UNIVERSITI PUTRA MALAYSIA

FACTORS RELATED TO CRITICAL THINKING DISPOSITION AND CRITICAL THINKING SKILLS OF UNDERGRADUATE STUDENTS AT A MALAYSIAN PUBLIC UNIVERSITY

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By

IBRAHIM NAZEM MAHMOUD GHADI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

October 2013

To my Mom and Dad

My deepest appreciation, with their unconditional love, whose days and nights are spent on relentless prayers and endless words of encouragement.

Abstract of this thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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October 2013

Chair: Nor Hayati Alwi, PhD
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The purpose of this study was to determine the Critical Thinking Dispositions (CTD) and Critical Thinking Skills (CTS) by Universiti Putra Malaysia (UPM) undergraduate students. Three objectives were stipulated, 1) to identify the CTD levels among undergraduate students from different majors of study (science-based and arts-based) versus, gender and academic year of study; 2) to identify the CTS levels among undergraduate students from different majors of study (science and arts-based) versus, gender and academic year of study; 3) to identify the dominant CTD elements that may influence CTS.

In this research, a quantitative survey method was employed using descriptive and inferential statistics such as t-test, and multiple-regression in analyzing the data. The t-test was employed to achieve the first and second objectives that aim to identify the CTD as well as CTS levels of university undergraduate students of different gender, year of study and major of study. While, to achieve the third objective multiple-regression was used to identify the influence of CTD on CTS.

Critical thinking ability instrument was measured by the researcher in order to meet the requirements of the current study. The instrument was translated into bilingual mode (Bahasa Malaysia and English) to answer the critical thinking

ability questions and items. Nine hundred and fifty one students from sixteen science-based and arts-based faculties in UPM responded to the survey.

The results indicated that, the CTD elements were on an average while CTS for the independent factors (gender, year of study and academic major) were on a high level. The result further shows a significant difference between CTD according to gender as well as CTS according to first and fourth year of studies. However, no significance difference was shown between CTD level according to major (science and arts) and year (first and fourth) on one hand and CTS level according to gender and major (science and arts). Furthermore, the CTD elements that have influence on CTS are analyticity, truth seeking, self-confidence and maturity.

In conclusion, the study reveals an interdependent relationship between CTD and CTS with the CTD elements being on the average level while CTS elements were on a high level. These results spell the need to inculcate the idea of developing critical thinking ability in the minds of students. Specifically, the need to strengthen the curriculum in the area of critical thinking especially for the newly enrolled undergraduate students is necessary to strengthen their potentials both professionally and academically.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

FAKTOR BERHUBUNG PENGATURAN PEMIKIRAN KRITIKAL DAN KEMAHIRAN PEMIKIRAN KRITIKAL MAHASISWA DI UNIVERSITI TEMPATAN DI MALAYSIA

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Oktober 2013

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Tujuan kajian ini adalah untuk mengenalpasti pengaruh Pengaturan Pemikiran Kritikal (CTD) ke atas Kemahiran Pemikiran Kritikal (CTS) mahasiswa Universiti Putra Malaysia (UPM). Tiga objektif yang telah ditetapkan untuk kajian ini ialah: 1) Untuk mengenalpasti tahap CTD dikalangan mahasiswa UPM yang berbeza pengajian utama (sains dan sastera) mengikut jantina dan tahun pengajian; 2) Untuk mengenalpasti tahap CTS dikalangan mahasiswa UPM yang berbeza pengajian utama (sains dan sastera) mengikut jantina dan tahun pengajian; 3) Untuk mengenalpasti elemen-elemen dominan CTD yang mempengaruhi CTS.

Dalam kajian ini, kaedah kaji selidik kuantitatif telah diguna pakai menggunakan analisis statistik diskriptif dan statistik inferensi seperti t-test dan analsis regresi pelbagai untuk menganalisa data. Ujian t-test digunakan untuk mencapai objektif pertama dan kedua bagi tujuan mengenal pasti tahap CTD dan CTS terhadap pemboleh ubah tidak bersandar (jantina, tahun pengajian, dan pengajian utama). Manakala untuk mencapai objektif ketiga, analisis regresi pelbagai digunaka pakai untuk mengenal pasti pengaruh CTD dan beberapa ciri demografi keatas CTS.

