

# **Informal Reasoning Fallacy and Critical Thinking Dispositions: A Univariate Study of Demographic Characteristics among Malaysian Undergraduates**

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## **Abstract**

*A component in the study of critical thinking which needs to be addressed is informal reasoning fallacy. It is a type of mental trickery which is able to self-deceive undergraduates and public at large. In order to practice good critical thinking, one has to detect and get rid of these fallacies. However, students have to be disposed in detecting these fallacies prior to having high critical thinking ability. The objective of this paper is to examine the influences of Malaysian undergraduates' background characteristics on informal reasoning fallacies and critical thinking dispositions. A cross sectional survey was conducted on 189 samples of undergraduates from three different disciplines, testing them on newly developed Informal Fallacy Reasoning Test (IFRI) and California Critical Thinking Dispositions (CCTDI). A high reliability was achieved from both tests, with Cronbach alpha .802 for IFRI and .843 for CCTDI. Finding shows that there were significant differences in disciplines on the IRFI scale, whereby respondents from Humanities background performed better than the others. Age and IRFI scores had a significant correlation. However, there was no significant difference between gender, programmes, GPA and reading hours. CCTDI differed significantly on disciplines with Humanities scoring the highest compared to Technical and Science. The total score of CCTDI differed significantly with GPA. However, age, gender, programme and reading hours did not contribute to a significant difference.*

## **Keywords**

Critical thinking disposition, informal logic, fallacy

## *Introduction*

Critical thinking disposition and informal reasoning fallacies are two essential components of critical thinking. The objective of this paper is to examine the influence of demographic variables on both of these components separately by utilizing univariate statistical method.

## *Theories of Critical Thinking*

The importance of critical thinking emerged in the modern era through a few theoreticians. Although there are various school of thoughts on critical thinking, similar underlying principles have been tackled.

In the context of understanding critical thinking, the father of modern critical thinking tradition, John Dewey claims that learners are aware of and control their learning by actively

participating in reflective thinking – assessing what they know, what they need to know, and how they bridge that gap – during learning. Robert Ennis also agrees with Dewey that critical thinking is reasonable and reflective thinking focused on deciding what to believe or do (Ennis, 1985).

Glaser asserts that critical thinking is the "attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experiences; knowledge of the methods of logical inquiry and reasoning; and some skills in applying those methods" (p. 5-6, Glaser, 1941).

Halpern devised her own taxonomy of critical thinking which incorporates verbal reasoning skills, argument analysis skills, skills in thinking as hypothesis testing, likelihood and uncertainty, decision-making and problem solving skills (Halpern, 1998). Whereas, Richard Paul (1995) described critical thinking as a unique and purposeful thinking which is systematic and habitual.

The most recent theory on critical thinking is formulated by Peter Facione (1990) who considers critical thinking to be purposeful, self-regulatory judgment, which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.

### *The Disposition Toward Critical Thinking*

It is noted that critical thinking skills do not stand alone in order for one to become a good critical thinker. It needs to be accompanied by good habits of thinking which is termed as "*critical thinking disposition*".

Critical thinking disposition can be traced back to education philosopher, Robert Ennis, (Ennis, 1987) who defines it as a tendency to do something given certain conditions. In order to qualify as a thinking disposition, the disposition must be exercised reflectively.

Another education philosopher, Stephen Norris agrees that individuals must either have formed habits to use certain abilities, or overtly think and chose to use the abilities they possess. A person with an ability to think critically under certain conditions will do it, only if so disposed (Norris & Ennis, 1989).

According to Facione, Facione and Giancarlo (2000), the dimension of critical thinking disposition has seven conceptually non-discrete constructs which emphasizes on developing the habitual intention to be truth-seeking, open-minded, systematic, analytical, inquisitive, confident in reasoning, and maturity in making judgments. Dispositions are thought to be critical spirit, a probing inquisitiveness, and a keenness of mind that weak critical thinkers generally lack. A person can be positively or negatively disposed toward certain thinking skills but not toward all dispositions equally. (Facione, et al., 2001).

Truth-seeking involves intellectual integrity and a courageous desire to strive for best possible knowledge, asks probing questions, accepts reasons and evidences although they are against the persons' beliefs. Open-minded refers to a person who has tolerant divergent views and sensitive to biases, a person who respects others' opinions. An analytical person is habitually alert to potential problems and alert in predicting consequences. A systematic person is always orderly, focused, persistent and diligent in problem solving. They are confident in reasoning skills which produces good judgments. A person who yearns to be well-informed and wants to know how things work are termed as inquisitive. A judicious person has cognitive maturity to

distinguish between black and white as well as able to make judgments in an uncertainty context (Facione,2011).

