THE CRITICAL THINKING ATTITUDINAL PROFILE OF SOME MALAYSIAN SECONDARY STUDENTS: A REFLECTION OF SCIENTIFIC ATTITUDES

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Scientific attitude is manifested by certain attributes, viz the attributes of scientists. In-depth analysis of these scientific attitudes reveals its inter-relatedness with critical thinking dispositions that are crucial in learning science. It could therefore be argued that students' critical thinking dispositions are a reflection of their scientific attitudes. This study explores the critical thinking attitudinal profile of some secondary students in Malaysia. A total number of 136 Form Five students participated in this study which used the California Critical Thinking Disposition Inventory (CCTDI) as the main instrument. Descriptive and inferential statistics were used in determining whether there is a significant difference between the arts and the science stream students in terms of their critical thinking dispositions. Results of the analysis revealed that the students exhibit a strong inclination towards critical thinking in general and differences in terms of educational background are only significant in terms of their Truth-Seeking and Systematicity attitudes.

INTRODUCTION

The combination of declining test scores, the increase of information and technology and fast-paced changes in society caused by the latter have focused on an increase in attention to the need to do more than merely the transmitting of information to children. The

role of educators is shifting towards providing means by which children develop skills in thinking and therefore, in ways of using information to produce individuals who are capable of thinking new thoughts, instead of merely repeating what others have thought about. This kind of transformation is described as a shift from the *epistemology of intelligence* to the *epistemology of mind*. It is a new emphasis on the process of thinking that is being witnessed (Butler, 1993).

It is also true, in an age when information can be attained almost instantly at our fingertips, via the Internet, that human memory need no longer be seen as the most important of intellectual skills. More appropriate is that learners learn how to utilize the data available to them and they need the ability to think intelligently about issues confronting them. It is therefore arguable that school programmes should be attending systematically to improving the thinking skills of their students. The prime reason is that adroitness in thinking does not develop on its own. Rather, it requires deliberate, continuing instruction, guidance and practice in order to develop to its fullest potential (Mayer, 1983; Swartz & Perkins, 1989), and it follows that schools must offer appropriate settings and expertise in instruction so that individuals are enabled to develop thinking proficiency.

Unlike factual skills which tend to be forgotten once the students leave the classroom, the skill of thinking will never be outdated (Quinby, 1985). On the contrary, such skills enable learners to acquire knowledge and to reason with it, regardless of the time or place or the kind of knowledge to which it is applied. Thus, thinking skills are often perceived as a survival skill for society as a whole as well as for individuals (Newmann, 1990; Michael, 1991). The contribution made by such learning to the well being of society will help a country to keep abreast of global technological advancement.

With respect to science education, many educators have indicated that teaching students to apply scientific knowledge so that thinking and problem solving skills can be nurtured and cultivated should be a significant goal of science instruction (Chiappetta & Russell, 1982; Ziedler, Lederman & Taylor, 1992; Zohar & Tamir, 1993). In fact, the development of thinking and problem solving skills has been regarded since ancient times as one of the major aims of science education (Resnick, 1987). Thus, science educators must continually strive to create a conducive learning environment that enhances critical thinking and problem solving skills. Such environment will depend upon more than the physical conditions of the classroom (Newmann, 1990). Science teachers must value thinking, provide time for it, support it and evaluate its growth for teachers to create the environment that will encourage active student participation; so that students will be *part* of the science environment, not *apart* from it.

Review of related literature on thinking as well as the evolution of thinking (Osman, 1999) unveils three main thinking enterprises that become the major thrust of thinking activities, namely, as skills, knowledge, and dispositions. It is therefore conceivable that adroitness in executing cognitive as well as metacognitive skills *per se* is not adequate. Besides possessing a repertoire of knowledge, someone has to instill a positive attitude towards thinking (or thinking dispositions) who will act as a motivator to inspire students to continuously think effectively and creatively. In the following segment, the inter-relatedness between the critical thinking dispositions and scientific attitudes will be discussed.

ATTITUDE TOWARDS SCIENCE, SCIENTIFIC ATTITUDE AND CRITICAL THINKING DISPOSITIONS

In the field of attitude research, there is a significant debate between two schools of thoughts regarding the meaning of attitude itself. Attitude, as conceptualised by Krech, Crutchfield and Ballackey (1962) embrace three distinct components: the *affective*, the *behavioural (conative),* and the *cognitive*. More recently, another school of thought, represented by Fishbein and Ajzen (1975) contend that attitude measurement should be concerned solely with *affective* domain, and that the *behavioural* (*conative*) and *cognitive* components should be assessed separately. Nevertheless, as pointed by Koballa (1989), regardless whether it is the age-old trilogy or monology of attitude one has accepted, what is important is that attitudes are learned either actively or vicariously, and therefore, can be taught.