Alat kajian Kebolehan Pemikiran Kritikal telah diukur oleh penyelidik bagi memenuhi keperluan kajian semasa. Alat kajian tersebut telah diterjemah kepada dwi bahasa (Bahasa Melayu dan Inggeris) bagi membolehkan responden menjawab soalan-soalan dan item-item berkenaan dengan Kebolehan Pemikiran Kritikal. Secara keseluruhan, sebanyak 951 pelajar

daripada 16 fakulti di UPM yang berteraskan sains dan sastera telah menjawab borang kaji selidik berkenaan.

Hasil dapatan kajian menunjukkan bahawa elemen CTD para responden berada pada tahap yang sederhana, manakala tahap CTS bagi faktor-faktor tidak bersandar (jantina, tahun pengajian, dan pengajian utama) berada pada tahap yang tinggi. Hasil dapatan juga menunjukkan perbezaan yang signifikan bagi tahap CTD antara responden lelaki dan perempuan, serta perbezaan yang signifikan bagi tahap CTS antara tahun pengajian pertama dan keempat. Namun, tiada perbezaan yang signifikan bagi tahap CTD antara responden pengajian sains dan sastera, serta tahun pengajian pertama dan keempat. Perbezaan yang tidak signifikan juga didapati bagi tahap CTS antara responden lelaki dan perempuan, serta pengajian berteraskan sains dan sastera. Selain itu, hasil kajian juga mendapati, elemen CTD yang mempengaruhi tahap CTS ialah keboleh upayaan untuk menganalisa, keyakinan, kematangan, dan keboleh upayaan mencari kebenaran.

Secara keseluruhan, kajian ini menunjukkan perhubungan yang saling bergantung antara CTD dan CTS, dimana elemen-elemen CTD berada pada tahap yang sederhana, dan elemen-elemen CTS pada tahap yang tinggi. Menerusi dapatan kajian ini, timbul satu keperluan untuk memupuk idea kebolehan berfikir secara kritikal dalam minda para pelajar menerusi penambah baikan kurikulum yang berkaitan dengan pemikiran secara kritikal bagi para pelajar prasiswazah baharu. Inisiatif ini dilihat mampu untuk meningkatkan potensi para pelajar prasiswazah baharu dari segi professional dan akademik.

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Most importantly, I would like to thank my family members: my brothers and sisters, who have sacrificed so much so that I could complete this program. I would also like to acknowledge the love and support of my Grandmother, Maryam who passed away before seeing me achieve this goal.

I certify that a Thesis Examination Committee has met on 31 October 2013 to conduct the final examination of Ibrahim Nazem Mahmoud Ghadi on his thesis entitled "Factors Related To Critical Thinking Disposition and Critical Thinking Skills of Undergraduate Students at a Malaysian Public University" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

Declaration by graduate students

I hereby confirm that:

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TABLE OF CONTENTS

		Page
DEDICATION		ii
ABSTRACT		iii
ABSTRAK		v
ACKNOWLEDGEMENTS		vii
APPROVAL		viii
DECLARATION		x
LIST OF TABLES		xv
LIST OF FIGURES		xvii
LIST OF ABBREVIATIONS		xxiii
CHAPTER		
1	**INTRODUCTION**	1
	1.1 Background of the study	1
	1.2 Statement of the problem	5
	1.3 Research objectives	6
	1.4 Research questions	7
	1.5 Research hypothesis	7
	1.6 Significance of the study	8
	1.7 Research limitations	8
	1.8 Operational definitions	9
2	**LITERATURE REVIEW**	11
	2.1 Introduction	11
	2.2 Critical thinking dispositions	12
	2.3 Critical thinking skills	15
	2.4 Relationship between critical thinking dispositions and critical thinking skills	20
	2.5 Critical thinking dispositions and critical thinking skills theories	24
	2.6 Critical thinking dispositions and critical thinking skills among demographics characteristic	29
	2.6.1 Critical thinking dispositions based on gender	29
	2.6.2 Critical thinking dispositions based on academic major	31
	2.6.3 Critical thinking dispositions based on academic year	32
	2.6.4 Critical thinking skills based on gender	34
	2.6.5 Critical thinking skills based on academic major	36
	2.6.6 Critical thinking skills based on academic year	37

