

# Influences of critical thinking dispositions on critical thinking skills of undergraduate students at a Malaysian Public University

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**Abstract.** Nurturing critical thinking in students is an aspiration of many professionals in higher education. It is also a quality that is often highly sought after by employers of university graduates. This study outaimed to find out the influences of critical thinking dispositions on critical thinking skills of the undergraduate students of the University of Putra Malaysia. The predictive relationships of student characteristics and perceptions towards critical thinking dispositions was examined by constructing a questionnaire to measure the critical thinking skills. In addition another instrument called Survey questionnaires on Critical Thinking Disposition CTD as well as Critical Thinking Skills were used to gather data. The respondents were drawn from undergraduate students at Universiti Putra Malaysia. The data were analyzed using multiple regression and the reliability of the instruments were checked by utilising alphacronbach, Kuder-Richardson 20 (KR-20). The results demonstrated that the undergraduate students were weak in systematicity, inquisitiveness and maturity, average in analyticity, open mind and truth seeking, and strong in self-confidence.

**Keywords:** Critical thinking dispositions, critical thinking skills, undergraduate students, Malaysian university.

## INTRODUCTION

The notion of critical thinking has continued to be an issue of concern to the various stakeholders in the education field. Research efforts in recent years in countries like Malaysia, the United States of America and Singapore showed that students in higher educational institutions have low critical thinking skills (Beckett, 2002; Guest and 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 felt many graduates lacked the critical thinking skills as well. Moreove, studies in the Middle East countries too, revealed that students after graduation had low critical thinking skills (Aliakbari and Sadeghdaghghi, 2013).

Some new studies conducted in Western Europe and

the United States of America revealed that the level of critical thinking among undergraduate students based on demographic characteristics such as gender, academic year and academic major showed no clear differences among them (Guest, 2000; Gelder, 2005). A similar situation was found to exist in Malaysia (Rosnani and Suhailah, 2003). In fact the two studies which were conducted show that after eleven years of schooling, students were still unable to apply critical thinking skills in their class or in real world situations as well. 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 even though their applications were turned down due to lack of Critical

Thinking Skill CTS (Rosnani and Suhailah, 2003; Konting et al., 2007).

According to Pandian (2005), university lecturers in Malaysia found that students' responses during examinations and other academic projects did not reflect application of critical thinking. 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. Crucially, these were the students who were expected to gain admission into public universities across Malaysia.

University Putra Malaysia (UPM) has a vision of becoming an internationally renowned university by equipping all her students with the required knowledge and competencies for future success. For this vision to be achieved, it is necessary to implement programmes and projects that maximize learning experiences (University Putra Malaysia, 2011). Hence necessary teaching and learning strategies, among other improvement drives, aimed at enhancing the overall CTS among students is imperative in the drive towards the achievement of this University's Vision and results obtained from studies such as this one could be useful in policy initiatives aimed at improving teaching and learning in the University.

According to Facione et al. (1994), one of the most important and required elements of CTS is attitude or dispositions in preparation for students to acquire critical thinking ability. They are affective elements of CTS (Pascarella and Terenzini, 2005).

Critical Thinking Disposition and Critical Thinking Skills need to be developed and nurtured concurrently. Thus, critical thinking ability focuses on:

- i) the ability to think "out of box";
- ii) the ability to make discussions on solid proves;
- iii) the ability to withstand while focusing on the tasks given; and
- iv) the ability to understand and be adaptive to the culture of the community and new working environment.

The CTD elements are employed to trigger critical thinking ability among students. The relationship between CTD and CTS are inseparable, where the former is like the soul and the latter represents the body (Beyer, 1987, 1988). According to the Ministry of Higher Education 2007, the critical thinking ability focuses on:

- i) the ability to identify and analyse problems in range and to evaluate with justification;
- ii) the ability to expand and improve thinking skills such as clarifying, analysing and evaluating discussions; and
- iii) the ability to seek ideas and alternative ways of solving problems.

Way back in the late nineteenth century, the teaching of critical thinking was given full attention (Paul et al., 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 thinking ability to be integrated into the curriculum of Malaysian universities, and to be taught explicitly (Hussin, 2003).