Essentially, attitudes towards science involve feelings, opinions, beliefs, and appreciation which individuals have formed as a result of interacting directly or indirectly with the various aspects of the scientific enterprise (Hasan & Bileh, 1975, Munby, 1983). It also covers emotional reactions that someone exhibits towards science (Gardner, 1975).

The term "scientific attitudes" on the other hand is perceived as desirable attributes of scientists in professional works and could be categorized as interests, adjustments, appreciation as well as values. These attributes include open-mindedness, critical mindedness, suspended judgment, curiosity, intellectual honesty, skepticism, rationality, objectivity and questioning attitudes (Kozlow & Nay, 1974; Krynoiwsky, 1985). In a similar vein, Aiken and Aiken (1969) perceive the term as "an adherence to knowledge of the scientific method" and Munby (1983) operationalised scientific attitudes as habits of mind and mental processes of a scientist at work. Gauld (1982) refers to scientific attitude as the execution of that particular

approach to solving problems, assessing ideas and information and making decisions.

A different insight to these definitions of scientific attitudes appears to be that the term scientific attitudes refers to attributes needed in executing higher order thinking, especially solving problems, judging ideas and making decisions. It could therefore be argued that having such attributes could ensure someone not merely being able to interpret the scientific knowledge and method as well as other things concerning their daily lives experiences.

CRITICAL THINKING DISPOSITIONS THAT ARE PARTICULARLY HELPFUL IN SCIENCE

Mildenhall (1998) in his literature analysis of several problem solving studies in science discovered that beside domain specific knowledge, other affective dimensions such as interest, motivation, confidence, perseverance and willingness to take risks have been considered in problem solving research. To reiterate, critical thinking theorists also argue that thinking requires something more fundamental than knowledge or skills, namely a set of dispositions (Beyer, 1987, 1988; Costa & Lowery, 1989; Ennis, 1985; Norris & Ennis, 1989). These dispositions are classified by Beyer (1987, 1988) as those that relate to thinking in general and as those that relate to specific cognitive operations. General critical thinking dispositions are suspended judgment and reflectivity. On the other hand, attitudes that relate to specific cognitive operations are willingness to consider from another point of view rather than one's own, a desire to secure as much information as possible before making a judgment, and a willingness to identify additional alternatives after an apparently acceptable alternative has been produced. Facione and Facione (1992) propose that critical thinking dispositions can be classified into seven major dispositions: Truth-Seeking, Open-Mindedness, Analyticity, Systematicity, Self Confidence,

Inquisitiveness and Maturity. These critical thinking dispositions are discipline neutral and encompass a generalisable description of the ideal critical thinker across multiple contexts and situations.

In her analysis of what habits of mind are important to mathematics and science students, Grotzer (2000) concurs with Perkins, Jay, and Tishman (1992) and contends that openness and appreciation for new ideas, skepticism and appreciation for evidence, consideration of alternatives, creative use of imagination are important dispositions for effective and meaningful scientific activity. Besides, in guaranteeing successful operation of scientific activities, additional elements such as curiosity, integrity, diligence and fairness will also be required. Table 1 summarises Jay's, Perkin's and Tishman's (1992) list of thinking dispositions according to seven factors that dispose a person employing critical thinking operations.

Studies conducted by Gogolin and Swartz (1992) found that the students' educational background (science and social science) has an impact in shaping someone's attitude towards science. Consequently, in this study, the main objective was to profile the secondary students' critical thinking dispositions. The profile will reveal not only their critical thinking dispositions that are particularly helpful in learning science but also their scientific attitudes. Besides, it also seeks to find out whether there are discernible critical thinking dispositions between the science and social science students.

