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THE ROLE OF UNIT EVALUATION, LEARNING AND CULTURE DIMENSIONS RELATED TO STUDENT COGNITIVE STYLE IN HYPERMEDIA LEARNING

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Abstract. Recent developments in learning technologies such as hypermedia are becoming widespread and offer significant contributions to improving the delivery of learning and teaching materials. A key factor in the development of hypermedia learning systems is cognitive style (CS) as it relates to users' information processing habits, representing individual users' typical modes of perceiving, thinking, remembering and problem solving.

A total of 97 students from Australian (45) and Malaysian (52) universities participated in a survey. Five types of predictor variables were investigated with the CS: (i) three learning dimensions; (ii) five culture dimensions; (iii) evaluation of units; (iv) demographics of students; and (v) country in which students studied. Both multiple regression models and tree-based regression were used to analyse the direct effect of the five types of predictor variables, and the interactions within each type of predictor variable. When comparing both models, tree-based regression outperformed the generalized linear model in this study. The research findings indicate that unit evaluation is the primary variable to determine students' CS. A secondary variable is learning dimension and, among the three dimensions, only nonlinear learning and learner control dimensions have an effect on students' CS. The last variable is culture and, among the five culture dimensions, only power distance, long term orientation, and individualism have effects on students' CS. Neither demographics nor country have an effect on students' CS.

These overall findings suggest that traditional unit evaluation, students' preference for learning dimensions (such as linear vs non-linear), level of learner control and culture orientation must be taken into consideration in order to enrich students' quality of education. This enrichment includes motivating students to acquire subject matter through individualized instruction when designing, developing and delivering educational resources.

1. Introduction

The use of information and communication technologies such as hypermedia is becoming widespread as a means of delivering learning and teaching materials. Recent developments in learning technologies offer significant contributions for improving the delivery of instructional materials. An essential factor in the development of hypermedia-based learning is cognitive style (CS), as it relates to users' information processing habits and represents the individual users' typical modes of perceiving, thinking, remembering and problem solving. Earlier research (Chen & Macredie, 2002; Wang, Hawk & Tenopi, 2000; Palmquist and Kim, 2000; Ford and Chen, 2000; Chen and Ford, 1998; Saracho, 1998; Reed & Oughton, 1997; Durfresne and Turcotte, 1997; Andris, 1996; Liu & Reed, 1994; Lee, et al., 2004) revealed that learning dimensions (characteristics and learning patterns) such as non-linear learning, learner control and multiple tools have significant effects on students' CS in a hypermedia learning system. On the other hand, evaluation in education has been long used to determine the worth or value of the continuation of a course. Feedback from evaluations provides quality control over the design and delivery of teaching and learning activities (Newby, 1992). Course evaluation is important as it provides an overall picture of teaching performance. Rapid advancement in technology has brought the world closer so that people of different cultures find themselves working together and communicating more and more. Understanding cultural differences is essential in order to comprehend what works in one location since it may not work somewhere else. Thus, culture may be viewed as an important source of an individual's values, expectations and needs (Markus & Kitayama, 1991). The increasing presents of student diversity in higher education institutions due to the effect of globalisation calls for further research in understanding different cultural background, characteristics and learning patterns of students. In addition, unit evaluations are commonly conducted to assess student's satisfaction of the delivery of teaching and learning activities in higher education. Student's satisfactory in teaching and learning activities is an indication of learning in matched condition. This study aims to investigate the relationship among them with the CS. This can help educators to have a deeper understanding of students' CS in a wider perspective prior to improving teaching method, course content and teaching technology.

2. Literature Framework

There are some variations in what students can acquire from a learning process, given that not all students are capable of developing their learning paths by themselves and that individual students learn in different ways. A number of studies have shown that there are variations in students' approaches to learning and learning environments (e.g. Entwistle & Entwistle, 1992; Maguire, Evans, & Dyas, 2001). In addition, research by Lee et al. (2004) has confirmed previous research that students' CS has the tendency to influence their preference for different types of learning. In responding to previous research, this study expands into other possible factors that may influence students' CS. The factors considered include unit evaluation and culture to assess their interaction and effect on students' CS. Such further investigation may provide a deeper understanding

and an awareness of students' particular preferences. This can then be used to improve the planning, production and implementation of educational experiences, particularly flexible learning, that are more compatible with students' learning preferences, in order to enhance their learning, retention and retrieval of information.

In the following subsections, the concepts and factors associated with a flexible learning process are discussed.