2.7 Conceptual framework 39

3 **METHODOLOGY** 41
3.1 Introduction 41
3.2 Research design 41
3.3 Location of study 42
3.4 Population of the study 42
3.5 Sampling procedures 43
3.6 Description of the instrument 47
3.7 Measuring the level of CTD 48
3.8 Measuring the level of CTS 49
3.9 Validity of instrument 49
3.9.1 Content validity 50
3.9.2 Translation validity 50
3.9.3 Construct validity 51
3.9.3.1 Convergent validity 51
3.9.3.2 Divergent validity 62
3.10 Reliability of instrument 64
3.11 Pilot test 66
3.12 Data collection 67
3.13 Data analysis 67

4 **RESULTS** 68
4.1 Introduction 68
4.2 Demographic findings 68
4.3 Findings of critical thinking dispositions 68
4.3.1 Question 1: What are the differences in the CTD levels of UPM undergraduate students based on gender? 72
4.3.2 Question 2: What are the differences in the CTD levels of UPM science-based and arts-based undergraduate students? 73
4.3.3 Question 3: What are the differences in the CTD levels of UPM first year and fourth year undergraduate students? 74
4.4 Findings of critical thinking skills 75
4.4.1 Question 4: What are the differences in the CTS levels of UPM undergraduate students based on gender? 76
4.4.2 Question 5: What are the differences in the CTS levels of UPM science-based and arts-based undergraduate students? 77

4.4.3 Question 6: What are the differences in the CTS levels of UPM first year and fourth year undergraduate students? 78
4.5 Question 7: What are the dominant CTD elements that influence the CTS levels of UPM undergraduate students? 79

5 SUMMARY, DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER RESAERCH 81
5.1 Introduction 81
5.2 Summary 81
5.3 Discussion 82
5.4 Implications 85
5.5 Recommendations for further research 87

REFERENCES 90
APPENDICES 112
Appendix A 113
Appendix B 116
Appendix C 119
Appendix C-1 128
Appendix D 130
Appendix E 139
Appendix F 142
Appendix G 144
BIODATA OF STUDENT 147
LIST OF PUBLICATIONS 148

LIST OF TABLES

Table		Page
2.1	Relationships between critical thinking dispositions and critical thinking skills	22
3.1	Population of study	43
3.2	Distribution of sample according Krejcie and Morgan (1970) and Cochran (1977)	44
3.3	Items of critical thinking ability instrument	48
3.4	Scale used to measure CTD among students	49
3.5	Interpretation of the CTS levels	49
3.6	Values of factor loading	51
3.7	Index and the recommended value of acceptance for every index	53
3.8	Fit Indices of CTD before Re-specified (n= 951)	56
3.9	Comparison of CTD models` goodness of fit indices (n=951)	58
3.10	Convergent validity of CTD items (n= 951)	59
3.11	Results for the extraction of common factors (n=951)	61
3.12	Factor loading matrix using principal component analysis with iterations and varimax rotation on six factors (n=951)	62
3.13	Divergent validity of CTD (n= 951)	63
3.14	Pearson product moment correlation of subs scales CTS (n=951)	64
3.15	Interpretation of reliability co-efficient (Cronbach alpha)	65
3.16	Reliability for CTD and CTS (n= 951)	65
3.17	Number of items before and after pilot testing	66
3.18	Data analysis of study based on inferential of statistics	67
4.1	Frequency distribution based demographic factors (n=951)	68
4.2	Mean and standard deviations for analyticity items (n=951)	69
4.3	Mean and standard deviations for open minded items (n= 951)	69
4.4	Mean and standard deviations for truth seeking items (n=951)	69
4.5	Mean and standard deviations for systematicity items (n=951)	70
4.6	Mean and standard deviations for self-confidence items (n=951)	70
4.7	Mean and standard deviations for inquisitiveness items (n=951)	71
4.8	Mean and standard deviations for maturity items (n=951)	71
4.9	Mean and standard deviation for CTD elements (n= 951)	71