According to the Malaysian Curriculum Development Division (KPM, 1996), the importance of critical thinking ability are as follows:

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

In order to produce quality graduates from UPM, the teaching and learning processes, assessment procedures and techniques should be highly tailored for the desired outcomes (Universiti Putra Malaysia, 2004). In other words, UPM's goal of producing quality graduates should be reflective in the teaching and learning objectives that are observable and achievable via adequate and appropriate teaching and learning approaches and strategies. Assessments should possess high degree of discriminating effects that classify students according to their actual varying critical thinking abilities.

## LITERATURE REVIEW

### Critical thinking dispositions

In the field of curriculum and instruction, there is no fixed definition of CTD (Mcbride et al., 2002). Although a variety of definitions have been offered in the past couple of decades, most include the same underlying principles. CTD strives to help students to be critical thinkers. It is purposeful, reasoned, and goal-directed in critical thinking and is the kind of attitude to thinking (Halpern, 1999).

Observations by Paul (1995) show that critical thinking disposition is dependent upon a person's disposition to effectively apply it. Several researchers have agreed that disposition to think critically can be viewed as consistent willingness, motivation, inclination and an intention to be engaged in critical thinking while reflecting on significant issues, making decisions and solving problems (Facione et al., 1995; Facione et al., 1997). According to Zoller et al. (2000), for a student to think critically, it is a necessity to utilise the dispositional aspect as a precondition for critical thinking and this immensely influences critical thinking capability.

Previously, Glaser (1985) viewed CTD as: (1) the

attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experiences, (2) the knowledge of the methods of logical inquiry and reasoning and (3) some skills in applying those methods. Furthermore, Glasser (1985) attempted to provide an empirical evidence of CTD as a fundamental element of critical thinking.

Arguments are rife regarding the undisputed fact that disposition is termed as an important dimension in critical thinking (Rudinow and Vincent, 2008). In 1990, Facione and his group of experts identified factors such as analyticity, open minded, truth seeking, systematicity, inquisitiveness and maturity as a set of specific skills dimension and a specific set of attitudes in CTD (Facione, 1990).

Using the consensus definition of CTD provided by the Delphi Report, Facione et al. (1997) highlighted the components of CTD. Those skills are analyticity, open minded, truth seeking, systematicity, self-confidence, inquisitiveness and maturity.

According to what had been mentioned above, CTD exposes students to become critical thinkers. Wen (1999) defines a critical thinker as a thinker who is involved in some special attitudes or activities. Previous reports by Wen (1999) revealed that critical thinkers have to be involved in CTD investigations. He stated that critical thinkers are involved in both extensive thinking (looking for the reasons for true decisions) and freethinking (thinking independently).

Another component of CTD according to Wen (1999) is reconstruction, which is approving or recognizing the current value system and changing his beliefs. It means the critical thinker is critically listening to others, giving feedback, accepting his own shortcomings and is able to postpone decision making to the end of the process to get the developmental result. It is obvious, that a critical thinker needs knowledge and awareness of those activities. However, learners need instruction. In other words, critical thinking ability can be enhanced in classes with lecturers' guidance.

Finally, CTD involves the seven dispositions (Analyticity, Open minded, Truth seeking, Systematicity, Self confidence, Inquisitiveness and Maturity) that provide the students with the needed skills, primarily basic logic, the abilities or proficiencies to be critical thinkers (Tishman and Andrade, 1996). The ability to be a critical thinker is a learned skill, one that is greatly influenced by learning environment, disposition and pedagogy (Wen, 1999).

### Critical thinking skills

Critical thinking skill is one of the main components of thinking skills (Avery, 1994). The word "critic" comes from the Greek word "kritikos" which means "able to evaluate". Originally, CTS was created to avoid mistakes, confusion and other wrong assumptions (Nelson, 1998). The skill

focuses on the ability to evaluate the possibility of an idea that is to weigh all the advantages and disadvantages by giving valid, clear, and strong reasons. This in turn can help avoid making some mistakes and at the same time to rectify the mistakes (Stine and Benares, 1994).