### *Theories of Informal Reasoning Fallacies*

The term fallacy originated from a Latin word, *fallacia*, from *fallac-*, *fallax* which means deceitful, or *fallere* to deceive (Webster Dictionary). Fallacies are sophisms or errors in reasoning which is connected with inferences as these errors sounds reasonable and valid, however their unreliability is vague. Informal fallacies are fallacies which are expressed in ordinary language and are common in everyday affairs which may be psychologically persuasive but logically flawed (Grcic, 2008). It is an important concept among students as well as public at large, because much of human thinking deceives itself while deceiving others (Paul, 2006).

Walton closely connects the term fallacies and heuristics, which means short cut in thinking. Fallacies are highly persuasive, hence the widespread use in everyday dialogues. Informal fallacies act as tools for critical thinking (Walton, 2010; Rudinow & Barry, 2008).

Fallacies are known to have a psychological dimension in the pattern of illusions and deceptions. Fallacies violate argument rules used in rational thinking or argumentation (Walton, 2010). Besides Walton, van Eemeren and Grootendorst too claim that informal fallacies are elucidated for violations of the rules for dispute resolution through rational discussion (van Eemeren & Grootendorst, 1987). The term “*informal reasoning fallacy*” is used for arguments that are psychologically persuasive but logically incorrect. It persuades humans when it is not suppose to (Copy & Burgess-Jackson, 1996, p. 97).

Five popular fallacies were selected in order to gauge undergraduates’ identification ability of informal reasoning fallacy.

### *Ad Hominem Fallacy*

Locke identified ad hominem through Aristotle’s *On Sophistical Refutations* as a strategy to downgrade someone with consequences resulting from his own principles and concessions.. Aristotle claims that rather than attacking the genuine error in the argument, it is answered in a twisted or inappropriate manner. Inappropriateness here refers to failure to relate to the context of the argument. Copi (1986) also contributed to irrelevancy by asserting that the character of a person is logically not relevant to the truth or falsehood of what he says or the correctness or incorrectness of his argument.

Ad hominem attack against a man is used to persuade others or to silence their opposition. However, Locke does not explicitly identify it as a fallacy, yet it may have fallacious occurrences depending on the appropriateness of the charge.

Other theoreticians believe that ad hominem fallacy is used as a sophistical tactic which concludes that a statement is false and backs it up with claims to attack. Nevertheless, the attacks are not addressing the worth of the statement which occurred in the argument but by discrediting a person’s character or credibility (Lee, 2002; Duplass & Zeidler, 2000; Walton, 1998).

Circumstantial ad hominem is one of the ad hominem branches which accuses the victim as being bias, by using irrelevant personal circumstance about the person as evidence against the person’s position. The arguer gains from the argument due to the victim’s circumstances. It diverts people’s attention from the argument to the person being attacked in the position (Rudinow & Barry, 2008). The following is the structure of circumstantial ad hominem:

1. A claims X.

2. B argues that A's claim is due to A's interest in the claim.
3. B makes an attack on A's circumstances.
4. According to B, X is false, which in fact is true.

Walton (1987) describes circumstantial ad hominem as the arguer who does not practice what he preaches, whereby the circumstance is inconsistent with the arguer's statements. In another tone, Walton claims that this type of argument is reasonable because inconsistency of an arguer's position should be open to criticism by questioning on the integrity of the arguer. However, it can be fallacious if the argument is rejected harshly or if the issue is evaded.

Other theoreticians challenge the traditional views that ad hominem are always fallacious. (Tindale, 2007; Mizrahi, 2010; Johnson, 2009; Woods, 2010). Tindale infers that the argument seems appropriate to focus into the person's character or circumstances when it has a direct support on the statement mentioned. Therefore, Tindale suggests to place the strategy for attacking an opponent under ethotic arguments. Ethotic arguments revolve around the speaker's character which has a link to Aristotle in his Rhetoric, where he observes that the character of the person is the mode of accepting an argument (Tindale, 2007). Which of the two views applies depends on the context in which the ad hominem argument is made (Michael, 2009). In order to be critical, one has to avoid attacking the person and focus on the falsehood of the argument instead.