2.1. HYPERMEDIA

"Hypermedia refers to on-line settings where networks of multimedia nodes are connected by links are used to present information and manage retrieval" (Federico, 2000, p.362). Multimedia nodes may include text, graphics, video, audio, animation, models, simulations and visualisations that can be accessed and viewed by interactive browsers. Often, the connectivity among nodes is constrained by the design of the specific network-based educational environment.

In this research, the course units in Australia and Malaysia used hypermedia learning management systems (WebCT and Blackboard). While navigation in these educational environments is restricted by the hierarchy determined by both the system and the unit designer, a student ultimately determines which paths to follow by freely controlling the movement among nodes according to intrinsic interests and present goals (Federico, 2000).

2.2. COGNITIVE STYLE

A cognitive style (CS) is an integrated component in an individual's psychological differentiation that determines the individual's responses and functioning in numerous situations. It includes stable attitudes, choices and habitual strategies related to an individual's style of perceiving, remembering, thinking and solving problems (Saracho, 1998). A widely-cited definition based on Messick's (1984), defined cognitive style as individual differences in preferred ways of organising and processing information and experience (Sadler-Smith, 2001; Chen & Macredie, 2002).

Among the different measuring approach to indentifying CS, "field-dependence (FD)/field-independence (FI)" is one the widely studied CS employed in education research (Messick, 1976; Witkin et al., 1977). In both cases, the content field is a distracting or confusing background. FD individuals prefer to be guided in their learning processes, employ a less analytic approach to learning, and to require more instructional guidance to assist them in finding relevant and meaningful information to reduce disorientation (Chou, 2001; Oughton & Reed, 1999; Tinajero & Paramo, 1998). On the other hand, FI individuals employ less guided but a more analytical and autonomous approach to learning (Chou, 2001 Oughton & Reed, 1999; Tinajero & Paramo, 1998). Details of the characteristics of field dependent and independent learners are summarised in Table 1.

Table 1. Field dependent and field independent categories

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

Source: Chen & Macredie (2002); Lee et al. (2004)

One of the most widely studied cognitive styles with the broadest application to educational issues is Witkin's Field Dependence and Field Independence Theory (Weller et al., 1994; Chou, 2001). Witkin's studies (Witkin & Asch, 1948; Witkin, 1950; Witkin & Moore, 1974) were aimed at distinguishing how well a learner is able to restructure information based on the use of salient cues and field arrangement. The field arrangement can be considered as the order of background information. These studies revealed that individuals are different but individually consistent in their preferred modes of processing information.

Recent studies on CS suggested that students who are FD succeed best with socially oriented and cooperative learning tasks, whilst FI students prefer to work on abstract and less social assignments (Saracho, 1998). Several studies, which examined matching instructional strategies with levels of FD, have indicated that learning in matched conditions may in certain contexts be significantly more effective than learning in mismatched conditions. Witten's (1989) investigation found that FD students performed at essentially equivalent levels as FI students in a congruent teaching method. Conversely, FD students were adversely affected when taught with an incongruent method. A similar result was reported by Ford (1995), who stressed that learning in matched conditions was significantly superior to that in the mismatched conditions.

Furthermore, in an empirical study of students learning how to use HTML, Ford and Chen (2001) found that FD students outperformed FI students when the learning conditions matched their CS. Fullerton (2000) discovered that FD learners scored lower than FI learners in a condition mismatched with their preferred manipulation. The

research outcome conducted by Lee (2000) showed that FI learners tended to be internally driven in contrast to FD learners who rely on external forces to perform a task. On the other hand, FD learners' performance deteriorated when they received an instructional strategy that contradicted their CS. FD individuals could outperform FI individuals when the preferences of their CS are matched. Therefore, matching the style of teaching to suit students' CS is essential with regard to learning effectiveness. This agrees with Chen (2010) finding that learners with different cognitive styles have similar but linear learning approaches, and learners with different cognitive styles adopt different navigation tools to process learning.

2.3. HYPERMEDIA LEARNING STYLES

According to Chen & Macredie (2002), there are three main categories of factors that can determine a person's CS category in a hypermedia-based learning environment; namely, non-linear, learner control and multiple tools.

2.3.1. Non-Linear Learning Approach (NL)

Individuals who prefer a linear learning approach are considered FD. Such individuals generally demonstrate greater social orientation, which means they enjoy working in groups. Furthermore, they are more likely to face difficulties in unstructured environment or when they have to restructure new information and forge links with prior knowledge because they demonstrate fewer proportioning skills. In other words, they prefer guided navigation or a linear format representation and tend to demonstrate more syllabus-bound characteristics. These individuals also fear failure but focus on a bare minimum pass as they often show less interest in the course content. In addition, they show heavy reliance on the use of their memory and are strongly dependent on external sources, such as their tutors who dictate the information to be learnt. These characteristics are often due to their lack of understanding of the purpose and objectives of the course. In contrast, individuals who adopt a non-linear learning approach are categorised as FI individuals. They are characterised as individuals who enjoy working alone and prefer free navigation or the use of a discovery approach to explore the topic of interest as well as 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 make use of evidence to draw conclusions.