There was a great deal of discussions in the empirical literature of the concept of CTS during the 1970s and 1980s. According to Brookfield (2006) there was a wide variety of definitions of CTS in the literature, however there was neither a consensus about what CTS entailed nor a consistent definition by which the CTS could be measured and assessed.

The definition of CTS has changed over the years. There are many definitions of CTS from various fields, started by the cognitive psychologists. Now, philosophers, behaviorally oriented psychologists and content specialists have joined the discussions. From the area of cognitive psychology, Crenshaw and Sallie, (2011) see CTS as the ability to analyze fact, generate and organize ideas, defend opinions, make comparisons, evaluate arguments and solve problems. Fisher and Scriven (1997) have agreed to a consensus that CTS is a mental process:

"Critical thinking skills are the skilled and active interpretation and evaluation of observations and communications, information and argumentation" (p 21).

Hatcher and Spencer (2004), for example, argued that CTS tries to arrive at a judgment only after honestly evaluating alternatives with respect to available evidence and arguments. Mazer et al. (2007) operationalise CTS as the ability to construct meaning and articulate and evaluate arguments, as well as evaluate sources and support. In 1988 and 1989, the American Philosophical Association (APA) sponsored an extensive qualitative study using the Delphi method to understand CTS in instruction and assessment (Facione, 2010). Forty-six scholars and educators came to a consensus on the following definition of CTS:

"We understand CTS to be purposeful, self-regulatory judgment which results in indicative, analysis, evaluation and deductive" (p3).

However, not too much emphasis should be placed on singular definitions of CTS. In 2000, Rudd and Backer studied definitions of CTS and recommended that there was sufficient overlap in definitions of different authors to move beyond the definitional stage. Halx and Reybold (2006) found similar results when they conducted a literature review on definitions of CTS. In fact, they concluded

"...the descriptions purposeful, reasoned and goal directed thinking appear consistently" (p294).

Williams and Worth (2001) studied operational definitions

of CTS and concluded that CTS is the ability to reach and evaluate conclusions from available evidences.

The Malaysian Curriculum Development Center (KPM, 1996) defines CTS as cognitive skills required to make skillful assessment of the data and information received. This involves making skillful analysis of the data and information. Making an analysis means breaking up the data and information into parts and studying each part in more detail. Skillful analysis involves the skills of comparing and contrasting, classifying, arranging and sequencing, identifying facts and opinions, identifying bias statements, giving the causes, predicting, making inferences and generalizations, interpreting and summarizing.

On the other hand, McPeck (1990) defines critical thinking as “thinking with skepticism” about a subject or field, critical thinking can include certain aspects of problem solving and various skills which include analysis, evaluation, deduction and induction. Leicester (2010) sees CTS as “cognitive skillful responsible thinking that facilitates good judgment because (a) it relies upon criteria, (b) it is self correcting, and (c) it is sensitive to context”. Adding to this analysis of CTS, Bensley et al. (2010) claims that CTS involves three principal elements. First, he claims that it is an attitude of being disposed to consider in a thoughtful, perceptive manner the problems and subjects that come within the range of one’s experience. Second, it can be seen as knowledge of the methods of logical inquiry and reasoning. Third, it requires skills in applying those methods.

Critical thinking skills are a process that supports belief and action. Fisher (2001) asserted that CTS depend on belief in its value and attitudes towards it. CTS can facilitate reasoning and understanding of past, present, and future events (Brookfield, 2006). It is goal directed, purposeful, abstract, logical, rational, and evaluative; it is also moral thinking and justification of ideas and knowledge (Daly, 1998). CTS are central to reflective thinking, and it is a principled process employing the cognitive skills of analysis, evaluation, deduction and induction.

In the philosophical field, Browne and Keeley (2011), defend CTS as “ the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing and evaluating information gathered from, or generated by observation, experience and reflection reasoning. According to Paul and Elder (2003), CTS is well explained as the ability of thinkers to take charge of their own thinking. This requires them to improve the criteria and standards for analyzing and assessing their own thinking and routinely use those criteria and standards to improve its quality.