4.10	Results of t-test on the difference between CTD scores according to gender (n= 951)	73
4.11	Results of t-test on the differences between CTD scores based on academic major (n= 951)	74
4.12	Results of t-test on the differences between CTD scores based on academic year (n= 951)	75
4.13	Scores and percentage of correct answers on CTS items (n= 951)	76
4.14	Mean score and standard deviation for critical thinking skills (n=951)	76
4.15	Results of t-test on the differences between CTS scores according to gender (n= 951)	77
4.16	Results of t-test on the differences between CTS scores based on academic major (n= 951)	78
4.17	Result of t-test on the difference between CTS scores based on academic year (n= 951)	79
4.18	Simultaneous multiple regression analysis summary for CTD constructs (n=951)	80

LIST OF FIGURES

Figure		Page
2.1	The relationship between CTD and CTS	23
2.2	Beyer`s (1988) theory of functional thinking	25
2.3	Swartz and Perkins (1990) critical thinking dispositions and critical thinking skills theory	26
2.4	Huitt's (1998) critical thinking theory	27
2.5	Ennis (1987) pictorial representation of critical thinking skills	28
2.6	Ricketts`s and Rudd (2004) theory of critical thinking skills dispositions (behavior)	29
2.7	Conceptual framework of the study	40
3.1	Multistage cluster sampling procedures	46
3.2	Measurement model of CTD	55
3.3	Measurement model of CTD after Re-specified	57
3.4	Eigen value plot for scree test criterion	60

LIST OF ABBREVIATIONS

AGFI	Adjust Goodness of Fit
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
BM	Bahsa Malaysia
CCTDI	California Critical Thinking Disposition Inventory
CCTST	California Critical Thinking Skills Test
CFA	Confirmatory Factor Analysis
CMIN/DF	Minimum value of the discrepancy
C.R.	Composite reliability
CTD	Critical Thinking Dispositions
CTS	Critical Thinking Skills
e	Error
EFA	Exploratory Factor Analysis
GFI	Goodness of Fit Index
KR20	Kuder-Richardson 20
MOHE	Ministry Of Higher Education
MSLQ	Motivated Strategies for Learning Questionnaire
MQF	Malaysian Qualification Framework
NFI	Normed Fit Index
NSSL	National study of Student Learning
OBE	Outcome Based Education
PNFI	Parsimonious Normed Fit Index
PSPTN	Pelan Strategik Pengajian Tinggi Negara
r	Correlation
R^2	Squared multiple correlations
RMR	Root Mean Residual
RMSEA	Root Mean Square of Error
S.E	Standard Error of regression weight
SEM	Structural Equation Modeling
SPSS	Statistical Package for Social Science
TESOL	Teaching English to Speakers of Other Language
TLI	Tucker-Lewis Index
UPM	Universiti Putra Malaysia
WGCTA	Watson-Glaser Critical Thinking Appraisal Test
χ^2	Discrepancy Chi-square
χ^2/df	Chi-square Degrees of Freedom
$\propto$	Cronbach's alpha

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

One of the most important agendas in the tenth Malaysian plan is human capital development. As Malaysia plans to progress from a developing country to a developed country in the year 2020, human capital development is emphasized as a catalyst for the improvement of the quality of mental and intellectual capacity of the citizens, specifically the creative and innovative skills (Ministry of Higher Education, 2009).

Hence the creative and innovative skills are recognized as important targets in the quest for the improvement of the overall thinking faculties of the Malaysian citizens. Creativity and innovation are elements of the soft skills that contribute to the success of human capital development (Hassan, Md.Zain, & Ali, 2007). The term soft skills may have different names, depending on the national development agenda of a country. According to Clayton, Blom, Meyers & Bateman (2003), soft skills is defined by the Australian educational system as the key competencies or employability skills. Likewise, the American defines soft skills as the necessary skills or employability skills. The British, nevertheless, defines them as the key skills or core skills (Association of Graduate Recruiters, 2006). The Malaysian educational system calls soft skills as generic skills (Ministry of Higher Education, 2007a).

In the Malaysian context generic skills as they are so described refer to a broad base of skills they are required in other to be able to partake meaningfully and engagedly to direct the course of action with cutting edge ideas for continuous improvement. To facilitate such efforts of producing highly creative and innovative citizens through higher learning institutions, the Malaysian Ministry of Higher Education (2007a) came out with a Pelan Strategik Pengajian Tinggi Negara (National Higher Education Strategic Planning). This strategic plan outlined, among other things, the strategic direction of Malaysia's higher education for the ultimate aim of achieving the goal of making the country a higher education hub in the sub region.