2.3.2. Learner Control (LC)

FD individuals perform better with a program control version of computer-based instruction, as they are relatively passive and less capable of learning independently (i.e. externally directed). These individuals can be characterised as using less control features in hypermedia programs. On the other hand, FI individuals use greater control features in hypermedia programs as they possess a higher ability to engage in independent learning with analytical thought (i.e. internally directed) and perform better in a learner control version of computer-based instruction (Yoon, 1994; Chen & Macredie, 2002). Hence, FI individual are likely to perform significantly better and learn more effectively than FD individuals in a hypermedia-based learning environment.

2.3.3. Multiple Tools (MT)

A hypermedia environment is usually designed using 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. Generally, individual learners are able to control their own paths through complex subject matter independently of the guidance provided by the course tutor. However, learners can quickly and easily get lost in cyberspace given the links and multiple tools available. In such a situation, FD individuals tend to desire greater navigation support in contrast to FI, since FD individuals are relatively passive while FI individuals tend to be more analytical when confronted with a problem. According to Chou (2001), FD individuals are relatively passive and are better at recalling social information such as conversations and relationships, approaching a problem in a more global way and capable of perceiving the total picture in a situation. In other words, FD individuals often experience surroundings in a relatively global fashion, accepting ideas as presented, and passively conforming to the influence of the prevailing field or context. Conversely, FI individuals are "more likely to do well with numbers, science and problem solving tasks. They tend to analytically approach a problem and perceive a particular and relevant item in a field of distracting items" (Chou, 2001, p.14).

2.4. EVALUATION OF UNITS

Unit evaluation is usually performed through the use of a paper or electronic survey, which requires a written or selected response to a series of questions about the instruction of a given course. Surveys are a means of producing feedback that the teacher and the university can use to improve their quality of teaching. The process includes: (i) gathering information about the impact of learning and teaching practice on student learning; (ii) analysing and interpreting this information; and (iii) responding to and acting on the results (Rahman, 2006). Surveys are beneficial because teachers can review how others interpret their teaching methods, thereby improving their teaching. The information can be also used by administrators, along with other input, to make summative decisions (e.g. promotion) that lead to the requirement of better teaching, or make formative recommendations (e.g. identify areas where an teacher needs to improve) (Dunegan and Hrivnak, 2003).

The literature on teaching is abundant and well researched, particularly on ways that teachers can present content and skills to enhance the opportunities for students to learn. The literature 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. Students often have little expertise in knowing if the method selected by an individual teacher was the best teaching method or simply the method with which the teacher was most comfortable. Renninger and Synder (1983) found that 9^{th}-12^{th} grader student perceptions of satisfaction matched with the teacher CS. Saracho (2001) had a similar finding that the kindergarten pupils' CS matched with their teachers' CS.

The use of students' ratings for evaluating teacher effectiveness is the most researched issue in higher education. Over 2,000 articles and books have been written on this topic since the 1930s (Ory, 2001). 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 learn more give their teachers higher ratings (Cohen, 1981; Theall and Franklin, 2001).

2.5. CULTURE DIMENSIONS

In the late 1960s and early 1970s, the Dutch academic Geert Hofstede (1980), based his four dimensions of culture on an extensive survey 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. The dimensions are:

- *Power Distance (PD):* 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. In high power distance countries (e.g. Malaysia, Slovakia), people accept power relations that are more autocratic and paternalistic. As such, the PD that Hofstede defines does not reflect an objective difference in power distribution but rather the way people perceive power differences. There seems to be an admittedly disputable correlation with predominant religions.
- *Individualism vs collectivism (IC):* individualism is contrasted with collectivism and refers to the extent to which people are expected to stand up for themselves and 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 cultures.
- *Masculinity vs femininity (MF):* refers to the value placed on traditionally expected male or female roles (as understood in most Western cultures). So-called „masculine' cultures value competitiveness, assertiveness, ambition and the accumulation of wealth and material possessions, whereas feminine cultures place more value on relationships and quality of life. Japan is considered by Hofstede to be the most masculine culture (replaced by Slovakia in a later study), and Sweden the most feminine. Because of the taboo on sexuality in many cultures, particularly masculine ones, and because of the obvious gender generalizations implied by Hofstede's terminology, this dimension is often renamed by users of Hofstede's work (Robbins, 2001, p.66). One example of renaming is quantity of life vs. quality of life. *Quantity of life* is defined as valuing material things whereas *quality of life* is defined is valuing relationships and concern for the welfare of others. Another reading (Waters, 1996) of the same dimension holds that in masculine cultures, the differences between gender roles are more dramatic and less fluid than in feminine cultures.
- *Uncertainty avoidance (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. Mediterranean cultures, Latin America and Japan rank the highest in this category. Cultures that scored low on UA have lower stress, are curious about differences and open-ended learning, and tolerant of opinions different from their own. Jamaica and Denmark rank the lowest in this category.

