International Journal of Asian Social Science, 2013, 3(6):1458-1466

International Journal of Asian Social Science

journal homepage: http://www.aessweb.com/journal-detail.php?id=5007

MEASURING CRITICAL THINKING SKILLS OF UNDERGRADUATE STUDENTS IN UNIVERSITI PUTRA MALAYSIA

Ibrahim Nazem Ghadi

Faculty of Educational Studies

Kamariah Abu Bakar

Institute of Mathematical Research, Universiti Putra Malaysia, Serdang, Malaysia

Nor Hayati Alwi

Faculty of Educational Studies

Othman Talib

Faculty of Educational Studies

ABSTRACT

This paper conducted a study to measure the Critical Thinking Skills of undergraduate students at Universiti Putra Malaysia based on a pilot study involving 433 students randomly selected. The main purpose of this paper is to describe the process in determining the suitability of all the items in the CTS instrument which would be used in the actual study. Four factors of the CTS (Analysis, Evaluation, Deduction and Induction) were tested for their validity and reliability. The CTS knowledge test comprised of 22 multiple-choice questions with two alternatives. All the four factors in the instrument were adapted from (Goel et al., 1997), (Choi et al., 2007), (Stanovich and West, 1997). Results from the pilot study have shown that the items to measure CTS have good discriminating quality, validity and reliability.

Keywords: CTS, Analysis, Evaluation, Deduction, Induction, Validity, Reliability, discriminating index.

Abbreviations: (CTS) Critical Thinking Skills, (KR-20) Kuder-Richardson-20, (rpbis) Point Biserial correlation.

1. INTRODUCTION

Critical thinking involves the formation of logical inference (Cottrell, 2011). Some scholars and educators erroneously assume critical thinking to be higher order thinking (Brookhart, 2010). According to Paul and Elder (2003), critical thinking is best understood as the ability of thinkers to take charge of their own thinking based on sound criteria and standards.

Leicester (2010) refers to critical thinking as the active, purposeful, and organized effort to make sense of our world by carefully examining our thinking, and the thinking of others, in order

to clarify and improve our understanding. According to Cottrell (2011), critical thinking involves solving problems, formulating inferences, calculating likelihoods, and making decisions. It can be argued that critical thinking skill (CTS) or reasoning skill as some authors call it, is a purposeful, self-regulatory judgment which results in analysis, evaluation, deduction, induction as well as explanation of evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (APA, 1990).

Critical thinking skills can be set apart from problem solving (McWhorter, 2010) in that problem solving is a linear process of evaluation, allowing the inquirer to properly facilitate each stage of the linear problem solving process. According to Black and Parks (2006), CTS is an active, purposeful and organized effort to make sense of our world by carefully examining thinking, and the thinking of others, in order to clarify and improve our understanding. Brookhart (2010) argues that CTS is thinking that is purposeful, reasoned and goal directed. It is the kind of thinking involved in solving problems, formulating induction, calculating likelihoods, and making decisions. According to Norris and Ennis, 1989, CTS are the reasonable and reflective thinking that focused upon deciding what to believe or do.

Brookfield (2011) maintains that it is a way of reasoning that demands an adequate support for one's beliefs and a willingness to be persuaded unless support is forthcoming. David (2011) defines it as a reasonable, reflective thinking that fuses analysing arguments and generating insights into particular meanings and interrelation. On the other hand, content specialists are of the view that CTS involve analytical thinking for evaluating what we read (David, 2011).

Recently, Brookhart (2010) and Lavery *et al.* (2009) attempted to define CTS as a conscious and deliberate process, used to interpret or evaluate information or experiences with a set of reflective attitudes and abilities that guide thoughtful experiences with a set of reflective attitudes and abilities that steer thoughtful beliefs and actions.

2. CONTEXT

In the Malaysian context, a study found that after eleven years of school, students are still unable to apply critical thinking in their schools or real world situation (Rosnani and Suhailah, 2003; Konting *et al.*, 2007). Besides, the Malaysian National Higher Education Research Institute (NHEM, 2003) conducted a study of unemployment problems among graduates. The study on 561 unemployed respondents showed that the respondents generally believed that they were well qualified and met all the requirements of the regular job market; however, their applications have been turned down due to the lack of CTS.

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.

- *Analysis:* Determine significance, interpret meaning, and detect possible inferential relationships.

- *Evaluation:* Testing the efficiency and validity of a statement and the strength of argument and solutions.
- *Deduction:* Reasoning is one in which it is claimed that it is impossible for the premises to be true but the conclusion false. Thus, the conclusion follows necessarily from the premises and inferences. In this way, it is supposed to be a definitive proof of the truth of the claimed conclusion.
- *Induction:* Reasoning is one in which the premises support the conclusion in such a way that if the premises are true, it is improbable that the conclusion would be false. Thus, the conclusion follows probably from the premises and inferences.

