reduce the performance discrepancies among learners, which in turn would yield greater learning effectiveness.
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APPENDIX A

Pilot Survey

Geographical & Time-related Differences in Learning Styles (pilot)

PARTICIPATION INFORMATION LETTER

Welcome to the survey: Geographical & Time-related Differences in Learning Styles.
I am a PhD student at Murdoch University investigating a detailed evaluation of the geographical and time-related changes in cognitive style in the development of e-learning related to the course you are undertaking in your University. My supervisors are Dr Fay Sudweeks and Dr Ray Webster (Murdoch University). Dr Tang Fu Ee of Curtin University of Technology, Sarawak is also assisting the research.

You can help contribute to this study by completing the survey. It is anticipated that the time to complete the survey will be about 20 minutes. The survey will ask for your evaluation in relation to the course, classroom culture and unit course. You will also be asked to provide demographic information. You can choose not to answer any of the questions on topics sensitive to you. There will be a follow up of a second survey and therefore you will be required to provide your student number as it will be used to link the results of the two surveys.
Completion of the survey is entirely voluntary and you can decide not to participate at any time simply by not completing and submitting the survey. All information given during the survey is confidential and no names or other information that might identify you will be used in any publication arising from the research.
If you have any questions about this research please feel free to contact either myself, Catherine Lee, at catherinelee.98@yahoo.com, or my principal supervisor, Dr Fay Sudweeks, at sudweeks@murdoch.edu.au. If you wish to talk to an independent body about your concerns you can contact Murdoch University’s Human Research Ethics Committee on 9360 6677 or email ethics@murdoch.edu.au.
If you are willing to participate in this study, please proceed by clicking on the "Next". Initially, you will be asked to read the participant declaration and indicate if you give your consent to participate by clicking the "Agree" button. If you agree, you will be able to commence the survey.

This study has been approved by the Murdoch University Human Research Ethics Committee ( Permit No. 2007/240)

Thank you,
Catherine Lee

Next
Page 1 PARTICIPATION DECLARATION

1. I have read the information above about the nature and scope of this research. Any questions I have asked about the research process have been answered to my satisfaction. I agree to take part in this research. By submitting the survey on-line I give my consent for the contents to be used in the research. However, I am aware that I may change my mind and withdraw my consent to participate in this initiative at any time.

I understand that all information provided is treated as confidential and will not be released by the investigator unless required to do so by law.

I agree that research data gathered for this study may be published provided my name or other information which might identify me is not used.

☐ Agree  ☐ Disagree

2. I would like to receive a summary of the results of the research.

   Email Address  

Next
### Geographical & Time-related Differences in Learning Styles (pilot)

#### Page 2 LEARNING STYLE

<table>
<thead>
<tr>
<th>3. EVALUATE YOURSELF IN RELATION TO THE UNIT.</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No Opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tr>
<td>I develop my own structure to answer questions.</td>
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<td>I mostly reproduce content from lecture notes to answer questions.</td>
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<td>I feel that I have acquired sufficient knowledge and skills to prepare me for the examination.</td>
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<td>I feel that much of what I am learning does not prepare me well for the examination.</td>
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<td>The flexibility of the unit content is empowering to me.</td>
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<td>I would rather study a unit that is completely online (distance) compared to a conventional (face to face) mode of learning.</td>
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<td>I would rather study a unit that incorporates both online (distance) and</td>
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<td>conventional (face to face) mode of learning.</td>
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<td>I learn better with written instructions as opposed to verbal instructions.</td>
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<td>I attend tutorials because of the immediate assistance I can get from my</td>
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<td>tutor.</td>
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<td>The unit is rewarding because it involved a lot of individualized learning.</td>
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<td>I feel disconnected to the learning in this unit due to the complexity of</td>
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### Evaluate Your Classroom Culture

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<tr>
<th>Strongly Agree</th>
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<th>Disagree</th>
<th>Strongly Disagree</th>
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<td>I believe people should enjoy the present time given the unchangeable past and unpredictable future.</td>
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<td>I believe people should focus on a long-term plan to secure future interests.</td>
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</table>
### 5. Evaluate the Unit

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<th>Disagree</th>
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<tr>
<td>The unit objectives were clear.</td>
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<td>The amount of materials and resources provided was sufficient.</td>
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<td>I was satisfied with the unit.</td>
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<td>The workload was appropriate for this unit.</td>
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<tr>
<td>I was satisfied with my involvement in the activities of this unit.</td>
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<tr>
<td>I gained practical knowledge from this unit.</td>
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</tbody>
</table>
6. About You:

Course Major

Year of Enrollment

Year you were born

Country of Origin

Current Nationality

First language

Additional language(s) spoken

7. Student Number:

8. Student Type:

Local Student

International Student
9. Enrolment Type:
   - [ ] Full time
   - [ ] Part time

10. I am:
    - [ ] On scholarship
    - [ ] On loan
    - [ ] Supported by family
    - [ ] Independent

11. Are you currently employed?
    - [ ] Yes
    - [ ] No

12. Marital status
    - [ ] Single
    - [ ] Married/Partner

13. My ethnicity:
    - [ ] African descendant
    - [ ] Asian
    - [ ] Caucasian
    - [ ] Hispanic
    - [ ] Indian
    - [ ] Middle Eastern
    - [ ] Other, please specify

Geographical & Time-related Differences in Learning Styles (pilot)

Page 6 END OF SURVEY

Please click the "submit" button to complete the survey. We appreciate you taking the time to take our survey.
Thank You.

Previous Submit

This survey is powered by www.surveymethods.com
Welcome to the survey: Geographical & Time-related Differences in Learning Styles.
I am a PhD Student at Murdoch University investigating a detailed evaluation of the geographical and time-related changes in cognitive style in the development of e-learning related to the course you are undertaking in your University. My supervisors are Dr Fay Sudweeks and Dr Ray Webster (Murdoch University). Dr Tang Fu Ee of Curtin University of Technology, Sarawak is also assisting the research.
You can help contribute to this study by completing the survey. It is anticipated that the time to complete the survey will be about 10 minutes. The survey will ask for your evaluation in relation to the course, classroom culture and unit course. You will also be asked to provide demographic information. You can choose not to answer any of the questions on topics sensitive to you. There will be a follow up of a second survey and therefore you will be required to provide your student number as it will be used to link the results of the two surveys. However, identifying information will not be given to your lecturer or tutor.
Completion of the survey is entirely voluntary and you can decide not to participate at any time simply by not completing and submitting the survey. All information given during the survey is confidential and no names or other information that might identify you will be used in any publication arising from the research.
If you have any questions about this research please feel free to contact either myself, Catherine Lee at catherinelee.98@yahoo.com, or my principal supervisor, Dr Fay Sudweeks at sudweeks@murdoch.edu.au, or you can contact Murdoch University’s Human Research Ethics Committee on 9360 6577 or email ethics@murdoch.edu.au.
If you are willing to participate in this study, please proceed by clicking on the “Next”. Initially, you will be asked to read the participant declaration and indicate if you give your consent to participate by clicking the “Agree” button. If you agree, you will be able to commence the survey.
This study has been approved by the Murdoch University Human Research Ethics Committee (Permit No. 2007/240)

Thank you,

Catherine Lee
1. I have read the information about the nature and scope of this research. Any questions I have asked about the research process have been answered to my satisfaction. I agree to take part in this research. By submitting the survey online I give my consent for the contents to be used in the research. However, I am aware that I may change my mind and withdraw my consent to participate in this initiative at any time.

   I understand that all information provided is treated as confidential and will not be released by the investigator unless required to do so by law.

   I agree that research data gathered for this study may be published provided my name or other information which might identify me is not used.

   □ Agree    □ Disagree

2. Please enter your email address if you would like to enter in a prize draw of a 8 GB Flash Drive and receive a summary of the results of the research.

   Email Address: 

   Next
### 3. Evaluate Yourself in Relation to the Unit.

<table>
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<tr>
<td>1. I develop my own structure to answer questions.</td>
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<td>2. I mostly reproduce content from lecture notes to answer questions.</td>
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<td>3. I feel that I have acquired sufficient knowledge and skills to prepare me for the examination.</td>
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<td>4. I feel that much of what I am learning does not prepare me well for the examination.</td>
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<td>5. The flexibility of the unit content is empowering to me.</td>
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<td>6. I would rather study a unit that is completely online (distance) compared to a conventional (face to face) mode of learning.</td>
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<td>8. I learn better with written instructions as opposed to verbal instructions.</td>
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<td>9. I attend tutorials because of the immediate assistance I can get from my tutor.</td>
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<td>10. The unit is rewarding because it involved a lot of individualized learning.</td>
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<td>42. I believe people should enjoy the present time given the unchangeable past and unpredictable future.</td>
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This survey is powered by www.surveymethods.com
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<thead>
<tr>
<th></th>
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<th>Agree</th>
<th>No Opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tbody>
<tr>
<td>44. The unit objectives were clear.</td>
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<tr>
<td>49. I gained practical knowledge from this unit.</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
6. **Student Number:**