Table 1
Critical Thinking Dispositions that are Particularly Helpful in Science

Factor	Definition[a]	Description[b]
T	The disposition of being eager to seek the truth, courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one's interests or one's preconceived opinions.	The disposition towards sustained intellectual curiosity includes tendency to wonder, probe, find problems, and the ability to formulate questions.
O	The dispositions of being open-minded and tolerant of divergent views with sensitivity to the possibility of one's own bias.	The disposition to be broad and adventurous involves open-mindedness, exploring alternative views, and generating multiple options.
A	The disposition of being alert to potentially problematic situations, anticipating possible results or consequences, and pricing the application of reason and the use of evidence even if the problem at hand turn out to be challenging or difficult.	The disposition to be 'planful' and strategic includes the drive, ability and alertness to the need to set goals, to make and execute plans, and envision outcome.
S	The dispositions towards organized, orderly, focused and diligent inquiry.	The disposition to be intellectually careful presents the urge, ability and sensitivity to the need for precision, organization and thoroughness.

C	The level of trust one place in one's own reasoning processes.	The disposition to seek and evaluate reasons includes the tendency and ability to as well as alertness for the need to question the given, demand justification, weigh and assess reasons.
I	Values of being well informed, wants to know how things work, and values learning even when the immediate payoff is not directly evident.	The disposition toward sustained intellectual curiosity includes the tendency to wonder, probe, find problems, and the ability to formulate questions.
M	Target how disposed a person is to make reflective judgment.	The disposition to be metacognitive includes awareness of and ability to monitor flow of one's thinking.

Note. T: Truthseeking C: Self-Confidence O: Open-mindedness
I: Inquisitiveness A: Analyticity M: Maturity
S: Systematicity
a Definition based upon the definition given in the CCTDI
b The description of critical thinking dispositions based upon Perkins, Jay and Tishman (1992) list of thinking dispositions

METHOD

The Respondents

The respondents involved in this study comprise 200 Form Four students from several secondary schools. The sampling technique used is stratified sampling (Neuman, 1999). By employing a stratified sampling approach, the researcher first divides the population into strata (science and art). The second step involved is systematically draw sample from each strata. By employing this type of probability sampling, the relative size of each strata can be controlled and monitored by the researcher.

The Instrument

The main data-gathering instrument used in this study is the California Critical Thinking Disposition Inventory (CCTDI) (Facione & Facione, 1992). The CCTDI comprises of 75 items and generates eight scores: a score on each of the seven scales (Truth-seeking, Open-mindedness, Analyticity, Systematicity, Self-Confidence, Inquisitiveness and Maturity) and the overall score on the critical thinking disposition (derived from the mathematically equal contribution from each sub-scale). Every sub-scale is composed of nine to twelve items, and is interspersed throughout the instrument in order to decrease the likelihood of giving socially desirable responses. Detail definitions of each sub-scale are as follows:

1. Truth-seeking

   Manifested by the disposition of being eager to seek the truth, courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one's self interests or one's preconceived opinions

2. Open-mindedness

   Targets the disposition of being tolerant of divergent views and sensitive to the possibility of one's own bias

3. Analyticity

   Measures prizing the application of reasoning and the use of evidence to resolve problems, anticipating potential conceptual or practical difficulties, and consistently being alert to the need to intervene

4. Systematicity

   Measures being organized, orderly, focused and diligent inquiry

5. Self Confidence

   Assesses the trust one places in one's own reasoning processes. Possession of these characteristics will allow one to trust the soundness of one's own reasoned judgments and to lead others in the rational resolution of problems

6. Inquisitiveness

   Measures one's intellectual curiosity and one's desire for learning even when the application of knowledge is not readily apparent.

7. Maturity

   Targets the disposition of being judicious in decision making. The critical thinking mature person is someone who is to determine and to approach problems, make inquiry, and decisions with a sense that some problems are necessarily ill structured. Some situations admit more than one plausible option, and many times judgments may be made based on standards, contexts and evidences that preclude certainty.

Responses are recorded using a six-point Likert scales ranging from strongly agree (6), less strongly agree (5), agree (4), disagree (3), less strongly disagree (2), to strongly disagree (1). For each item, to agree (or disagree) is consonant with (or in opposition) to a recognized critical thinking dispositional attribute. In this context,

every student is placed in a position whereby he/she must either agree or disagree with each item, there being no middle choice. The 75 CCTDI statements prompt familiar opinions, beliefs, values, expectations and perceptions. Phrased in 'simple' English, it uses no technical vocabulary or critical thinking jargon and no educational content level is presumed.