Critical thinking skills can be considered as a piece of problem solving scheme. According to McWhorter (2010) in problem solving there is a linear process of evaluation, allowing the inquirer to make each stage of the linear problem-solving process easier. According to Black and

Parks (2006), CTS is an active, purposeful and organized efforts to understand our world by carefully examining thinking, and the thinking of others with the purpose of clarifying and improving our understanding. According to Brookhart (2010), CTS is thinking that is purposeful, reasoned and goal directed. It is sort of thinking included, in solving problems, formulating induction, calculating probabilities, and making decisions. Simply put, CTS are the reasonable and reflective thinking that is emphasized on deciding what to believe or do (Clifford et al., 2004).

Brookfield (2011) analyzed a way of reasoning that demands an adequate support for ones beliefs and a willingness to be persuaded unless support is forthcoming. Moore (2011) defines it as reasonable, reflective thinking that fused analyzing arguments and generating insights into particular meanings and interrelation. On the other hand, content specialists views CTS as involving analytical thinking for evaluating what is read. Brookhart (2010) and Lavery et al. (2009) defined it as a conscious and deliberate process, which is used to interpret or evaluate information or experiences with a set of reflective attitudes and abilities that guides thoughtful experiences, beliefs and actions.

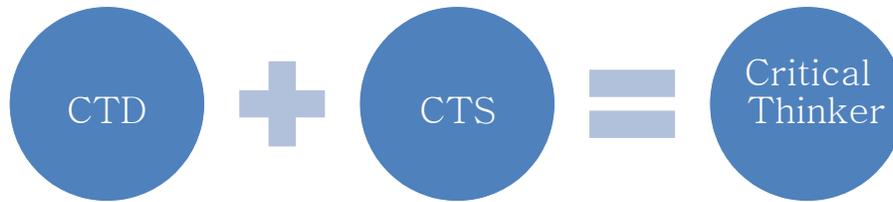
In order to be successful in inculcating CTS, it is argued that significant mechanisms are demanded that the public at large must acknowledge CTS as essential to the education of today’s learner depending on the several definitions above. The researcher believes that critical thinking is a complex process, and it is generally higher order thinking or cognitive processing. A critical thinker is able to solve problems, make decisions, evaluating information and formulating inferences. This means that CTS involve the ability to use our mind to achieve our goals.

Finally, the critical thinking skills that were identified previously by the panel of experts will be used in this study because they most closely matched the definition of critical thinking skills that we have adopted

### **Relationship between critical thinking dispositions and critical thinking skills**

Despite the fact that CTD and CTS are two different dimensions which depend on different factors, there is an interdependent relationship between the two. For example, having CTS but no motivation to use it will limit the use and value of both the CTS and CTD skills and vice versa. This is supported by Numrich’s (2006) study where a positive correlation was found between CTS and CTD among university entrants. The author concluded that CTS and CTD are related in some respects although superficially varied and that some results from CTS research may be generalized for CTD (Bette, 1999) in certain contexts and instances.

Hence it is evident that both CTD and CTS are indispensable components of critical thinking ability in



**Figure 1.** The relationship between CTD and CTS. Source: Facione and Facione (2007).

order to be called a critical thinker (Baysala et al., 2010). A good critical thinker exhibits two dimensions: 1) CTD analyticity, open-minded, truth seeking, systematicity, self-confidence, inquisitiveness, and maturity; and 2) CTS analysis, evaluation, deduction and induction (Facione and Facione, 2007).

As shown in Figure 1, dispositions are necessary to identify CTS so as to take root and flourish in students. According to Facione and Facione (2007), a good critical thinker should have some of the following characteristics:

- a) able to support his belief with good and sufficient reasons no matter how pathetic they may be;
- b) able to make wise decisions, regardless of how common those decisions are;
- c) honest with himself, acknowledges what he does not know, recognizes his limitations and watchful of his errors;
- d) regards problems and controversial issues as exciting challenges;
- e) strives for understanding, keeps curiosity alive, remains patient with complexity and ready to invest time to overcome confusion;
- f) sets aside personal preferences and bases judgment on evidence, and defers judgment whenever evidence is insufficient.
- g) revises judgment when new evidence reveals errors;
- h) interested in other people's ideas, willing to read and listen attentively, even when he tends to disagree with the other person;
- i) practises restraint, controls his feelings rather than being controlled by them, and thinks before acting.