7. **Gender:**
   - Male
   - Female

8. **About You:**
   - Course Major
   - Year of Enrolment
   - Year you were born
   - Country of Origin
   - Current Nationality
   - First language
   - Additional language(s) spoken
9. **Student Type:**
- [ ] Local Student
- [ ] International Student

10. **Enrolment Type:**
- [ ] Full time
- [ ] Part time

11. **I am:**
- [ ] On scholarship
- [ ] On loan
- [ ] Supported by family
- [ ] Independent

12. **Are you currently employed?**
- [ ] Yes
- [ ] No

13. **Marital status**
- [ ] Single
- [ ] Married/Partner

14. **My ethnicity:**
- [ ] African descendant
- [ ] Asian
- [ ] Caucasian
- [ ] Hispanic
- [ ] Indian
- [ ] Middle Eastern
- [ ] If other, please specify


15. Religion:
- No religion
- Buddhist
- Christian
- Hindu
- Muslim
- If other, please specify

16. Computer experience:
- <1
- 2-3
- 4-5
- 6-7
- 8-9
- >10

17. First introduced to computer:
- Home
- Workplace
- Preschool
- Primary school
- Secondary school
- University

18. Computer use:
- None
- Monthly
- At least once a week
- A few times a week
- Everyday
Please click the "submit" button to complete the survey. We appreciate you taking the time to take our survey.
Thank You.
Actual Survey Semester 2

Geographical & Time-related Differences in Learning Styles (Murdoch)

<table>
<thead>
<tr>
<th>Participation Information Letter: Geographical &amp; Time-related Differences in Learning Styles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am a PhD Student at Murdoch University investigating a detailed evaluation of the geographical and time-related changes in cognitive style in the development of e-learning related to the course you are undertaking in your University. My supervisors are Dr. Fay Sudweeks and Dr. Ray Webster (Murdoch University). Dr. Tang Fu Ee of Curtin University of Technology, Sarawak is also assisting the research.</td>
</tr>
<tr>
<td>Thank you to all 45 students who had attempted the first survey conducted between May and July this year. As mentioned previously, a second survey will be carried out in order to complete the longitudinal study. In other words, we would like to invite those who had previously participated in the first survey to participate for a second time in this survey. The questions in the second survey are exactly the same to the first survey. Your participation is very much appreciated!</td>
</tr>
<tr>
<td>For those who have not previously participated in this survey, you still can do so by completing this survey and the results will help us to complete the cross-sectional part of this study.</td>
</tr>
<tr>
<td>It is anticipated that the time to complete the survey will be about 10 minutes. The survey will ask for your evaluation in relation to the course, classroom culture and unit/course. You will also be asked to provide demographic information. You can choose not to answer any of the questions or topics sensitive to you.</td>
</tr>
<tr>
<td>Please note that you will be required to provide your student number as it will be used to link the results of the two surveys.</td>
</tr>
<tr>
<td>However, identifying information will not be given to your lecturer or tutor.</td>
</tr>
<tr>
<td>Completion of the survey is entirely voluntary and you can decide not to participate at any time simply by not completing and submitting the survey. All information given during the survey is confidential and no names or other information that might identify you will be used in any publication arising from the research.</td>
</tr>
<tr>
<td>If you have any questions about this research, please feel free to contact either myself, Catherine Lee at <a href="mailto:catherinlee_95@yahoo.com">catherinlee_95@yahoo.com</a>, or my principal supervisor, Dr. Fay Sudweeks at <a href="mailto:sudweeks@murdoch.edu.au">sudweeks@murdoch.edu.au</a>.</td>
</tr>
<tr>
<td>If you wish to talk to an independent body about your concerns, you can contact Murdoch University’s Human Research Ethics Committee on 6308 8677 or email <a href="mailto:ethics@murdoch.edu.au">ethics@murdoch.edu.au</a>.</td>
</tr>
<tr>
<td>If you are willing to participate in this study, please proceed by clicking on the “Next”. Initially, you will be asked to read the participant declaration and indicate if you give your consent to participate by clicking the “Agree” button. If you agree, you will be able to commence the survey.</td>
</tr>
<tr>
<td>This study has been approved by the Murdoch University Human Research Ethics Committee (Permit No. 2007/240).</td>
</tr>
<tr>
<td>Thank you,</td>
</tr>
<tr>
<td>Catherine Lee</td>
</tr>
</tbody>
</table>

| Next |
1. I have read the information about the nature and scope of this research. Any questions I have asked about the research process have been answered to my satisfaction. I agree to take part in this research. By submitting the survey online I give my consent for the contents to be used in the research. However, I am aware that I may change my mind and withdraw my consent to participate in this initiative at any time.