TRANSLATION PROCEDURES

In this study, the translation from English to the Bahasa Melayu (Malay Language) is a central feature. The process of "decentered translation" (Warner & Campbell, 1970) was employed by critical thinking and language experts at the Universiti Kebangsaan Malaysia. Brislin (1970), Chapman and Carter (1979) and recently Yeh (1996) show that "decentered translation" approach maintains the loyalty of meaning between the source and target language. Not only that, revisions to improve meanings are also permitted which would ultimately produce a concise and high degree of equivalency across the two versions. In order to ensure the clarity of the translated version of the CCTDI, three main tasks in cross-cultural adaptation requirements developed by Guillemin, Bomvardier and Beaton (1993) were also employed by the experts: translation, backtranslation and review of the translation and back translation.

RELIABILITY OF THE CCTDI

Before the instrument was used for the actual study, a pilot study was conducted in order to test the reliability of the instrument. The Bahasa Melayu version of the CCTDI was tested on a group of 40 students with a similar characteristic with the sample of the present study. The reliability of the CCTDI was computed using the Cronbach alpha (a) to obtain internal consistency of the CCTDI for each sub-scale. It was found that the alpha value ranged from .40 to .81. for the sub-scales and .88 for the overall score. Nevertheless,

it should be noted that in this study, the Bahasa Melayu target language version of the CCTDI is treated like a new instrument and therefore, an alpha of .70 is considered adequate (Nunally & Bernstein, 1994). The computed alpha for the overall CCTDI score falls 25.7% beyond the predetermined value and thus signifies the internal consistency reliability. Across the subscales, only two had an internal consistency coefficient greater than .70 (Truth Seeking = .71, Self Confidence = .81).

Table 2
Coefficient Alpha for the Seven Sub-scales and the Overall Score of the Bahasa Melayu CCTDI

Sub-Scale Name	Number of Item	Alpha Reliability
Truth Seeking	12	.71
Open Mindedness	12	.42
Analyticity	11	.40
Systematicity	11	.57
Self Confidence	9	.81
Inquisitiveness	10	.52
Maturity	10	.63
CCTDI Total Score	75	.88

One reason, which account for a low internal consistency index is the homogeneity of the sample and test size (Anastasi, 1982; Youngman, 1979). The Truth Seeking sub-scale, where alpha value exceeds the predetermined point of .70, was calculated on the basis of the same number of items as the Open Mindedness score (a = .42). In fact the highest alpha value is shown by the test with the lowest number of items (Self Confidence; a = .81). Therefore, the number of items on the sub-scales does not explain the relatively low reliability. Another factor, which triggers low internal consistency, is the low variability of the test scores. An increase in score variability (indicated by score variance) will generate increased

internal consistency reliability. From the results, the lack of variability among the scores appears in all the sub-scales. Consequently, it could be concluded that lack of score variability, resulting from the sample homogeneity, is the reason for the low internal consistency reliability.

CRITERION AND CONSTRUCT VALIDITY OF THE CCTDI

In the past few years, the CCTDI has been used extensively in the correlational studies. Mainly these studies employed a multi-group research design (contrasted group method) in which the participants were categorically grouped according to their level of educational experiences. In most cases, the dispositions towards critical thinking was measured alongside the measurement of critical thinking skills and the relationship between the two scores was probed by means of correlation analysis. Literature analyses also show that these studies quantified the effect of several other demographic variables such as gender, age and major of specialization upon the CCTDI score. As suggested by Anastasi (1982), the information gathered from these studies could be cited as evidence of the effectiveness of the CCTDI in predicting an individual's behaviour in a specified situation, viz. criterion validity.

Studies conducted by Bower (1995), Doas (1996), Lacey (1996) and Walsh (1996) serve to elicit a better understanding of the criterion validity of the CCTDI. Sternberg and Weil (1980) advocate that when an individual's performance on a particular test is connected with several basic elementary processes, not only the diagnostic use of the test is enhanced, but the test also strengthens and enriches our understanding of what the test actually measures. In other words, information derived from the field of cognitive psychology could be used as indices of construct validation. Studies conducted by Sánchez (1993) and more recently Hicks (1997) justify the construct validity of the CCTDI.