Hofstede and Bond (1988) subsequently found a fifth dimension, initially called *confucian dynamism,* and later incorporated into Hofstede's framework:

- *Long term vs short term orientation (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 (perseverance), 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 ones face, respect for tradition, and reciprocation of greetings, favours, and gifts. China, Japan and the Asian countries score especially high (long term) here, with Western nations scoring rather low (short term orientation) and many of the less developed nations very low.

Although there is considerable literature on these culture dimensions, there is little research on the relationship between CS and the five culture dimensions. The two levels within CS – FI and FD – appear similar to IC. How important these culture dimensions are compared with unit evaluation and learning style dimensions is unknown. Figure 1 shows the relationship between CS and culture as well as the other variables discussed.

3. Hypotheses

This study is a extension of a previous study by Lee et al. (2004) in which it was found that Australian students' CS has the tendency to facilitate or interfere with interaction and learning from an innovative environment such as a hypermedia learning system. Results derived from Lee et al.'s research may not apply in other countries and therefore must be treated with a degree of caution as CS may vary with different cultures. In addition, 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. Therefore, factors, such as culture and unit evaluation were taken into consideration for the purpose of this study. Lee et al. used tree-based regression to explore the higher order interactions among predictor variables affecting CS. So, we applied the same statistical model to model the effect of the higher order interactions among student's hypermedia learning dimensions and culture dimensions on CS.

H_A: Students' approaches to learning, culture dimensions and unit evaluation affect their CS

H_B: Higher order interactions among students' hypermedia learning dimensions affect their CS

H_C: Higher order interactions among students' culture dimensions affect their CS