One of the key elements in the *Pelan Strategik Pengajian Tinggi Negara* is to increase the quality of teaching and learning in Malaysian higher learning institutions in order to produce presentable and employable graduates (Pandian, 2005). Consequently, Malaysian Qualification Framework (MQF) was introduced in which, Outcome Based Education (OBE) was given emphasis. To

initiate the OBE, the Ministry of Higher Education has published several modules to be implemented in Malaysian public universities, including Universiti Putra Malaysia (UPM). One of the modules specifically focuses on students' *Kemahiran Insaniah* or soft skills (Ministry of Higher Education, 2007a).

As a follow up to the pronouncement of developing soft skills in the higher education environment, many institutions followed suit in carving out measures geared towards such end. A case in point is UPM which devise tangible measures in teaching and learning in other to produce quality and marketable graduates. For instance to produce quality graduates in Malaysian public universities, including UPM, teaching and learning instruction, assessment procedures and techniques should be highly tailored for the desired exit outcomes (Universiti Putra Malaysia, 2004). To facilitate this UPM's goal of producing quality graduates are reflective in the teaching and learning objectives which are observable and achievable via adequate and appropriate teaching and learning approaches and strategies. Assessments also possess high degree of discriminating effects that classify students according to their actual soft skills, varying as they are. Ultimately, improving the soft skills of undergraduate students in Malaysian public universities such as UPM is very important due to several reasons (Pandian, 2005).

The improvement of soft skills as highlighted above is crucial in Asian countries, studies have shown that Asian undergraduates students lack soft skills, especially the thinking skills, thus reducing their job opportunities as employers are usually very keen on such skills, (Biggs, 1999; Tiwari, Avery & Lai, 2003; Ministry of Higher Education, 2009; Chan, 2011). Secondly, the global market demands more competitive and creative employees (Ministry of Higher Education, 2009). Thirdly, due to the rapid evolution in communication technology and the increment of trade among countries worldwide, most large companies are transformed into multi-national corporations. As such, they frequently seek employees who, apart from being technically qualified, must also possess good leadership, communication and critical thinking skills (Shakir, 2009).

In the education enterprise, the concept of soft skills revolves around seven key skills, which will be discussed accordingly. These skills are generally applicable to all higher education institutions (Jelas & Azman, 2006; Ministry of Higher Education, 2007a; Nikitina & Furuoka, 2012). In the Malaysian perspective, soft skills are considered as generic skills and these include various learning approaches that aim at incorporating aspects of interpersonal and intrapersonal skills (Ministry of Higher Education, 2007b). Interpersonal skills include communication skills, teamwork skills, life-long learning and information management as well as leadership skills, while intrapersonal skills include entrepreneurship skills, moral and ethical professional skills and critical thinking skills (CTS).

The seventh of the seven soft skill highlighted by MOHE is the critical thinking skills (CTS) which advocate that students should think critically and analytically. CTS further specify that students should be able to apply their knowledge in complex situations, as well as making justifiable evaluation (Pandian, 2005; Ministry of Higher Education, 2007b). In addition they should also possess the ability to provide ideas or alternative solutions that may improve thinking skills and problem solving (David, 2007).

Several studies in different countries show the importance of the CTS to the overall employability of its graduates (Shakir, 2009). In Malaysia, however, studies in this direction are limited. This limitation often leaves policy makers with limited policy options to implement strategies that may improve students' critical thinking skills. More so, undergraduate students suffer from the lack of these skills and thus affect their career life (Pandian, 2005; Konting et al. 2007). On a similar note, the education systems in some countries such as China tend to put more emphasis on imparting knowledge rather than developing students' CTS, despite the fact that CTS is considered to be one of the most important soft skills in education as far as employers are concerned (Barry, Stein, Haynes & Jenny; 2003).