SCORING PROCEDURES

The response consonant with a strong disposition towards critical thinking will yield four or more points as opposed to responses consonant with weak disposition towards critical thinking which will yield three points or less. Since there is an unequal allocation of items for each subscale, the raw score needs to be converted into proper scale score (range from 1 to 60) by using the "CCTDI Scale Standardisation Table" (Facione & Facione, 1992) provided by the publisher. Considering the number of items for every sub-scale and points consonant with strong/weak dispositions towards critical thinking, it is recommended that the cut-off score for each sub-scale is 40 and the suggested target score is 50. Students who score below 40 on a given sub-scale are considered as weak in critical thinking attitudinal aspects and those who score above 50 on a scale are considered as strong in that particular attitude. Just as a score of less than 40 manifests weakness, an overall CCTDI total score of less than 280 shows serious overall deficiency in the disposition towards critical thinking (7 sub-scales X 40). Correspondingly, an overall score of 350 (7 sub-scales X 50) or more is a solid indication of strength in the disposition towards critical thinking

DATA ANALYSIS

In an effort to build the attitudinal profile, the main data analysis procedure involved was the descriptive analysis, which focused on the mean value. In this case, the means and the standard deviations were computed for each of the seven sub-scale and the total score to provide the critical thinking disposition profile. A multivariate analysis of variance (MANOVA) on the seven sub-scales was also done to determine whether the students' educational background impacted their critical thinking dispositions.

THE RESULTS

Means, standard deviations, and ranges of scores for each of the seven sub-scales and the total score of the CCTDI are summarized in Table 3. Generally, the mean of the total score ($Mean_{science}$=304.58; $Mean_{social}$ =302.58) revealed a positive inclination towards critical thinking. An analysis of every sub-scale demonstrates a similar trend except Self Confidence and Maturity. Most of the students possess stronger Truth-Seeking, Open-Mindedness, Systematicity and Inquisitiveness, with in each case some 90% of students scoring above the cut value of 40. A summary attitudinal profile is illustrated graphically in Figure 1. The percentage of students with a score over 40 on each of the seven given disposition attributes is reported along bottom of the horizontal axis. Given the data from Table 3 and Figure 1, it can be inferred that this group of students as:

- being strongly and positively disposed towards inquisitiveness and having a strong inclination towards focus, diligence and persistence in inquiry (science: I = 97%, S = 94%; social science: I = 90%, S = 84%);
- having a strong tendency in seeking knowledge which threatens their preconceptions or interests, possessing a strong tolerance of divergent worldviews and being very sensitive to the possibilities of their own personal biases (science: T = 91%, O = 88%; social science: T = 88%, O = 94%);
- having low confidence in their own reasoning processes, although being potentially users of reasoning and fact finding strategies in approaching serious problems (science: A = 63%, C = 29%; social science: A = 34%, C = 29%), and
- not having reached the cognitive maturity level yet (science: M = 15%, social science: M = 33%)

The MANOVA analysis yielded a significant main effect for the educational background, ($F(7, 124) = 3.99$, $p<0.005$). Follow-up univariate F tests revealed that the science cohort scored higher than the social science cohort on the Truth-Seeking ($F(1,135) = 4.561$, $p<0.05$) and Systematicity ($F(1,135) = 16.730$, $p<0.05$) sub-scales.

Table 3
Mean and Standard Deviations (SD) on the CCTDI Sub-Scale

CCTDI	Science Cohort		Social Science Cohort	
Sub-scale	Mean	SD	Mean	SD
Truth-Seeking	48.32	4.94	46.40	5.57
Open-Mindedness	47.28	5.73	48.71	5.01
Analyticity	40.71	4.32	40.90	5.01
Systematicity	47.43	4.64	44.06	4.95
Self Confidence	37.29	4.23	36.06	5.25
Inquisitiveness	47.31	4.49	48.15	6.70
Maturity	36.22	3.86	37.32	4.25
Total Score	304.58	14.27	302.58	22.32

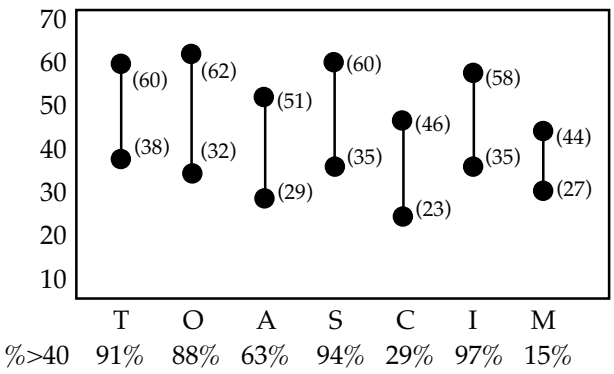
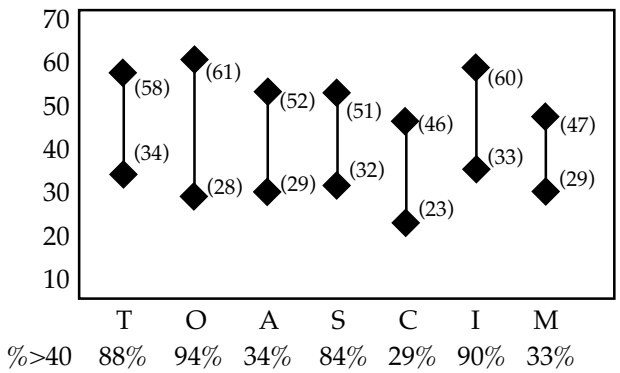