### *Slippery Slope Fallacy*

In informal logic studies, slippery slope is a specific causal fallacy which includes objection arising from unwarranted assumption which will lead to some negative consequences, eventually to even more negative consequences down the slippery slope until a disaster occurs (Rudinow & Barry, 2008; Rizzo, 2004).

Since this research focuses on informal logic, the type of slippery slope that I intend to discuss is the empirical (or psychological or causal) version. The empirical form tells us that the effect of accepting A will be that, as a result of psychological and social processes, we sooner or later will accept B (Burg, 1998).

Burg (1998) outlines it in an argument structure:

- If you take step A, due to sticky sequence of events, step B will necessarily or very likely to follow.
- B is not acceptable therefore you must not take step A.

Such arguments as the above structure are frequently regarded as mistaken, often on the grounds that they rely on speculative or insufficiently strong empirical premises (Douglas, 2010). Mc Kay professes that when predictions are made pertaining to some consequences of an action, one needs to specify the causal processes that produce those consequences. Wright (2000) claims that acknowledging the premise, taking actions or adopting policies will most probably lead to wrong or bad outcomes. "The 'slope' is 'slippery' because there are no plausible halting points between the initial commitment to a premise, action, or policy and the resultant bad outcome. The desire to avoid such projected future consequences provides adequate reasons for not taking the first step." (p.197).

Volokh (2003) makes an important point about slippery slope which can be a helpful metaphor, but it could start by enriching our vision and ends by clouding it. He suggests to go beyond the metaphor and examine specific mechanisms which cause the phenomenon that the metaphor describes—mechanisms that connect to human reasoning. He notes that there is often a risk at the first step of the slippery slope. This need causes impatience to many. It is a claim that we ought not make a sound decision today, for fear of having to draw a sound distinction tomorrow. Accepting “ideas we hate” sooner or later lead to restrictions on “ideas we cherish”. A and B may be in a continuum where B in some sense more than A, a condition in any event be hard to define precisely. The more we believe that one step now may lead to other steps later, the more we may view such situations with concern. However, not all slippery slopes will end dangerously, hence not fallacious. Volokh advises to alert the public on slippery slope risks, which may be dangerous for certain groups because it may make them seem extremist. Slippery slope may, though not always, present real risk, but often enough that we shouldn't ignore the possibility of such slippage.

Slippery slope arguments are inclined to indefinite and ill-formed argument. People can be swayed easily compared to modus ponens because it sounds suggestive in the absence of argumentative details (Lafollette, 2005).

### *Hasty Generalization*

Hasty generalization exaggerates the statistical significance of evidence taken from a similar sample (Rudinow & Barry, 2008). It fails to see the limitations or exceptions to an argument by over representing the statistical data. This fallacy is developed when a generalisation is drawn from a sample of the population, however the size of the sample is too small to support the generalization or conclusion. According to Paul, 2006, for a generalization to be called a fallacy, it needs to fulfill the criteria of either too few instances or unrepresentative (Paul, 2006).

Philosophers called this fallacy as jumping too quickly to conclusion by not adequately supported by premises. Such arguments are often based on generalizations that are stereotypes like (Walton & Gordon, 2009; Johnson & Blair, 1977). Walton and Gordon (2009) generated five errors that fit the category of jumping to a conclusion: “(1) insufficient premises as evidence to prove a conclusion (2) fallacious argument from ignorance, (3) arguing to a wrong conclusion, (4) using defeasible reasoning without being open to exceptions, and (5) overlooking/suppressing evidence” (p.1).

Hurley (2003) deals with hasty generalization as a kind of inductive fallacy. When the sample is not representative of the population, then hasty generalization fallacy is committed. Hasty generalization violates the requirements of good reasoning in sampling theory, a component of statistics.

Duplass and Zeidler (2000) alleges that students commit this fallacy whenever they make or accept a generalization on the basis of a sample that is neither sufficiently large nor representative or randomly selected. At times, overemphasizing rare events that contain a greater impact yet underestimating the occurrences of common events could happen. Unrepresentative samples result due to relying too much on heuristic or short cut approaches to obtaining support for a situation.