H_D: Students' demographics background information affects their CS

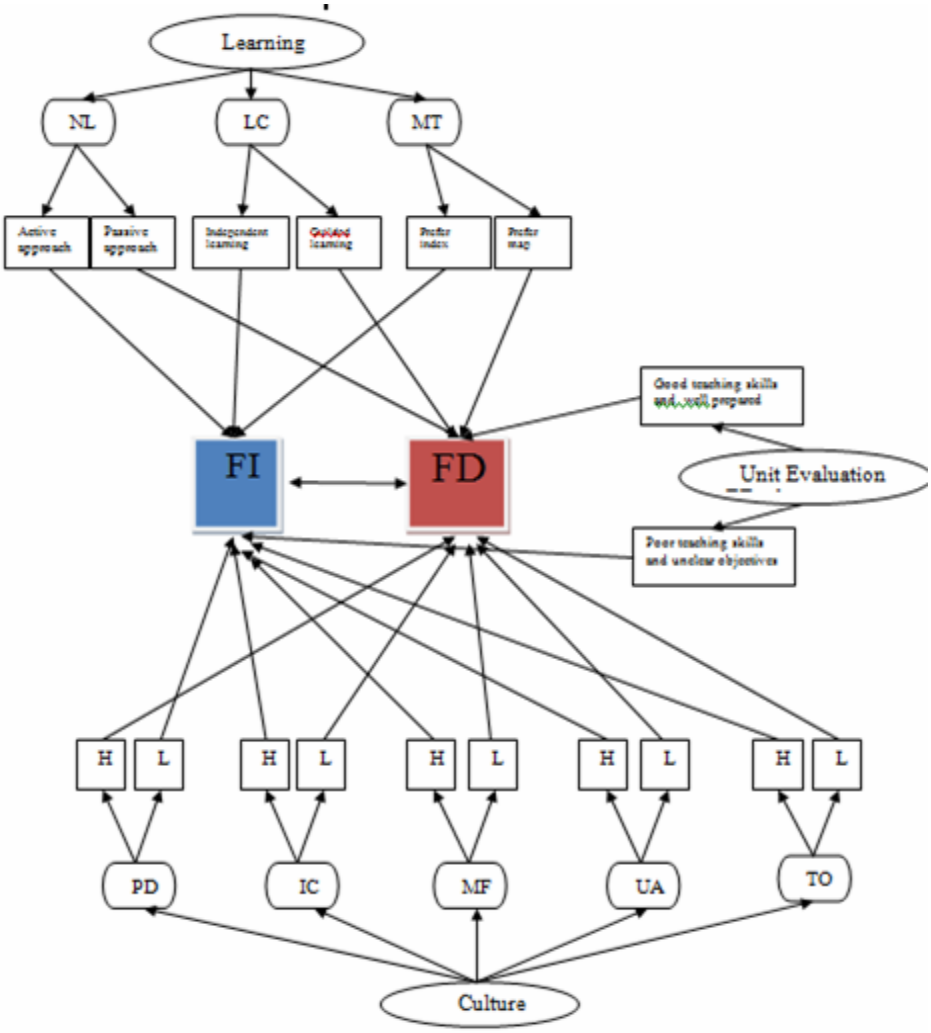

Figure 1. Plot of the relationships among all variables.

4. Case Studies

4.1. MURDOCH UNIVERSITY, AUSTRALIA (GROUP 1)

Students enrolled in four different units in the School of Information Technology, Murdoch University, Australia were invited to participate in both the pilot and main study. 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 in which students in their fourth year (Honours) could also enrol (ICT650 Information Technology Research Methodologies). Murdoch University is a multicultural institution and the cohorts in each unit comprised approximately 50% Australian born students with the other 50% a cultural mix of international students.

4.2. CURTIN UNIVERSITY OF TECHNOLOGY, MALAYSIA (GROUP 2)

Students who had completed the Software Technology 151 and Engineering Programming 100 units by mid-2008 were approached to complete the survey. Both these units are first-year units within the Bachelor of Technology (Computer Science) and Bachelor of Engineering programs. Students in both programs consist mostly of Malaysians, with a small number of international students. For entry into both programs, students would have completed the Foundation Studies programs in Engineering and Science, delivered by Curtin University, or other matriculation studies such as General Certificate of Education (GCE) Advance Levels from other institutions.

5. Pilot Study

A survey was designed based on a theoretical framework adapted from Lee et al.'s (2005) research and Chen and Macredie's (2002) characteristics and learning dimensions of FD and FI individuals. Some survey items were also taken from Entwistle and Entwistle's (1992) approaches to learning (ASSIST). Participants were asked to respond to all questions on a Likert scale of 1 to 5. The high (>3) and low (<3) scores of each variable except background information are listed in Table 2. There are 4, 7, 9, 7, 3, 3, 3, 3, 3, 6 and 18 questions for CS, LC, MT, NL, PD, UA, TO, MF, IC, EU and background information respectively. The pilot study was conducted to determine the required sample size for the main survey. It was also conducted to improve the survey by means of detecting errors and limitations prior to the main survey. The first half of the pilot study was conducted in May 2008 with 6 student participants at Murdoch University, Australia (Group 1), who were selected based on cluster sampling. For the second half of the pilot study in July 2008, using the same survey, a similar sampling procedure was conducted with 6 student participants at Curtin University, Malaysia (Group 2). 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. Following the pilot study, there were minor changes to the wording of some of the questions. For the main study, the same cluster sampling was used to ensure sample collection consistency.

Table 2. Summary of the high and low scores of each variable.

Variables	*Scores*	*Description*
CS	H (FD)	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.
	L (FI)	Employs a less guided but a more analytical and autonomous approach to learning.
NL	H	Demonstrates greater social orientation, which means enjoys working in groups.
	L	Enjoys working alone and prefers free navigation or the use of a discovery approach to explore the topic of interest and generate ideas.
MT	H	Relatively passive; better at recalling social information such as conversations and relationships; approaches a problem in a more global way; capable of perceiving the total picture in a situation.
	L	Tends to analytically approach a problem and perceives a particular and relevant item in a field of distracting items.
LC	H	Relatively passive and less capable of learning independently.
	L	Possesses a higher ability to engage in independent learning with analytical thought.
PD	H	Indicates that society accepts an unequal distribution of power and people understand „their place' in the system.
	L	Means that power is shared and well dispersed.
IC	H	Lacks interpersonal connection and shares little responsibility beyond family and perhaps a few close friends.
	L	Immense loyalty and respect for members of their social group.
MF	H	Values material things.
	L	Values relationships; concern for the welfare of others.
UA	H	Enjoy novel events and values differences; governed by few rules; encouraged to discover their own truth.
	L	Tries to avoid ambiguous situation whenever possible; governed by rules and order and seek a collective „truth'.
TO	H	Short term oriented; values past and present; respect for traditions; fulfils social obligations.
	L	Long term oriented; looks to the future and value changes; thrift and persistence.
EU	H	Indicates the objective of the unit is not clear and practical.
	L	Indicates the unit is well-prepared and sufficient to motivate learning.