I understand that all information provided is treated as confidential and will not be released by the investigator unless required to do so by law.

I agree that research data gathered for this study may be published provided my name or other information which might identify me is not used.

☐ Agree  ☐ Disagree

2. Please enter your email address if you would like to receive a summary of the results of the research and to enter in a prize draw of a 8 GB Flash Drive (2 Flash Drive to be won).

Email Address
3. **Evaluate Yourself in Relation to the Unit.**

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No Opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I develop my own structure to answer questions.</td>
<td></td>
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<td>2. I mostly reproduce content from lecture notes to answer questions.</td>
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<td>3. I feel that I have acquired sufficient knowledge and skills to prepare me for the examination.</td>
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<td>4. I feel that much of what I am learning does not prepare me well for the examination.</td>
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<td>5. The flexibility of the unit content is empowering to me.</td>
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<td>6. I would rather study a unit that is completely online (distance) compared to a conventional (face to face) mode of learning.</td>
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<td>7. I would rather study a unit that incorporates both online (distance) and conventional (face to face) mode of learning.</td>
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<tr>
<td>8.</td>
<td>I learn better with written instructions as opposed to verbal instructions.</td>
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<td>9.</td>
<td>I attend tutorials because of the immediate assistance I can get from my tutor.</td>
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<td>10.</td>
<td>The unit is rewarding because it involved a lot of individualized learning.</td>
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<td>11.</td>
<td>I feel disconnected to the learning in this unit due to the complexity of the unit.</td>
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<tr>
<td>12.</td>
<td>I prefer navigating virtual learning environments that contain less text but many graphical representations.</td>
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<td>13.</td>
<td>I enjoy the challenge of navigating a complex virtual learning environment.</td>
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<td>14.</td>
<td>I find email is a useful online tool in the virtual learning environment.</td>
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<td>15.</td>
<td>I find it useful to have an online chat in the virtual learning environment.</td>
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<tr>
<td>16.</td>
<td>I find it useful to have an online forum in the virtual learning environment.</td>
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<tr>
<td>17.</td>
<td>A virtual learning environment that is clear and easy to navigate holds my interest.</td>
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<td>18.</td>
<td>I get disoriented in virtual learning environments due to too many links and the complexity of the tools featured.</td>
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<td>19. I am more comfortable in using software that I am familiar with instead of learning a new one.</td>
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<td>20. I navigate better in a virtual learning environment that contains a detailed map rather than an index tool.</td>
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<td>22. I consider myself an outgoing person.</td>
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<td>23. I research the literature beyond the list of references given by the lecturer.</td>
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<td>24. I do the required tutorial reading before attending a tutorial.</td>
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<td>25. I like sharing my thoughts or opinion in class.</td>
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<td>26. I like to sit back, listen and accept ideas presented.</td>
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<td>27. I like working alone and having my individual performance assessed.</td>
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<td>28. I like working in a group for any assessment work.</td>
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</tbody>
</table>
### Geographical & Time-related Differences in Learning Styles (Murdoch)

**Page 3 CULTURE**

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>29. I feel empowered when my voice and perspectives are heard and acknowledged by my lecturer and peers during class interaction.</td>
<td></td>
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<td>30. I am afraid to voice any disagreement I have with my lecturer.</td>
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<td>31. I prefer to use a title when addressing my lecturer.</td>
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<td>32. I know what I want in life and what I have to do to accomplish it.</td>
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<tr>
<td>33. I often feel nervous when sitting for exams even though I'm well prepared.</td>
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<tr>
<td>34. I enrolled in this unit purely to understand more about the topic.</td>
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<tr>
<td>35. I feel I should help my classmates who face difficulties with the unit.</td>
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<tr>
<td>36. It is important to have a sense of true friendship and connection with my classmates.</td>
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<tr>
<td>37. I feel it is better to study in a prominent university for a better career.</td>
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<td>38. It is important to have sufficient time for personal or family life.</td>
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<tr>
<td>39. I am more comfortable learning in a study group.</td>
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<tr>
<td>40. I prefer to enroll in the same class as my close friends.</td>
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<tr>
<td>41. I believe people should pass on their traditions to their future generation.</td>
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<tr>
<td>42. I believe people should enjoy the present time given the unchangeable past and unpredictable future.</td>
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### Geographical & Time-related Differences in Learning Styles (Murdoch)