## *Post Hoc Ergo Propter Hoc*

In Latin, *post hoc ergo propter hoc* means “*after this, therefore because of this*” (Rudinow & Barry, 2008). *Post hoc ergo propter hoc* is also termed as “*false cause*”. Causal conclusions are based on correlations. This fallacy is committed when the arguer leaps to causal conclusion quickly, without considering other alternative evidences (Hurley, 2003, p. 135).

This fallacy is inferring that a particular event is caused by another event, because both the events happen one after another. Although it happens as such, it is insufficient to infer a causal relationship between these events. Damer, 2001 argues that a chronological relationship is only one of the indicators of a possible causal relationship. If temporal priority is the sole reason to indicate a causal relationship, then generally any event which precedes another may also have a causal relationship, which evolves many superstitious thinking. Such thinking is unable to distinguish between a coincidence and a causal relationship (Damer, 2001). Walton also agrees with Damer that it involves inference of causation from temporal succession alone (Walton, 1987, 1989).

The fallacious false cause, according to Copy and Burgess-Jackson (1996) can be schematically described as follows:

1. B occurs after A (“*post hoc*”).  
Therefore (“*ergo*”)
2. B happens because of A (“*propter hoc*”).  
So, A and B has a causal connection.

In order to evade false cause, one is required to identify or to avoid confusing necessary and sufficient causes or to distinguish causal relations from mere correlations (Carter, 2005). Therefore, one should strip the situations of their contexts and inspect the logical structure, which is embedded in the context (Jungwirth, 1992). Walton & Gordon (2009) generated three critical questions matching the argumentation scheme in order to avoid falling into the trap of false cause fallacy:

- (a) Is there a true correlation between A and B?
- (b) Are there any reasons to believe that the correlation is more than a coincidence?
- (c) Are there any alternative factors, that are causing both A and B?

One who commits the *post hoc* fallacy argues in a way that fails to comply with the conditions of a good argument. The defect is using insufficient evidence in drawing conclusion. Its adequacy is achieved only if it is supported by convincing evidences (Damer, 2001).

### *False Analogy*

An analogy is a comparison between two things or situations. Epstein defines reasoning by analogy as a comparison when it is part of an argument: we draw a conclusion on one side of the comparison, therefore, on another side we ought to conclude the same (Epstein, 2006).

Although analogies are inconclusive, they are powerful in reasoning about things that can be otherwise. The differences may seem overpowering than the similarities. However, it depends on whether there are more similarities or more differences (Corbett & Eberly, 2000).

False analogy is classified as inductive logic. Inductive arguments generate evidence for some conclusions. Since false analogy resembles inductive argument, it is sometimes called fallacy of weak induction (Carter, 2005).

An argument by analogy has the following form according to Jason (Jason, 2001).

1. A is like B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, ....
2. B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, .... all have property of P.
3. Therefore, A has P.

A is considered a subject, whereas B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, .... are analogs. P is a projected property. In order to distinguish between a strong or weak argument by analogy, certain criteria should be met. Jason also claims that assuming all are equal, the more the dissimilarities between B and A, the weaker the inference. An inductive argument can be made stronger or weaker by the addition of extra premises. It is termed as false analogy when such an argument is too weak even to be plausible. False analogy ignores significant differences between the subject and the analog(s). In false analogy, the project property is more closely connected with the differences between the subject and the analogs rather than with their similarities. In order to determine whether an analogy is false or not, one requires knowledge of the subject being discussed.

The first two premises establish an analogy between some familiar phenomena. Since, the familiar phenomena have some additional properties, the new phenomenon will also have that property. Arguments by analogy are fallacious if they are more persuasive than they should be. It is a defect if the similarities that moulds the analogy are not related to the property that is at issue in the conclusion (Carter, 2005).

Since analogies can be deceptively persuasive, they appeal to our sense of imagination (Boss, 2010). Note that not all arguments using analogies are hazardous. Boss claims that its' success depends on the type and extend of relevant similarities and dissimilarities between the issues being compared.

As Rudinow and Barry explain, the argument is based on similarities which are not relevant to conclusion. They simplified methods in detecting false analogy by introducing only two steps: a) detect the differences between items compared in the analogy; b) detect the relevance of the stipulated differences (Rudinow & Barry, 2008).