5.1. SAMPLE SIZE DETERMINATION

The results from the pilot study were used to estimate the required sample size for the main survey. The required sample size depends on the following four factors (Zar 1998, p.33): (i) the minimum detectable difference; (ii) the population variance; (iii) the significance level of committing Type I error; and (iv) the power of the test or the

significance level of committing Type II error. Both 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 significance level of committing a Type I error (p=<5%) and the significance 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). From the power analysis, the effective sample size is 37 students in each group.

5.2. STATISTICAL METHODS

A paired t-test was used to compare the mean of two groups. 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. Statistical modelling was carried out using both parametric and nonparameteric models; namely, multiple and tree-based regression models. 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. Tree-based regression was also used to study the effect of higher-order interaction of the predictor variables on the response variable. The predictor variable consists of 5 groups: (i) 3 hypermedia learning dimensions; (ii) 5 culture dimensions; (iii) 1 unit evaluation (iv) 18 background characteristics; and (v) 1 spatial dimension. The response variable is CS.

6. Main Study

Using the methodology developed with the pilot study data, the main study was undertaken and the data was collected in a similar manner to the pilot study. A total of 97 students attempted the survey and the response rates of completed information for Australian and Malaysian students were 40/45=89% and 37/52=71% respectively. The overall response rate of the completed survey was 77/97=79%. The time spent in completing the survey ranged from 12 minutes to 90 minutes with the average being 25 minutes. Investigation of interactions among independent variables was limited due to the total number of 77 observations.

7. Results

There is a significant difference (P=0.043) between Australian and Malaysian students' CS (Table 3). Malaysian students are more likely to be FD compared with Australian students. In the learning dimensions, both MT and NL are significant (P<0.05) between Australian and Malaysian students. This indicates that Malaysian students prefer greater navigation support compared to Australian students. Among the culture dimensions, IC MF, UA and TO, there is a significant difference (P<0.05) between Australian and Malaysian students. Malaysian students tend to lack interpersonal connection and share little responsibility beyond their family and perhaps a few close friends compared to

Australian students. On the other hand, Australian students value material things more than relationships and welfare of others in contrast to Malaysian students. Also, Australian students are more certain in what they want to accomplish in life compared to Malaysian students. Surprisingly, Malaysian students tend to be long-term oriented, whilst Australian students tend to be short-term oriented. Australian students believe that people should pass down their tradition to the next generation and enjoy the present due to the unchangeable past and unpredictable future. However, Malaysian students believe that people should focus on a long-term plan to secure future interest. There is a highly significant difference (P=0.006) between Australia and Malaysian students' EU. Australian students are more satisfied with their lecturer's teaching performance compared to Malaysian students. Their satisfaction was attributed to clear course objectives, provision of sufficient material and resources, appropriate workload, involvement in activities and knowledge gained from the course.

Table 3. Summary of the mean and SD of the response variables and three types of predictor variables.

Groups	Name of variables	Total (SD)	Australia (SD)	Malaysia (SD)	P-value
Response	CS	2.822 (0.530)	2.702 (0.577)[n=40]	2.939 (0.457)[n=41]	**0.043**
Predictors-Learning dimensions	LC	3.304 (0.370)	3.236 (0.401)[41]	3.371 (0.329)[40]	0.100
	MT	3.620 (0.325)	3.542 (0.319)[n=41]	3.695 (0.314)[n=40]	**0.033**
	NL	2.985 (0.435)	2.846 (0.435)[n=41]	3.122 (0.0.394)[n=40]	**0.004**
Predictors-Culture dimensions	PD	2.868 (0.587)	2.825 (0.599)[n=40]	2.912 (0.578)[n=38]	0.515
	UA	2.919 (0.591)	3.083 (0.617)[n=40]	2.746 (0.517)[n=38]	**0.011**
	MF	2.556 (0.422)	2.650 (0.459)[n=40]	2.456 (0.359)[n=38]	**0.0417**
	IC	2.842 (0.550)	2.642 (0.552)[n=40]	3.052 (0.468)[n=38]	**0.001**
	TO	2.752 (0.554)	2.875 (0.493)[n=40]	2.623 (0.591)[n=38]	**0.044**
Predictors – Evaluation	EU	2.392 (0.710)	2.179 (0.784)[n=40]	2.622 (0.541)[n=37]	**0.006**