#### EVALUATE THE UNIT

<table>
<thead>
<tr>
<th>Q</th>
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<th>Disagree</th>
<th>Strongly Disagree</th>
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<tbody>
<tr>
<td>44. The unit objectives were clear.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
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<td>45. The amount of materials and resources provided was sufficient.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>46. I was satisfied with the unit.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>47. The workload was appropriate for this unit.</td>
<td>☐</td>
<td>☐</td>
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</tr>
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<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>49. I gained practical knowledge from this unit.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
*6. Student Number:


7. Gender:

   - Male
   - Female

8. About You:
   - Course Major
   - Year of Enrollment
   - Year you were born

9. Country of Origin:

   - Australia
   - Britain
   - China
   - India
   - Indonesia
   - Malaysia
   - Singapore

   Other, please specify

   


294
10. Nationality
- Australian
- British
- Chinese
- Indian
- Indonesian
- Malaysian
- Singaporean
Other, please specify:

11. Spoken Languages:
- Bahasa
- Chinese (Mandarin)
- English
Other, please specify:

12. Student Type:
- Local Student
- International Student

13. Enrolment Type:
- Full time
- Part time

14. I am:
- On scholarship
- On loan
- Supported by family
- Independent
15. Are you currently employed?
- Yes
- No

16. Marital status
- Single
- Married/Partner

17. My ethnicity:
- African descendant
- Asian
- Caucasian
- Hispanic
- Indian
- Middle Eastern
- Other

18. Religion:
- No religion
- Buddhist
- Christian
- Hindu
- Muslim
- Other

19. Computer experience:
- < 1
- 2-3
- 4-5
- 6-7
- 8-9
- > 10

20. First introduced to computer:
- Home
- Preschool
- Primary school
- Secondary school
- University
- Workplace
21. Computer use:

- None
- Monthly
- At least once a week
- A few times a week
- Everyday

Geographical & Time-related Differences in Learning Styles (Murdoch)

Please click the "submit" button to complete the survey. We appreciate you taking the time to take our survey.

Thank You.
APPENDIX B

Murdoch University Ethics Application and Approval

Monday, 10 September 2007

Dr Fay Sudweeks
School of Information Technology
Murdoch University

Acknowledgement of Receipt of Ethics Application

Dear Fay,

Please check the details below that have been recorded on the Human Ethics Database and advise the Research Ethics Office of any changes that need to be made.

Permit Application No.
Project Title
Chief Investigator
Co-Investigator’s
Student Researcher’s
Date Application Received

2007/240
The spatial and temporal change of cognitive style in the development of hypermedia learning
Dr Fay Sudweeks
Dr Ray Webster
Catherine Lee
10/09/2007

This application has been placed on the Agenda for the next Human Research Ethics Committee Meeting, which will take place on 25/09/2007.

In any correspondence with the Research Ethics Office, please quote the Permit Application Number and the Project Title of the project.

Kind Regards,

[Signature]

Dr. Erich von Dietze
Manager of Research Ethics

CC:
Dr Ray Webster
Catherine Lee
Friday, 14 December 2007

Dr Ray Sadeweke
School of Information Technology
Murdoch University

Dear Ray,

Permit No. 2007/240
Project Title The spatial and temporal change of cognitive style in the development of hypermedia learning

Thank you for addressing the conditions placed on the above application to the Murdoch University Human Research Ethics Committee. On behalf of the Committee, I am pleased to advise the application now has:

OUTRIGHT APPROVAL

Permits are granted for three years. You will need to submit an annual report to the Research Ethics Office. Please note you are required to report immediately any unforeseen or adverse events especially if they might affect the ethical standing of the project. Once the project has been completed, please submit a Permit Closure Report. All forms are available on the Research Ethics website.

I wish you every success for your research.

Please quote your ethics permit number in all correspondence.