Whereas Boss generated other means for evaluating arguments based on analogies:

- (a) Identify what is being compared;
- (b) List down the similarities.
- (c) Question whether the similarities are strong enough to support the conclusion.
- (d) Upon listing down the similarities, cancel off similarities which are irrelevant.
- (e) The lesser the similarities, the weaker the analogy.
- (f) List down the dissimilarities / differences.
- (g) Question whether are they relevant in ways that affect the argument.
- (h) The more the dissimilarities, the weaker the analogy is.
- (i) Next, compare the list of similarities and differences.
- (j) Question whether the similarities strong enough to support the inference.
- (k) Are the dissimilarities relevant in important ways?
- (l) Examine possible strong counteranalogies and finally determine if the analogy supports the conclusion.

## Methodology

### *Procedure*

A cross-sectional study began with a purposive sampling technique. Undergraduates in universities or colleges functioned as a sampling unit. Undergraduates were contacted through emails obtained from respective school heads and lecturers, describing the study with attached

informed consent. A total of 259 students agreed to participate in this study by filling up two sets of tests. Undergraduates from various universities were administered with the Informal Reasoning Fallacy Instrument and the California Critical Thinking Dispositions Inventory via an online survey method using the surveymonkey.com website. There was no time limit provided as this is not a speed test. Students were allowed to make changes to their responses. Participation of all students in this study was on a strictly voluntary basis. Informed consent forms were provided to participants. Since participation is on a voluntary basis, they will be instructed to withdraw from answering the tests at any point of time during the administration. Respondents were informed that any information obtained from them or about them would be kept confidential.

Due to the missing and incomplete data from 70 students, the final sample consisted of 189 students. Demographic information was collected prior to administering the instrument. With regard to the demographic distribution of the sample, 63% (n = 119) of them were females and 37% (n = 70) were males. The respondents ranged in age from 18 to 24 years old. Majority of respondents (69%) are pursuing their Bachelor's Degree, whereas 31% of them are pursuing their Diploma. 58% of the respondents are in Humanities discipline, 25% in technical field and 17% in the science discipline.

### *Instruments*

#### *Informal Reasoning Fallacy Instrument (IRFI)*

Informal Reasoning Fallacy test is a 50-multiple choice item test. It measures whether someone exhibits strong reasoning by being non-fallacious. Though MCQ is well known for being objective in terms of providing answers, this instrument is flexible in a sense that it functions as a Likert scale. A scoring rubric was developed which was adopted from Ricco (2007), Neuman (2003), Weinstock et al (2004). A score of 0 point means falling into the trap of fallacies with poor reasoning; 1 point indicates partial score due to not falling into the fallacy trap but provides reasonable reasoning; 2 points projects full score for not being fallacious and for providing strong reasoning. A range of 0 - 100 (50 items x 2points) points were set. Scores for the five sub-scales range from 0 – 20 points. The distracters were compiled based on the most frequently generated poor reasoning made by students via open ended questions from the first phase of instrument development. Each question may take approximately 1 - 2 minutes to answer.

The use of expert validation reinforced the items further. Two experts in the field of critical thinking provided their feedback on the content of the scenarios, the response choices, the scoring rubric and the language used. The empirical validation section is the final step in instrument development study which validated the test.

Reliability represents the extent to which the indicators measure the same trait. It measures the degree whereby a group indicators of a latent construct is internally consistent on the grounds of how highly interrelated the indicators are with each other. It is inversely related to measurement error. As reliability increases, measurement error declines, thus the relationship between a construct and the indicators are greater (p. 636, Hair, et.al. 2010). Since an overall internal consistency of .802 was achieved for the overall total reliability, this indicates that the construct explains more of the variance in each item, hence the amount of error decreases. The reliability of the fallacy sub-scales were .593 for Ad Hominem Fallacy, .541 for Slippery Slope, .476 for Hasty Generalization, .582 for Pos Hoc and .306 for False Analogy.

### *California Critical Thinking Disposition Inventory (CCTDI)*

The California Critical Thinking Disposition Inventory (CCTDI) is a 75-item attitudinal measure, which is designed for use with the general adult population which includes college-aged students (Giancarlo & Facione, 2001). It uses a 6-point Likert-type response format, ranging from 1 (Strongly Agree) to 6 (Strongly Disagree).

It measures whether someone habitually exhibits the mindset of an ideal critical thinker. In other words, it assesses test takers' consistent internal motivations to engage in critical thinking skills. CCTDI is used to measure the dispositional aspects of critical thinking by obtaining the participants indication of the extent to which they agree or disagree with the statements expressing beliefs, values, attitudes and intentions that relate to reflective formation of reasoned judgments. (Insight Assessment, 2009). It doesn't presume any college level content knowledge (Facione, et.al., 2000).