A summary of the correlation coefficients (ρ) between all variables, excluding the background information, from the two student groups are presented in Tables 4 and

5. In the Australian student group, CS is significantly (P<0.05) correlated with EU, NL and IC, and MT is significantly (P<0.05) correlated with IC and TO. MF is significantly (P<0.05) correlated with IC. NL is significantly (P<0.05) correlated with TO. In the Malaysian student group, CS is significantly (P<0.05) correlated with LC. LC is significantly (P<0.05) correlated with EU. NL is significantly (P<0.05) correlated with IC and UA. UA is significantly (P<0.05) correlated with IC. MA is significantly (P<0.05) correlated with EU. TO is negatively significantly (P<0.05) correlated with EU.

The results generated by multiple regression models selected by AIC indicated that EU (P=0.03), LC (P=0.05), NL (P=0.02), PD (P=0.11) and TO (P=0.15) fixed effects and PD*TO (P=0.09) interaction terms are significant (P<0.05) or marginally significant (P<0.20). All 18 predictor variables of background information are not significant (P > 0.10). The estimated coefficients for EU, LC, NL, PD, TO and PD*TO are 0.31, 0.33, -0.89, -0.76, 0.18 and 0.31 respectively. Students with lower LC or lower NL or lower EU are FI. Students with higher PD or higher TO are considered FI. Students with 1 unit higher in PD from 2 units, 1 unit higher in TO from 2 units are expected to have –0.80-0.76=-1.56 unit, which is lower from FD to FI, provided there is no interaction between PD and TO. In other words, there is a change in students' CS. However, students are expected have –1.56+0.31*(3*3-2*2)=-0.01 unit lower from FD to FI due to the interaction term. This indicates there is no change in students' CS. The estimated residual standard error and mean residual deviance are 0.47 and 0.22 with 70 degrees of freedom.

On the other hand, the estimated residual deviance is 0.15 (<0.22) with 70 degrees of freedom from tree-based regression (Figure 2). Therefore, the tree-based regression model outperforms the multiple regression models given its better fit. The first split on the left hand side of EU (<2.417) is with CS equal to CS 2.633 and the students are FI (<2.819). It implies that EU is the main factor to determine students' CS in comparison with other factors such as learning dimensions and culture dimensions. The second splits consist of learning dimensions; namely, NL and LC. The third splits consist of IC, PD and TO, which are culture dimensions. Hence, the order of importance in determining CS is unit evaluation followed by learning dimensions and culture dimensions.

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). While 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). Students with higher learning control (LC >=3.155) and higher unit evaluation (EU>2.417) tend to be FD (CS=3.219>2.819, n=24). Also, they tend to be FD with response of cognitive style (CS=3.406>>2.819) and long-term orientation (TO>2.5, n=24).

The tree-based regression provides more detailed information of the data compared with multiple regression models. From the tile plot (lower part of Figure 2), only the mean CS =2.15 and CS=3.406 have larger differences in residuals within the

same node. Therefore, CS with the range less than 3.406 and 2.150 are considered to be good fit.

Table 4. Summary of the estimation correlation coefficients of all predictor variables from Australia students.

	LC	**MT**	**NL**	**PD**	**UA**	**MF**	**IC**	**TO**	**EU**
CS	0.21	0.01	**0.34**	0.05	0.04	0.09	**0.34**	0.12	**0.48**
LC		0.23	-0.01	-0.29	0.08	-0.23	-0.03	0.1	0.12
MT			0.13	-0.17	0.09	-0.07	**0.45**	**0.34**	0.08
NL				0.13	0.23	-0.06	**0.31**	0.16	0.3
PD					0.03	0.2	0.04	-0.05	0.03
UA						-0.09	0.01	0.23	0.06
MF							-0.04	**0.31**	0.13
IC								-0.02	-0.01
TO									0.29

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

Table 5. A summary of the estimation correlation coefficients of all the predictor variables from Malaysia students. Bold means it is significant with 5% of Type I errors.