Figure 1: Critical Thinking Attitudinal



Profile of the Science Cohort

Figure 2: Critical Thinking Attitudinal Profile of the Social Science Cohort

DISCUSSION

The CCTDI used in this study was originally developed in the United States of America (1992). When a test constructed for use in one cultural setting is reapplied in another culture, the procedure involved as suggested by Eckenberger (1972) requires an "implicit" cross cultural research procedure. Thus, the Malaysians attitudinal profile obtained in this study can only be understood by taking cultural specifics into consideration. The result from this study and other studies using the same research instrument will be compared in light of the current scenario of Malaysian education and the status of science teaching in Malaysia.

Results of this study reveal that both the science and art students demonstrated an inclination towards critical thinking. The overall mean score for both groups fell above the 280 cut-off points. Further exploration on every sub-scale revealed that both groups were strong in Truth-Seeking, Open-Mindedness, Systematicity and Inquisitiveness. In most cases, higher and lower means gained in

the sub-scales were also followed by a higher and lower percentage of those who scored above the cut-off point 40.

When the attitude profile is compared to previous studies that used the same instrument, a similar trend of attitudinal profile is often found. For instance, Yeh (1996) found that on average Chinese respondents, like the Malaysians, were endowed with strong Inquisitiveness dispositions. Additionally, there also demonstrated deficiency in Maturity sub-scale. It seems this is not simply a problem attaching to Malaysian students.

It was described before that Truth-Seeking is "courageous craving for the best of knowledge, even if the knowledge fails to support one's preconceptions or beliefs" (see page 11). Thus it could be argued that strong possession of such an attitude implies strong intellectual perseverance; viz. having a consciousness of the need to use intellectual insight in spite of difficulties, and having a firm adherence to rational principles despite the irrational opposition of others, and to assimilate in oneself the need to struggle with confusion and unsettled questions over an extended period of time to achieve deeper understanding or insights (Paul, 1997). In Malaysia the shift from an exam-oriented and assessment curriculum coupled with a heavy emphasis on the higher level of Bloom's Taxonomy could be argued as the contributing factors towards the nourishment of the Truth Seeking dispositions especially among the science students. Additionally, the vast majority of the students participated in this study is the Muslim students. The main topic in the Al Quran is in fact the human mind. Thus, insofar as Malaysian Muslims are committed to the Islamic faith, their Truth-Seeking attitude will or should be cultivated.

We now turn to the Open-Mindedness, Systematicity and Inquisitiveness. Higher Open-Mindedness attribute could be connected with pluralistic and multi-cultural characteristics that paint the Malaysian society. Extensive effort by the Government to

decrease racial sentiment among the populations prevents the establishment of such attitudes from the children's affective psyche. Accordingly, students' higher score on Open-Mindedness scale is related to their attitudes towards being organized, orderly, focused, and diligent in inquiry (Systematicity). Sánchez (1992) has shown that Systematicity has the strongest correlation with ego resiliency; viz. a person's ability to alter their modal perceptual and behavioural functioning to adapt to situational constraint. To put it another way, those who possess Systematicity disposition are flexible and adaptable person.

Inquisitiveness on the other hand, measures intellectual curiosity and desire for learning even if the application of knowledge is not readily apparent. In this study, strong inclination towards Inquisitiveness, because curiosity and desire to know are among the defining characteristic of liberally educated person. The democratic political environment in Malaysia provides a supportive environment for the inculcation of this attribute.

The attribute of Self-Confidence according to Paul (1997) is cultivated when one performs a task by justifying why it is being performed; accept beliefs based on firm justification and not merely on the basis of authority or social pressure. Eleven years of formal schooling is inadequate to cultivate beliefs in the students' capacity for thinking for themselves, forming rational viewpoints, drawing reasonable conclusions and thinking coherently. For most of the Malaysian students, especially the science cohort, decision, even as a result of some persuasion, must be made essentially by reasons.