CCTDI assesses one's disposition to critically think in 7 main areas, which are; Truthseeking, Open-mindedness, Analyticity, Systematicity, Critical Thinking Self-Confidence, Inquisitiveness and Maturity of Judgment (Insight Assessment, 2009).

For each of the seven scales, the participants may score a minimum of 10 points to a maximum of 60 points. The interpretive guidelines for the scores are as follows; positive inclination of the characteristic for a score of 40 points and above, ambivalence toward the characteristic for a score between 31-39 points and disinclination or opposition toward the characteristic for a score of 30 points and below (Giancarlo & Facione, 2001). Accordingly, the overall CCTDI score can be computed by summing up the seven scale scores, which would then range from a minimum of 70 points to a maximum of 420 points. The interpretative guidelines of the scores are as follows; 'positive disposition' for scores of 280 and above, 'ambivalence' for scores that range between 211 and 279 and 'negative disposition' for scores below 210 (Tiwari, et. al, 2006).

Overall Cronbach's alpha obtained was .843. Sub-scale of Truthseeking generated an internal consistency of .680, Open-mindedness was .455, Analyticity contributed to .555, Systematicity .560, Self-Confidence .681, Inquisitiveness .656 and Maturity .722. Three sub-scales produced reliability slightly below .60.

Finding by Facione et. al. (1995) demonstrated .90 reliability on Cronbach Alpha with subscales ranging from .60 to .78. Another finding coincides with Giancarlo and Facione in 2001 whereby the internal consistency reveals that the Cronbach's alpha for the seven scales of CCTDI range from .71 to .80, which is highly acceptable and shows that the items in this inventory consistently measures the same underlying construct (Giancarlo & Facione, 2001).

Emir (2009) found an overall reliability coefficient of the scale as .89 on CCTDI. The subscales Cronbach Alpha reliability ranged from .65 -.74. Whereas Rudd et. al (2000) claims that CCTDI's overall reliability (Chronbach's alpha) is .90 and subscale reliability scores from .72 - .80. Kyungrim et al (2006) obtained a Cronbach's alpha coefficient of 0.7847 on the translated version of CCTDI into Korean language.

It is noted that open-mindedness carries a reliability of .455, among the lowest. In defense to the low reliability of a sub-scale, a study conducted by Crawford (2002) among 164 baccalaureate nursing students reveals that the overall Cronbach's alpha reliability for CCTDI was .88, & subscales' reliabilities ranged from .33 to .76. Open-mindedness scored .45. Nevertheless, further reliability test will be carried out in the final collection of data with a bigger sample to determine its contribution.

## Results

In this section, findings for informal reasoning fallacy and critical thinking dispositions are separately discussed based on the objective of the study which is to examine the influence of demographic variables on informal reasoning fallacy ability and critical thinking disposition among Malaysian undergraduates.

### *IRFI Ability Based on Demographic Variables*

Neither gender was significantly different in terms of overall IRFI test as well as its sub-scales. Gender was also not a predictor for critical thinking skills test in many literatures (Ingle, 2007; Myers & Dyers, 2004; Facione, 1995; Alpay-Altug, n.d.; Subramaniam, et. al. 2009).

Respondents who are pursuing their Diploma and Bachelor's programme did not differ significantly in total score of IRFI and their sub-scales. A comparison of CCTST scores among groups revealed that the BSN students scored 13.33, RN-to-BSN 11.42, and ADN 9.87, showing a statistically significant difference ( $F = 24.205, p < 0.0001$ ) (Kyungrim, 2006).

A one-way ANOVA was conducted to test the differences among the disciplines. All sub-scales and total of IRFI showed homogeneity of variances with  $p > .05$ . A one-way ANOVA on respondents' Ad Hominem fallacy reasoning ability based on discipline of courses showed that there was a significant difference,  $F(2,186) = 3.99, p < .05$  among the three disciplines, namely Humanities, Technical and Science. Tukey's test revealed that the ability of Humanities students are greater than the other disciplines with a mean of 14.44. Hasty generalization sub-scale also produced a significant difference among the disciplines,  $F(2,186) = 4.59, p < .05$ . The total scores of IRFI test indicated a difference among disciplines as well,  $F(2,186) = 4.94, p < .01$ . Tukey pos hoc test once again revealed that respondents from Humanities background performed better than the others. Refer to Table 1 for ANOVA results. this finding supports Facione's third technical report, whereby **academic major** resulted in a **significant differences** in regards to **CCTST** on their posttest scores among college students. (Facione, 1990). There was a significant difference also among Malaysian science and arts students (Chua, 2002) Sufiah Su'ut (1996) also found that there is a difference among Form 6 science and arts students in Malaysia in terms of critical thinking skills with an effect size of 0.86 upon administering the Cornell critical thinking skills test.