	LC	**MT**	**NL**	**PD**	**UA**	**MF**	**IC**	**TO**	**EU**
CS	**0.31**	0.06	0.23	0.17	0.2	-0.17	-0.2	0.17	0.05
LC		-0.11	0.05	0.02	0.16	0.16	0.13	-0.16	**0.33**
MT			0.01	0.03	0	0.11	0.21	0.26	0.08
NL				**0.58**	**0.38**	-0.15	0.25	-0.17	-0.1
PD					0.2	-0.21	0.27	-0.02	0.12
UA						0.11	**0.34**	-0.01	0.05
MF							0.16	-0.19	**0.36**
IC								-0.13	0.06
TO									**-0.37**

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

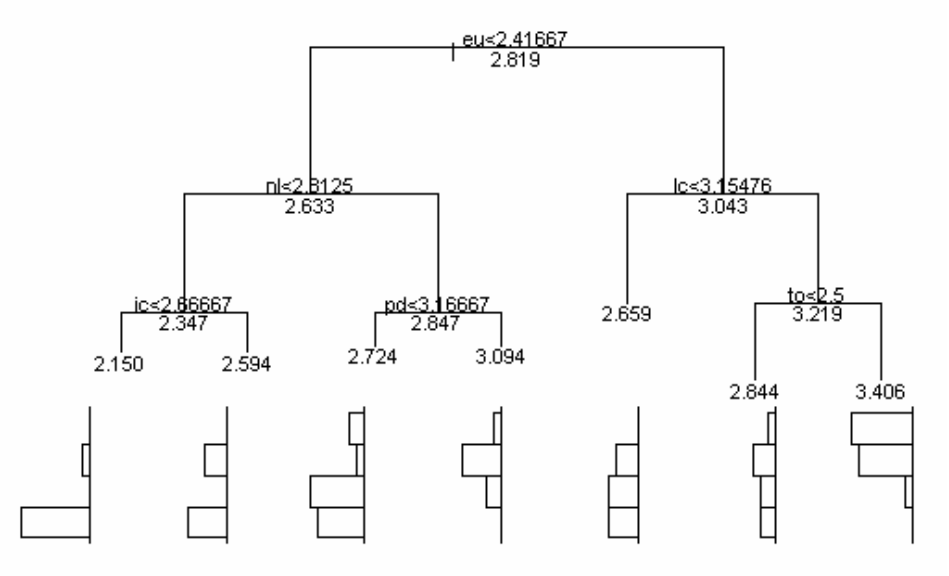

Figure 2. Summary of tree-based regression result with response variable CS and the predictor variables. The tile plot is the distribution of the residuals in each terminal node.

8. Discussion

Clearly, tree-based regression outperformed multiple regression models based on the comparison made in this study. The mean residual deviances fitted by multiple regression models are greater than the mean residual deviance fitted by tree-based regressions. In other words, tree-based regression resulted in better fits compared with the generalized linear model. The results based on multiple regression models are very difficult to interpret and could not further explain the interactions of all variables given the limited data. Tree-based models are easier to interpret and discuss in contrast to multiple regression models 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. Multiple regression models do not allow interactions between independent variables unless they are in multiplicative form. Tree-based models can detect interaction between parts of levels or parts of the numeric range of independent variables. Thus, the tree-based regression method was mainly employed to determine CS by analysing the relationship among learning and culture dimensions, unit evaluation and background information.

The overall findings suggest that student CS is a key factor in the development of hypermedia learning system since unit evaluation, different types of learning, and culture dimensions are evident and must be taken into considerations in order to enrich

the quality of education for students. This is essential in order to achieve a level of teaching effectiveness that could accommodate the learning; needs of different learners. Additionally, this research supports previous studies by researchers such as Liu and Reed (1994), Papanikolaou, Grigoriadou, Magoulas, and Kornilakis (2002), Rada (1991) and Triantafillou et al. (2003). These studies emphasised the importance of having different perspectives of hypermedia design for potential matching with various learner characteristics and preferences, which would possibly result in a higher quality of learning. Moreover, the learning model adapted from Chen and Macredie (2002) had essentially confirmed its effectiveness in illustrating the effects of CS on hypermedia systems. This indicates that such a model can be applied to the design of adaptive hypermedia systems that can be tailored to individualize instruction.

The results derived from this research may not apply in other countries even though it is a cross-countries study. Cluster sampling may lead to a biased result. Ideally, this research should have used random sampling but, in practice, it is very difficult to be carried out, as it requires a huge sample size. An area of future research, which should prove especially interesting in researching students' CS and hypermedia, is to carry out a longitudinal data collection since students' CS may change with time throughout their 3+ years of study.

Teachers also have limited control over many of the most important factors that impact learning including students' attitudes, background knowledge of the course content, study and learning skills, time spent on learning, emotional readiness to learn, and so forth. Unit evaluation has been found to be the important variable in determining students' CS. This suggests that unit evaluation should be completed after each course is completed, in order to understand students' CS prior to improving teaching method, course content and teaching technology.

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