Recent research efforts in countries like Malaysia, the United States of America and Singapore showed that students in higher education institutes have low critical thinking skills (Beckett, 2002; Guest & Schneider, 2003; Cheong et al. 2005; Pandian, 2005; Konting et al. 2007). Likewise, in the United Kingdom, according to the National Institute of Adult Continuing Education (BBC News, 2007; Ford, 2007; AOP, 2012; Philabaum, 2012), employers feel many graduates lack soft skills such as critical thinking. Similar studies, in Middle Eastern countries showed that students after graduation still have low critical thinking skills (Aliakbari & Sadeghdaghighi, 2013).

In the Malaysian context, the same situation exists among college students (Rosnani & Suhailah, 2003). Two studies carried out in Malaysia affirmed that after eleven years of schooling, students were still unable to apply critical thinking skills in their class or in real world situation (Rosnani & Suhailah, 2003; Konting al. 2007). Another study on 561 unemployed graduates conducted by the Malaysian National Higher Education Research Institute (NHEM, 2003) showed that the respondents generally believed that they were well qualified and met all the requirements of the regular job market. However, potential employers turned down their applications on the perceived lack of CTS.

According to Pandian (2005), university lecturers in Malaysia are with the opinion that students' responses during exams and other academic projects do not reflect any critical thinking skills usage. This finding was supported by Konting et al. (2007) in their study which showed that high school students in Malaysia scored low in their CTS test. Arguably, these students were expected

to gain admission into public universities across Malaysia. Hence, it is imperative for universities, including UPM to put in place the necessary teaching and learning strategies aimed at boosting the overall CTS levels of entrants.

One important element that contributes to CTS is critical thinking Disposition (CTD). Critical thinking disposition deals with the affective aspects of thinking which basically shapes ones usual ways of thinking to real life issues (Facione, Noreen, Facione & Sanche, 1994). Student's ability to think critically is triggered by the employment of CTD elements (Pascarella & Terenzini, 2005).

CTD and CTS are inseparable, where the former is like the soul and the latter represents the body (Beyer, 1987). To make good meaning out of the relationship between the two one can describe a critical thinker as an individual who has critical thinking ability which in totality is an aggregate of the collective attributes of CTS and CTD. The relationship between critical thinking disposition and critical thinking skills has been expounded on by various researchers. By way of highlighting the relationship it is important to highlight major differences between a skill and a disposition. A skill is what a person can do such as the ability to read or think whereas a disposition is a habitual inclination such as being open-minded, regular or neat (Schafesman, 1991). A skill is tested by asking someone to do a task while disposition is tested by asking about a person's beliefs, preferences etc. While we can have skills we may not be disposed to use them. While CTD and CTS are two different dimensions that rely on different components their interdependent relationship is evident. As highlighted in the literature acquiring CTS without the necessary motivation to utilize it will hamper the use and value of both the CTS and CTD elements (Alshraideh, 2009).

Way back in the late nineteenth century, the teaching of critical thinking ability was given real attention (Paul, Elder and Bartell, 1997). In Malaysia, there has been a great deal of development in the higher education curriculum as the education department of higher learning has realized the needs for critical thinking ability to be integrated into the curriculum of Malaysian universities, and to be taught explicitly (Hussin, 2003). According to Ministry of Higher Education (2007b), critical thinking ability focuses on:

i. the ability to identify and analyze problems in range and to evaluate with justification;
ii. the ability to expand and improve thinking skills such as clarifying, analyzing and evaluating discussions; and
iii. the ability to seek idea and alternative ways of solving problems.

Furthermore, according to the Curriculum Development division in Malaysia (KPM, 1996), the importances of critical thinking ability are as follows:

- to produce Malaysians who can think critically in order to achieve the goals of the Vision 2020;
- to develop individuals who are intellectually, spiritually, emotionally and physically balance and harmonious; and
- to develop students' ability to think critically and creatively as well as to make decisions and solve problems.

A lot of studies have been carried out in different parts of the world aimed at finding ways and means of improving students' critical thinking ability (Lotto & Barrington, 2006; Society for Human Resource Management, 2007). A study conducted by Numrich (2006) for instance revealed a positive correlation was found between CTS and CTD among university entrants. Likewise studies have also shown that CTS and CTD are related but not redundant, meaning that some results from CTS research may be generalized for CTD (Bette, 1999). Similarly other studies found that there is a relationship between CTD and CTS while others have confirmed that students who have high CTS are likely to have high CTD, while students who possess low CTS tend to have low CTD. This in effect helps to conclude that both CTD and CTS are crucial components of critical thinking ability to stand to be called a critical thinker.