In summary therefore a critical thinker is an individual who possesses critical thinking ability which can only be attained in the presence of CTD and CTS. Those two elements are indispensable components of critical thinking and play an important role on the ability to become a critical thinker.

### Conceptual framework

The conceptual framework of this research is based on the fact that critical thinking skill is one cognitive outcome in the education process, and thus it becomes an important variable in student learning. The acquisition of

this skill in the learning process is related to various factors in teaching and learning. The study is structured based on the model of student learning developed by Biggs (1993) and Biggs and Tang (2011).

The conceptual framework of this research follows the same structure in which critical thinking skills as the product variables is the outcome of student variables, critical thinking skills and critical thinking dispositions.

From the model on learning (Biggs, 1993), a conceptual framework has been constructed for the present study as shown in Figure 2. The relationship between students' critical thinking skills and critical thinking dispositions (student variables), were investigated. The conceptual framework is illustrated in Figure 2.

### Research hypothesis

The null hypothesis for this research is:

$H_0$ : Critical thinking dispositions do not influence critical thinking skills among students.

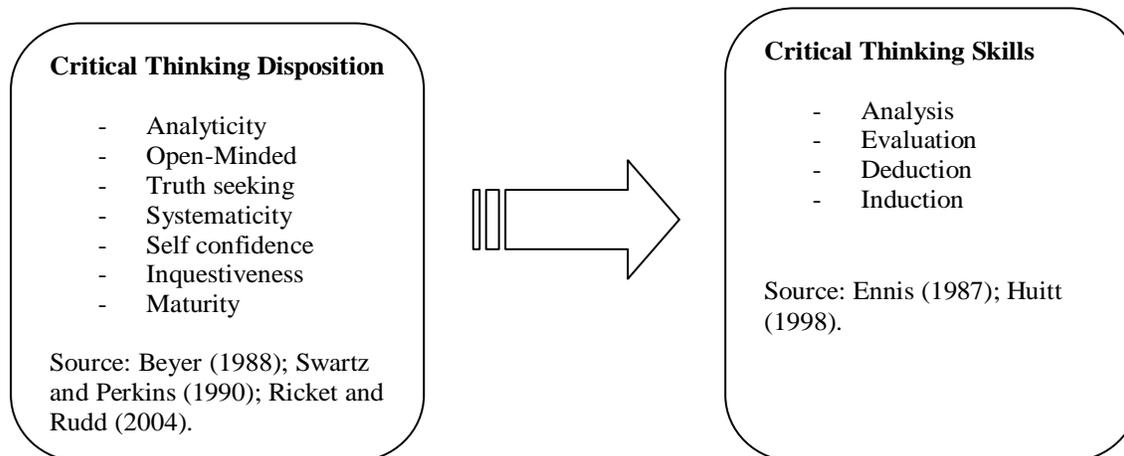
### METHODOLOGY

This study utilises the descriptive survey design where data were collected using questionnaires from dissimilar undergraduate students knowledge. A multistage cluster sampling technique was employed to select a sample size of 951 undergraduate students at University Putra Malaysia (UPM). The respondents were selected according to the year of study with 448 students from Year 1 and 503 students from Year 4. The reason for targeting these two groups was that the first and final year students would facilitate some form of comparison of the levels of CTS and CTD.

### Instruments

Four instruments were administered to the respondents. The researcher also included questions related to the respondents' demographic profile such as gender and academic major. The instruments used were:

1. A Critical Thinking Disposition (CTD) questionnaire using



**Figure 2.** The conceptual framework on the influence of the critical thinking dispositions on critical thinking skills among students.