Kind Regards,

[Signature]

Dr Erich von Dietze
Manager of Research Ethics

cc: Dr Ray Webster
    Catherine Lee
Dear Prof. Kaniraj,

Please find attached document on the information letter and consent form for my survey as requested by Dr. Tang. For your information, this is an online survey, participants will be required to read a “Participation Information Letter” page and convey their consent by clicking the “Agree” button on the “Participation Declaration” page. Participant will not be able to commence the survey until they have affirmatively respond. You can access the survey on the following link:


Please let me know if this information is sufficient or you require further information. Thank you.

Sincerely,
Catherine Lee

ID can be used because there is a guarantee given by researcher. However, I think our students’ willingness to participate because of this might be reduced.
Letter of Confirmation

[a] The CSM Ethics Committee has received your Ethics and Research Practice Clearance form for "The Spatial and Temporal Change of Cognitive Style in the Development of Hypermedia Learning"

from July 2008 to July 2009
You may proceed with the research.

[b] Target of Survey

<table>
<thead>
<tr>
<th>No Survey</th>
<th>CSM students</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

[c] Project requires amendment, to be resubmitted to reviewer for approval
(attach list of amendments)
Summary of amendments required:

[d] Applicant instructed to submit an Application Form X and Ethical Issues Checklist to the CSM for approval

[i] Name of reviewer (BLOCK LETTERS) Dr. JOAN GRIBBLE
Signature: [Signature]
Date: 27/05/08

[ii] Name of reviewer (BLOCK LETTERS) Dr. KANIRAJ SHENBAGA
Signature: [Signature]
Date: 27/05/08
## APPENDIX C

### Summary of Major Changes and Improvement of Research Methodology

<table>
<thead>
<tr>
<th>Content</th>
<th>Preliminary study (Lee et al., 2005)</th>
<th>Current study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response variable, replicate(s) of question in the survey and scale used</td>
<td>-CS -no replicate -Likert scale of 0 to 1</td>
<td>-CS -three replicates -Likert scale of 1 to 5</td>
</tr>
<tr>
<td><em>Predictor variables, replicate(s) of question in the survey and scale used</em></td>
<td>-Learning dimensions (NL, LC &amp; MT) and students’ background information. -14, 7 and 24 replicates of question for NL, LC and MT -no replicate for background information. -Likert scale of 0 to 1</td>
<td>-Learning dimensions (NL, LC &amp; MT), culture dimensions (MF, IC, UA, PD &amp; TO), unit evaluation (EU), groups and background information, -at least 6 replicates for each learning dimensions -2 replicates for culture dimensions and 5 replicates for EU, group (2 levels, Australia and ) -Likert scale of 1 to 5</td>
</tr>
<tr>
<td>Pilot study and sample size determination</td>
<td>-No pilot study and sample size determination</td>
<td>-Conduct pilot study to determine the effective sample size in the main survey.</td>
</tr>
<tr>
<td>Time and duration</td>
<td>-Three years study from 1999 to 2001 at the Murdoch University.</td>
<td>-One year study in year 2008 at the Murdoch University and the Curtin University of Technology</td>
</tr>
<tr>
<td>Research tool</td>
<td>-Students answered printed questionnaire after their lectures completed.</td>
<td>-Students voluntarily answered in consistent internet environment.</td>
</tr>
<tr>
<td>Rewards used to handle non-response bias</td>
<td>-Nil</td>
<td>-Two prize draw for each survey location were given away.</td>
</tr>
<tr>
<td>Statistical models used in the analysis</td>
<td>-Generalized linear models &amp; tree-based regression</td>
<td>-Multiple linear regression &amp; tree-based regression.</td>
</tr>
<tr>
<td>Comparison of statistical models used</td>
<td>-Tree-based regression outperformed generalized linear models in fitting the data</td>
<td>-Tree-based regression outperformed multiple linear regression in fitting the data</td>
</tr>
<tr>
<td>Final results from tree-based regression</td>
<td>-Learning dimension NL is</td>
<td>-EU is the most important</td>
</tr>
<tr>
<td><strong>Based regression</strong></td>
<td>The first important predictor variables. -There are higher order interactions among the three learning dimensions that affecting the CS.</td>
<td>Predictor variable. Learning dimensions NL and LC are the second important predictor variables. -Culture predictor variables IC, PD and TO are third important variables. (Fig. 6.3)</td>
</tr>
</tbody>
</table>
APPENDIX D

Past Publications