IFRI scales		Sum of Squares	df	Mean Square	F	Sig.
Ad Hominem	Between Group	84.86	2	42.43	3.99	.020
	Within Group	1980.58	186	10.65		
	Total	2065.44	188			
Hasty Generalization	Between Group	64.38	2	32.19	4.59	.011
	Within Group	1305.73	186	7.02		
	Total	1370.11	188			
Total Score	Between Group	1121.91	2	560.95	4.94	.008
	Within Group	21141.85	186	113.67		
	Total	22263.76	188			

Table 1: ANOVA Results for IRFI Scales on Disciplines

Age and total score of IRFI had a significantly low correlation ( $r = .152$ )  $p < .05$ . Age and hasty generalization sub-scale had a significant correlation ( $r = .188$ )  $p < .01$ . Therefore, their null hypotheses need to be rejected. All other sub-scales did not correlate significantly with age of respondents. However, age was not a significant predictor for critical thinking skills in Ingle's study (2007). Based on the lifespan theory, college goers are typically around their late adolescence or early adulthood. It is known that as the physical body changes, emotional as well as cognitive abilities do make an impact. Hence, maturity of humans increases as we age. This concept supports Colucciello, 1997; Gross et al., 1987; Thompson & Rebesch, 1999 whereby there was an increase in critical thinking skills with progressive education as in with age. Age also has a positive coefficient with ( $p < .000$ ) critical thinking ability, tested using WGCTA, whereby critical thinking also improves with increasing age among Turkish adolescents (Alpay-Altug, n.d.).

All sub-scales and the total of IRFI were not successful in rejecting the null hypothesis for respondents' CGPA. This result can be supported through a study by Jones and Morris, 2007 whereby it was found that there was no significant relationship existed between critical thinking scores and GPA among the nursing students time of entry and time of completion of studies. Academic performance (GPA) bore no relationship with critical thinking performance among Chinese undergraduates (Ku, et. al. 2009). There was no significant difference between reading hours and total score of IRFI and its sub-scales as well.

#### *CCTDI Based on Demographic Variables*

Correlation analyses indicated no significant relationship between total score and age, sex, ethnicity. Overall CCTDI test and its sub-scales failed to detect any gender differences. Facione too did not find any gender differences on overall CCTDI scores between females and males among private university students. (Facione, et.al. 1995). Leaver-Dunn too found no significant difference between critical thinking disposition and gender among undergraduate athletic training students (Leaver-Dunn, 2002).

Respondents who are pursuing their Diploma and Bachelor's programme too did not differ significantly in total score of CCTDI. This result is in contrast to Kyungrim, 2006 whereby a comparison of CCTDI scores revealed that the BSN students scored 267.40, RN-to-BSN 261.15, and ADN 261.50, showing a statistically significant difference ( $F = 4.159$ ,  $p = 0.017$ ). The BSN students scored significantly higher on critical thinking, as noted in the CCTDI scores. However, in this research paper, among the seven sub-scales, respondents' programmes differed significantly in open-mindedness scale ( $t = -2.55$ ,  $p < .05$ ) between 59 Diploma respondents ( $M = 37.53$ ,  $SD = 4.38$ ) and 130 Degree programmes ( $M = 39.45$ ,  $SD = 5.00$ ). This result is in tandem with Kyungrim which detected significant differences in several scales, namely, truth-seeking ( $p = 0.003$ ), open-mindedness ( $p = 0.038$ ), critical thinking self-confidence ( $p = 0.016$ ), and maturity of judgment ( $p = 0.000$ ) (Kyungrim, 2006).