Factors related to critical thinker have been variously written on in several research works. Among the most common of these factors include gender, academic major and field of specialization, (Alhelfawi, 2007), Cumulative Grade Point Average (CGPA) and academic year (Berzins & Francesco, 2008) region and cultural background (Lun, 2010) but to a name a few.

1.2 Statement of the problem

The literature on CTD and CTS has shown in previous references the salient role of critical thinking ability in many educational systems in the world and its prominence as one of the goals of education. As in the case of the Malaysian scenario, development and reforms in education are taking place and on-going efforts are being made to enhance the acquisition of critical thinking ability among undergraduate students (Razak, 1998). The desire to cultivate students' ability to think critically is worded emphatically in the Malaysian syllabus itself (Ganakumaran, 2003).

In the Malaysian context, The Ministry of Human Resource states that the number of unemployed graduates in 2010 was approximately 32,000 (Ministry of Human resources, 2010), and constituted 34% of an approximately 93,000 graduates (Ministry of Higher Education, 2010). The reason often echoed by the employers then was that local graduate were generally viewed as technically

proficient but lacked required soft skills, especially the CTS (Konting et al. 2007 & Pandian, 2005).

In a bid to quantify the level of soft skills among students in Malaysian universities, a study by Yunus et al. (2007) indicates that UPM, which is one of the research-based higher learning institutions in the country, secured the third best grade in the CTS test amongst Malaysian universities. Another study by Yunus et al. (2006) shows that majority of undergraduate students (Konting et al. 2007) as well fresh undergraduate students (2007-2008) attained moderate scores in CTS test.

A limitation of the studies on CTD and CTS in Malaysia is the omission of the extent to which CTD might influence the overall CTS of students and the CTD elements which influence on CTS. Most importantly the influence of gender, academic major and academic year as factors which would inform a lot of important considerations in dealing with CTD and CTS influences among several other similar attributes are all conspicuously not much ventured. Such a gap requires a study to be filled and as such this study aims at filling that void in the CTD and CTS literature in Malaysia. Furthermore, CTS are one of the many skills required to be acquired wile enrolled in both the graduate and undergraduate programs as emphasized by both Ministry of Higher Education (MOHE) and encapsulated in the mission statements and objectives of the individual universities in Malaysia.

Furthermore, there is a lack of a comprehensive instrument to measure the actual levels of the CTD influence on CTS. In particular, actual levels of CTD influence on CTS considering some factors such as academic major, academic year and gender among several others is also mainly absent. This research to come up with a new instrument that able to measure such is crucial to gain an understanding the subject matter of CTD and CTS. This study focus to identify the level of CTD and CTS of the undergraduate students' based on the following factors (gender, academic major and academic year) and their CTD influence towards CTS.

1.3 Research objectives

Specifically, the objectives of this research are as follows;

1. to identify the CTD levels among undergraduate students from different majors of study (science and arts-based) versus, gender and academic year of study;
2. to identify the CTS levels among undergraduate students from different majors of study (science and arts-based) versus, gender and academic year of study;

3. to identify the dominant CTD elements that influence CTS among UPM undergraduate students.

1.4 Research questions

1. What are the differences in the CTD levels of UPM undergraduate students based on gender?
2. What are the differences in the CTD levels of UPM science-based and arts-based undergraduate students?
3. What are the differences in the CTD levels of UPM first year and fourth year undergraduate students?
4. What are the differences in the CTS levels of UPM undergraduate students based on gender?
5. What are the differences in the CTS levels of UPM science-based and arts-based undergraduate students?
6. What are the differences in the CTS levels of UPM first year and fourth year undergraduate students?
7. What are the dominant CTD elements that influence the CTS levels of UPM undergraduate students?

1.5 Research Hypothesis

The null hypotheses tested in this study are;

H_{01}: There is no significant difference in the CTD levels of UPM undergraduate students based on gender.

H_{02}: There is no significant difference in the CTD levels of UPM undergraduate students based on their academic majors.

H_{03}: There is no significant difference in the CTD levels of UPM undergraduate students based on their academic years.