**Table 1.** Items for critical thinking ability.

Part	Students factor	Definition based the Instrument	Number of Items
CTD	Analyticity	Tendency to examine a situation carefully	4
	Open-minded	Willingness to consider ideas and opinions that are new or different	4
	Truth seeking	Looking for the real fact about a situation	3
	Systematicity	Tendency toward a focused and organized plan	3
	Self-confidence	Being sure about yourself and your ability	3
	Inquisitiveness	Curious and desire to explore	3
	Maturity	Graduality of mind and age	3
CTS	Analysis	Tendency to examine a situation carefully and thoroughly	3
	Evaluation	Making value judgment	3
	Deduction	Solve problems using available premises information	7
	Induction	Drawing reasonable conclusions from various elements	5

a four-point Likert rating scale (1 = Disagree Strongly; 2 = Disagree Moderately; 3 = Agree Moderately; 4 = Agree Strongly). There were 23 items were adopted by (Pintrich et al., 1993; Robert, 2003; Bochario, 2004; Stanovich, 2010; Manrique, 2011).

2. The Critical Thinking Skills (CTS) test consisted of twenty-two critical thinking sub-skills questions; each of which had had to be answered using two options; either 'Yes' or 'No'. This critical thinking skills test had been adopted by Goel et al. (1997), Choi and Choi, (2007) and Stanovich (2010).

### Reliability of instruments

The determination of the reliability of the CTD questionnaire was achieved through a commonly used procedure termed the Cronbach's alpha (Ary et al., 2010). The overall reliability coefficient of the scale was .92. The Cronbach Alfa reliability of the subscales were:

.87 for Analyticity, .92 for Open-Mindedness, .96 for Truth Seeking, .98 for Systematicity, .97 for Self Confidence, .88 for Inquisitiveness and .79 for Maturity Subscale.

According to Freidenberg (2009), when questions are scored dichotomously (0 and 1), "it is easier to calculate the alpha for these tests using one of the Kuder-Richardson formulas, such as the KR-20". The reliability of the CTS items were assessed by computing Kuder-Richardson 20 (KR-20) correlation and the overall CTS reliability index was found to be .73. (Table 1)

### Procedures

The researcher personally distributed 951 questionnaires to UPM's first and fourth undergraduate students from the faculties of Computer Science and Information Technology, Agriculture, Food Science and Technology, and Educational Studies.

Before the actual data collection was done, a request

**Table 2.** Mean and standard deviation for CTD constructs (n = 951).

Construct	Mean	Std. deviation
Analyticity	2.694	.911
Open mind	2.483	.891
Truth seeking	2.401	1.045
Systematicity	1.810	.850
Self-confidence	3.175	1.125
Inquisitiveness	1.772	.611
Maturity	1.743	.602
CTD	2.297	.486

**Table 3.** Mean and standard deviations for critical thinking skills (n = 951).

Construct	Mean	Std. deviation
Analysis	0.811	0.241
Evaluation	0.823	0.238
Deduction	0.772	0.208
Induction	0.687	0.318
CTS	3.437	0.736

**Table 4.** Summary of the simultaneous multiple regression analysis for CTD constructs (n = 951).

Variable	B	SEB	Beta
Analyticity	.090	.032	.111**
Open mind	.019	.033	.023
Truth seeking	-.082	.030	-.116**
Systematicity	.005	.033	.006
Self-confidence	-.054	.024	-.083**
Inquisitiveness	.035	.051	.029
Maturity	-.095	.050	-.078**

Note: R<sup>2</sup> = .150, F (7. 943) = 3.811, p < 0.001 \*\*p < .01

for permission to conduct the research was sent to the dean of each faculty involved. Following approval from the deans, letters of request were also sent to individual lecturers seeking permission to distribute the instruments in their classes. The letter of request included the list of courses randomly selected for the data collection. A letter of permission from each dean was obtained in order for the researcher to conveniently approach the respective lecturers of the selected courses. When approvals were obtained from the lecturers the instruments were administered to the students in the classes. The data collection was conducted during span of two months.

**Data analysis**

Descriptive statistics is used to provide data about

background information of the participants. The descriptive statistics included mean, standard deviation, scores and percentage to summarize the data. The hypothesis was tested using multiple regressions to identify the elements that influence CTS among UPM undergraduate students.