CCTDI scale of Open-mindedness differed significantly  $F(2,186) = 7.53$ ,  $p < .01$  against three disciplines. Maturity scale differed significantly,  $F(2,186)$ ,  $p < .05$ , revealing a mean of 36.70 for humanities discipline. Truthseeking obtained a significant difference,  $F(2,186) = 5.15$ ,  $p < .01$  and Analyticity,  $F(2,186) = 3.69$ ,  $p < .05$ . The total score for CCTDI also managed to reject its null hypothesis by detecting a significant difference on disciplines,  $F(2,186) = 6.54$ ,  $p < .05$ . Tukey pos hoc test reveals that all significant scales pointed respondents from Humanities discipline as greater achievers in CCTDI than Technical or Science fields. Refer to Table 2 for

ANOVA results. Walsh, 1999 revealed that highest scores generally were found in English, psychology, and nursing. When majors were grouped into (i.e., nursing, education, business) and nonpractice disciplines (i.e., English, history, psychology), non-practice discipline had generally higher disposition scores (Walsh et. al. 1999).

<b>CCTDI Scales</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
Open mindedness	Between Group	336.46	2	168.23	7.53	.001
	Within Group	4157.39	186	22.35		
	Total	4493.85	188			
Maturity	Between Group	492.93	2	246.47	4.56	.012
	Within Group	10054.31	186	54.06		
	Total		188			
Truthseeking	Between Group	352.60	2	176.30	5.15	.007
	Within Group	6363.73	186	34.21		
	Total	6716.33	188			
Analyticity	Between Group	179.44	2	89.72	3.69	.027
	Within Group	4521.51	186	24.31		
	Total	4700.95	188			
Total Score	Between Group	7342.60	2	3671.30	6.54	.002
	Within Group	104488.07	186	561.76		
	Total	111830.67	188			

Table 2: ANOVA Results for CCTDI Scales on Disciplines

Truthseeking scale correlated positively with respondents' age with a weak Pearson  $r = .171$ ,  $p < .05$ . All the other scales including the total scores were insignificant. Age among nursing students was uncorrelated with CCTDI based on a research by Crawford (2002). This supports Thompson and Rebesch (1999) who determined no significant correlation between age and critical thinking dispositions. Age does not appear to have a bearing on ones disposition toward critical thinking according to Rudd et. al. (2000). Chau et. al. (2001) also found no significant relationship between age and critical thinking habits.

However, the total score of CCTDI differed significantly with GPA,  $F(4,184)$ ,  $p < .05$ . This concurs with Bers et. al. (1996) who found a positive correlation between overall CCTDI and GPA.

One way ANOVA showed a significant difference in reading hours on self confidence scale of CCTDI  $F(5,182)$ ,  $p < .05$ . Respondents who read for 20-25 hours yielded the highest self-confidence upon testing by using the Tukey's pos hoc test. However, there was no significant difference between reading hours and total score of CCTDI.

## Discussion

Among the gender, age, discipline, programme, GPA and reading hours variables analysed, only discipline and age were significantly associated with informal reasoning fallacy. Age is an essential component in cultivating critical thinking. According to Facione, one of his constructs on disposition is maturity in making judgments. Glaser too claims the same whereby 'to render accurate judgment' seems to be one of the criteria for thinking critically. Both of them claim that maturity influences a person to think critically. The significant differences of informal reasoning fallacies among the disciplines are thought to be the results of the variations in subject

matter among the 3 disciplines, namely Humanities, Science and Technical. Humanities was found to score the highest, this could probably be due to the nature of the subjective subjects being taught where it promotes many in class activities with lots of reading, arguing, role playing etc. in comparison to Science and Technical fields where subject matters are quite objective and rigid.

There was no significant difference between reading hours and total score of IRFI and its sub-scales as well. This could be perhaps due to the lack of ability to read critically among students. Another possible culprit could be the vast materials that students source out from the internet which poses doubtfulness on the credibility of such materials.

Results also indicate that academic achievement has nothing to do with informal reasoning fallacy. This could be because most probably rote memorization is still being practiced in universities or perhaps lack of reading encouragement occurs except for reading up their class notes.

For critical thinking disposition, discipline, GPA and reading hours contributed to the critical thinking disposition. Again, humanities achieved the highest mean. Students are prone to be disposed in the non-rigid field of studies, due to the opportunities for discussions, arguments and the like compared to Science and technical studies background.

Academic achievement has an association with critical thinking disposition. Since critical thinking disposition is a human's trait of mind as said by Richard Paul, it motivates a person, hence becomes a habit to think critically. Students who gain high achievement in the classroom are always motivated to the same drive. Similarly, students who spend more time reading happen to be more disposed critically.

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