An understanding of the Maturity scale reasonable resides in Piaget's theory of cognitive development. However, as shown by Shayer and Adey (1981), most secondary students entering schools are still at concrete operational level, and the majority remains so even at 16+. Thus, it can be argued that these cohorts of students are not yet fully developed their formal reasoning abilities.

In summary, this study may be the first attempt to explore the critical thinking attitudinal profile of the Malaysian secondary students. Generally, the students exhibit a strong inclination towards critical thinking and their formal educational experiences seem to shape their attitudes towards critical thinking especially in the Truth-Seeking and Systematicity attributes. The inter-relationship between critical thinking dispositions and scientific attitudes explain why the science cohorts demonstrate higher critical thinking dispositions as measured by the CCTDI as compared to their art counterparts.

REFERENCES

Aiken, L. F & Aiken, D. A. (1969). Recent research in attitudes concerning Science, *Science Education, 53*, 295 - 305.

Anastasi, A. (1982). *Psychological testing: Fifth edition*. New York: Collier Mac Millan Publishing Co.

Beyer, B. K. (1987). *Practical strategies for the teaching of thinking*. Boston: Allyn and Bacon.

Beyer, B. K. (1988). *Developing a thinking skills programme*. Boston: Allyn and Bacon Inc.

Bower, M. M. (1995). A measurement of critical thinking dispositions and skills of baccalaureate nursing students, *Dissertation Abstract International 56*, 2981.

Brislin, R. W. (1970). Back-translation for cross-cultural research, *Journal of Cross-Cultural Psychology*, *3*,185 –216.

Butler, J. (1993). Thinking skills in human development: At school and at work. *Paper Presented at the International Convention on Excellence in Thinking*, Universiti Kebangsaan Malaysia, Malaysia.

Chapman, D. W. & Carter, J. F. (1979). Translation procedures for the cross-cultural use of measurement instruments, *Education Evaluation and Policy Analysis*, *3*, 71-76.

Chiappetta, E. L., & Russell, J. M. (1982). The relationship among logical thinking, problem solving instruction, and knowledge and application of earth science subject matter. *Science Education, 66*(1), 85-93.

Costa, A. L. & Lowery, L. F. (1989). *Techniques for teaching thinking.* California: Midwest Publication.

Doas, M. D. (1996). The relationship between critical thinking skills and dispositions of generic nursing students and registered nurses enrolled in a Bachelor of Science in nursing programme, *Dissertation Abstract International, 57,* pp.4295.

Eckenberger, L. H. (1972). *The necessity of a theory for applied cross-cultural research*. Hague: Marion Publisher.

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership*, 44-48.

Facione, P. & Facione, N. (1992). *The California Critical Thinking Dispositions Inventory (CCTDI) and the CCTDI Test Manual.* Milbrae CA: California Academic Press.

Fishbein, M. & Azjen, I. (1975). *Belief, attitude, intention and behaviour: An introduction to theory and research*. Washington. DC: Reading, Addison and Wesley Pub.

Gardner, P. L. (1975). Attitudes to science: A review. *Studies in Science Education, 2*, 1-41.

Gauld, C. F. (1982). The scientific attitude and science education: a critical appraisal. *Science Education, 66*, 109-121.

Gogolin, L. & Swartz, F. (1992). A quantitative and qualitative inquiry into the attitudes towards science and non science college students. *Journal of Research in Science Teaching, 29,* 487-504.

Grotzer, T. A. (2000). Learning the habits of mind that enable mathematical and scientific behaviour. *Research Booklet on Research in Math and Science Learning, 2*,1-8.

Guillemin, F., Bomvardier, C. & Beaton, D. (1993). Cross-cultural adaptation of helath related quality of life measures: Literature review and proposed guideline. *Journal of Clinical Epidemology, 46,* 1417-1431.

Hasan, O. E., & Bileh, V. Y. (1975). Relationship between teacher's change in attitudes towards science and some professional variables. *Journal of Research in Science Teaching, 12,* 255-261.

Hicks, F. D. (1997). Critical thinking abilities and clinical decision making consistency among critical care nurses. *Dissertation Abstract International, 58*, pp. 1801

Koballa, T. R. (1989). Changing and measuring attitudes in the science classroom, *Research Matters to the Science Teacher*, No 8901. National Association for Research in Science Teaching.