**RESULTS**

As shown in Table 2, the CTD sub-skills levels among undergraduate students were reported at: Mean = 2.297, S.D. = 0.486. CTD consists of seven attitude constructs. The highest mean was “Self-confidence” (Mean = 3.175, S.D. = 1.125), followed by “Analyticity” (Mean = 2.694, S.D. = 0.911), “Open Mind” (Mean = 2.483, S.D. = 0.891), “Truth seeking” (Mean = 2.401, S.D. = 1.045), “Systematicity” (Mean = 1.810, S.D. = 0.850), “Inquisitiveness” (Mean = 1.772, S.D. = 0.611) and “Maturity” (Mean = 1.743, S.D. = 0.602).

The results shows that, There were four elements scored above the overall mean for CTD (M = 2.297, S.D. = 486) namely, analyticity, open minded, truth seeking and self-confidence. Therefore, the CTD among undergraduate students were reported at average level (Mean = 2.297, S.D. = .486).

As shown in Table 3, the overall CTS level among the undergraduate students was reported at (Mean = 3.437, S.D. = 0.736). The CTS consists of four constructs and the mean for the construct “Analysis” was Mean = 0.811, S.D. = 0.241, followed by “Evaluation” (Mean= 0.823, S.D. = 0.238), “Deduction” (Mean = 0.772, S.D. = 0.208) and “Induction” (Mean= 0.687, S.D. = 0.318).

Table 4 displays the result of simultaneous multiple regression to investigate the best predictors of the CTD variables to CTS among undergraduate students. In addition, the normality assumption was not violated. The prediction of the variable CTD among undergraduate students in UPM from the seven constructs, analyticity, truth seeking, self-confidence, and maturity is shown in Table 4 where F (7.943) = 3.811, p < 0.001.

Table 4 provides evidence that the analyticity, truth seeking, self-confidence, and maturity were the best predictors of the variable critical thinking skill when all the variables were included. The estimated regression coefficient respectively for truth seeking was -0.116, analyticity 0.111, self-confidence -0.083, maturity -0.78.

The result of the analysis shows four variables were the most potent predictors that significantly influence the CTS of undergraduate students namely, Analyticity, Truth seeking, Self-confidence, and Maturity, while; three other variables were not significant. Therefore, it can be concluded that the CTD influenced the CTS. Hence, the null hypothesis set for this study was rejected.

Critical Thinking Dispositions and Critical Thinking Skills inter-operated closely for the benefit of the critical thinker. For instance, the ability to think analytically and

verify information can provide analyticity, which generally involves CTS. Conversely, the ability to acquire or convey knowledge, discuss ideas, evaluate information and think critically, are CTS variables for truth seeking, which is an evaluation process. Furthermore, being able to interpret quantitative data, analyze problems and develop positions are CTS variables for systematicity, which is a deductive reasoning process. Similarly, as argued by Colucciello (1997), inductive reasoning provides CTS for self-confidence in decision-making based on scientific evidence as well as responsiveness to values and interests of individuals and society.

## DISCUSSION AND CONCLUSION

This study was to identify the elements of CTD that have influence on CTS among undergraduate students at UPM. The CTD construct elements are analyticity, open mind, truth seeking, systematicity, self-confidence, inquisitiveness and maturity. The findings of this study have identified the best predictors of CTD among undergraduate students toward CTS. Overall, the degree of CTS increased as the level of CTD increased. Again, this signifies the differences of the two focus-wise and the directional relationship between them in terms of the role they play in complementing each other.

Moreover, the result showed analyticity, truth seeking, self-confidence, and maturity were the best predictors of CTD among undergraduate students toward CTS. Could it be that analytic students are able to anticipate consequence by applying deep reasoning. At the same time open minded students look to be seeking for the truth and concerned with the authoritative right answer. As well, the students who have self confidence also appear to believe and trust their own reasoning skills rather than others' opinions. Finally, UPM undergraduate students as per the indications in the results seem to take enough time to solve a problem best on the solution available.

Several studies have found that analyticity, truth seeking, self-confidence and maturity are the most significant elements to influence CTS of students (Nickerson, 2008). This finding was recently corroborated by Colucciello (1997) and Finn (2011) who showed that the students who have high CTS tend to possess high CTD, while students who possess low CTS tend to have low CTD. Thus, in general, CTS and CTD are co-related and inseparable in people.

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