H_{04}: There is no significant difference in the CTS levels of UPM undergraduate students based on gender.

H_{05}: There is no significant difference in the CTS levels of UPM undergraduate students based on their academic majors.

H_{06}: There is no significant difference in the CTS levels of UPM undergraduate students based on their academic years.

H_{07}: There are no CTD elements that have an influence on the CTS of UPM undergraduate students.

1.6 Significance of the study

While CTD and its influence on CTS has been variously researched and written on, not much is concentrated about it within the Malaysian context especially in the Public Universities. Hence some substantive study into the CTD levels amongst students is imperative to gauge how they are faring and what needs to be done to help further perk up on the current levels. The influence of CTD on CTS which is also critical to carve out a way forward with regards the further improvement of the levels among students is also required.

The significance of this study therefore is to identify the CTD levels especially the dominant CTD elements among undergraduate students in UPM, answers to which could be utilized to provide means of improving CTD among students. On the other hand results of this study could be lined along similar studies on CTD and CTS on other students from other institutions in order to gauge the performance level of these students as compared to their counterparts. Such comparison would not only help to highlight the performance levels of students in this study but would also help to identify the gaps which would thereby spur the need to for efforts towards the improvement of CTD and CTS levels.

Most importantly the study concentrated on identifying CTD levels among undergraduate students according to academic year, gender and major area and a discovery of any significant differences in CTD and CTS levels based on these categories would be crucial in both the policy directions as well as the teaching and learning approaches for use in this University.

Furthermore the results of this study would help improve the CTD and CTS of students as it highlights their current levels of CTD especially the elements that influence CTS among students. Knowledge of this would be useful to suggest intervention levels and how this could be approached for further improvement.

1.7 Research limitations

This research is limited to the CTS and CTD and does not include any other kind of thinking such as creative thinking. In addition, this research is limited to UPM undergraduate students who are in the first semester and seventh semester of 2011/ 2012 academic year to see whether the university has any influence on their critical thinking ability and does not include postgraduate students at UPM.

1.8 Operational definitions

Critical thinking dispositions

In this research, critical thinking dispositions comprise seven different elements, which are analyticity, open-mindedness, truth seeking, systematicity, self-confidence, inquisitiveness and maturity, that enable students to solve problems and make decisions in a critical manner.

Analyticity: In this study, analyticity means the ability to anticipate consequences by applying deep reasoning and breaking down the question, objects and idea to smaller part.

Open-mindedness: In this study open-mindedness means the ability to accept and see others' opinions and views even if they do not match with ours.

Truth seeking: In this study truth seeking means the courageous attitude to find an optimal solution or best knowledge best on a personal belief or background.

Systematicity: In this study systematicity means the ability to focus and organize ways on solving problems at all levels.

Self-confidence: In this study self-confidence means believing and trusting one`s own reasoning skills rather than others' opinions or strategies to tackle a problem.

Inquisitiveness: In this study inquisitiveness means the curiosity and eagerness to learn more even if the knowledge is not immediately apparent.

Maturity: In this study maturity means taking enough time to solve a problem best on the solution available.

Critical thinking skills

In this research, critical thinking skills comprise four types of skills, which are analysis, evaluation, deduction and induction, that help students in making decisions after evaluating the available solutions in an effective way.

Analysis: In this study analysis means the ability to determine significance of something, interpret meaning, and detect possible inferential relationships.

Evaluation: In this study evaluation means the ability to test the efficiency and validity of a statement and the strength of argument and solutions.

Deduction: In this study deduction means that reasoning is one in which it is claimed that it is impossible for the premises to be true when the conclusion is false. Thus, the conclusion follows necessarily from the premises and inferences. In this way, it is supposed to be a definitive proof of the truth of the claimed conclusion.

Induction: In this study induction means that reasoning is one in which the premises support the conclusion in such a way that if the premises are true, it is improbable that the conclusion would be false. Thus, the conclusion follows probably from the premises and inferences.

Academic major

Refers to the main of study of respondents, either the science-based (study of subjects such as Chemistry, Biology, and Physics) or arts (taking any combination of subjects other than the three main science subjects) as major.

Academic year

Refers to first and fourth year of Universiti Putra Malaysia (UPM) students who have not completed the courses pertaining to undergraduate level.

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