Kozlow, M. J. & Nay, M.A. (1974). An approach to measuring scientific attitudes. *Science Education, 60*, 147-172.

Krech, D., Crutchfield, R. S., & Ballackey. E. L. (1962). *Individual in Society*. New York: McGraw Hill.

Krynoiwsky, B. A. (1985). *The development of the attitude toward the subject science scale*, Report No 85:7, Educational Research Institute of British Colombia

Lacey, M. D. (1996). An examination of the dispositions towards critical thinking and critical thinking ability of the associate degree and baccalaureate nursing students and nursing faculty. *Unpublished Doctoral Dissertation*, Temple University.

Mayer, R. E. (1983). *Thinking, problem solving and cognition*. San Francisco: W. H. Freeman and Co.

Mcbride, R. E., Ping Xiang, & Wittenburg, D. (2002). Disposition towards critical thinking: The pre-service teacher perspective. *Teachers and Teaching; Theory and Practice, 8,* 29-40.

Michael, M. M. (1991*). Level of classroom thoughtfulness in Fifth Grade social studies lesson: An examination of teacher practice*. Unpublished Doctoral Dissertation. The University of San Francisco.

Mildenhall, P. T. (1998). Mental models of forces and motion in 11 to 18 year olds. *Unpublished PhD thesis*, UK: The University of Manchester.

Munby, H. (1983). Thirty studies involving the scientific attitude inventory: What confidence can we have in this instrument? *Journal of Research in Science Teaching, 20,* 141-162.

Neuman, W. L. (1999). *Social research methods: Quantitative and qualitative research approaches*. Boston: Allyn and Bacon

Newmann, F. M. (1990). Higher order thinking in teaching social studies: A rationale for the assessment of classroom thoughtfulness. *Journal of Curriculum Studies*, *22*(1), 41-56.

Norris, S. & Ennis, R. H. (1989). *Evaluating critical thinking: The practitioners' guide to teaching thinking*. California: Widwest Pub.

Nunally, J. C. & Bernstein, I. H. (1994). *Psychometric theory: Third edition*. New York: McGraw Hill.

Osman, K. (1999). Inculcating and encouraging the use of critical thinking skills in science student teachers in Malaysia. *Unpublished PhD thesis*, UK: The University of Manchester

Paul, R. (1997). *Fundamental of critical thinking*. California: Center for Critical Thinking.

Perkins, D. N., Jay, E. & Tishman, S. (1992). Beyond abilities: A dispositional theory of thinking. *Merrill-Palmer Quarterly, 39*,1-21.

Quinby, N. (1985). On testing and teaching intelligence: A conversation with Robert Sternberg. *Educational Leadership, 43*(2), 50-53.

Resnick, L. B. (1987). *Education and learning to think*. Washington: National Academy Press.

Sánchez, C. A. (1993). An explanation of cognitive strategies and dispositions in relation to ego resiliency. *Unpublished Manuscript*, University of California.

Shayer, M. & Adey, P. (1981). *Towards a Science and Science Teaching.* London: Heinemann.

Sternberg, R. J. & Weil, E. M. (1980). An aptitude X strategy interaction in linear syllogistic reasoning. *Journal of Educational Psychology*, *72*, 226-239

Swartz, R. J., & Perkins, D. N. (1989). *Teaching thinking: issues and approaches.* California: Critical Thinking Press and Software.

Walsh, C. M. (1996). Critical thinking dispositions of university students in practice discipline: An exploratory study. *Unpublished Doctoral Dissertation*, University of Maryland College Park.

Warner, O. & Campbell, D. T. (1970). Translating, working through interpreters, and the problem of decentering. In R. Narroll, E. Cohen (Eds.) *A Handbook of Method in Cultural Anthropology*. New York: American Museum of Natural History Press.

Yeh, M. L. (1996). Translation and validation of the California Critical Thinking Dispositions Inventory (Chinese). *Unpublished Doctoral Dissertation*, University of Maryland Baltimore.

Youngman, M. B. (1979). *Analysing Social and educational research data*. London: McGraw-Hill Book Company (UK) Limited.

Ziedler, D. L., Lederman, N. G. & Taylor, S. C. (1992). Fallacies and student discourse: Conceptualising the role of critical thinking in science education. *Science Education*, *76*(4), 437-450.

Zohar, A. & Tamir, P. (1993). Incorporating critical thinking into a regular high school biology curriculum. *School Science and Mathematics*, *93*(3), 136-140.