In order to be successful in inculcating CTS, it is argued that a significant mechanism is demanded, that the public at large must acknowledge CTS as essential to the education of today's learner and dependent on the several definitions above. The researchers believe 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.

In summary, it is an established fact that in deductive reasoning, the conclusion is certain while in induction, the inference is probable. The deduction reasoning is logical while the induction statements are based more on observation. In induction, the inference may be true even if some of the evidence is false. However, in a deduction, if the evidence is false, it will lead to a false inference. The difference between deduction and induction is mostly in the way the arguments are expressed. Any induction can also be expressed deductively, and any deduction can also be expressed inductively.

3. METHODOLOGY

The main focus of the pilot study was to evaluate and eliminate items that did not fulfil the required criteria, and to determine the validity and reliability of the research instrument (Wiersma and Jurs, 2005). The CTS instrument illustrated the four stages, namely, analysis, evaluation, deduction and induction subscales, which were reported by (Goel *et al.*, 1997; Stanovich and West, 1997; Choi *et al.*, 2007). The CTS comprised 22 multiple-choice questions with two alternatives. Face and content validity for the instrument was obtained from three experts in the field of Educational studies from Universiti Putra Malaysia. The instrument was administered to 433 undergraduate students at UPM.

Following the suggestions of Chatterji (2003), Kaplan and Saccuzzo (2005) and Varma (2008), the quantitative method of items analysis was conducted on all the factors of the instrument. The aim was to evaluate and select quality items that could be used to measure CTS of the students perfectly. This process involved computation of discrimination indices (using Point Biserial), difficulty index and item reduction analyses. Discrimination index determines whether a respondent who had done well on particular items had also done well in the whole test. A good discrimination index item would be able to differentiate respondents who really knew the content from those who did not. Unclear, confusing and problematic items needed to be determined, and

later reviewed, reworded or removed from the instrument.

On the other hand, the difficulty index indicates the number of respondents who manage to get a particular item correct. The index was used to assess whether an item was too vague, unclear or complex for the majority of the respondents to identify the correct answer (Chatterji, 2003; Kaplan and Saccuzzo, 2005). Meanwhile, Kuder-Richardson 20 and Cronbach alpha coefficients were computed for measuring the internal consistency of items and instrument reliability. Different computer Statistical Packages were used to perform the calculations, such as SPSS version 20 and Microsoft Excel 2010.

4. RESULTS

The demographic findings of this pilot study using 433 respondents are as follows: 121 (28%) of respondents were male, while 312 (72%) of the samples were female. A total of 312 (72%) of them were majoring in science while 121 (28%) were studying in the arts field. The years of study of the data set were distributed, i.e. 287 (61.2%) respondents were in the first year and 168 (38.8%) of them being in the fourth year.

Discrimination Index

According to Varma (2008) if the discrimination index value is more than 0.25, it is considered good, and the value of more than 0.15 was acceptable. Table 1 showed the analysis of the discrimination index for 22 items in the CTS test which ranged from 0.11 to 0.96. On further examination, one item (Q19) had a value below 0.15, and therefore needed to be removed from the instrument.

To calculate the number of Point Biserial correlation (rpbis), Equation 1 below was used,

$$rpb = \frac{Mp - Ma}{St}\sqrt{pq} \qquad (1)$$

where,

Mp: is the mean measure of the n1 respondents answering the item correctly.

Ma: is the mean measure of the n0 respondents answering the item incorrectly

St: is the standard deviation of all respondents.

p : is the proportion of the variable code 1.

q: : is the proportion of the variable code 0.

Difficulty Index

The analysis of difficulty index for 22 items in the CTS test is shown in Table 2. The purpose of this analysis was to specify the difficulty level of every item. This index refers to the number of respondents who answered a particular item correctly. A high difficulty index indicates that the item is relatively easy (Chatterji, 2003; Kaplan and Saccuzzo, 2005). The effective difficulty index is between 0.3 and 0.9 with optimal level of 0.5 (Wong, 2002; Rosnaini, 2006; Patock, 2008).

According to Table 2, the CTS test has difficulty index values ranging from 0.57 to 0.96. Moreover, the data indicated that there were three items that were too easy, which had values more than 0.9 (Q1, Q3, Q9). These items were removed from the instrument.

To calculate number of difficulty index, Equation 2 below was used,

$$Nj = \frac{Nc}{N} \qquad (2)$$

Nc: number of correct answers to item.

N: total number of students taking the test.

Item Reduction Analysis

Based on the CTS test, item reduction analysis was done by drawing a graph. This analysis helps to find out whether item reduction is necessary, by plotting discrimination index on the x-axis and the difficulty index on the y-axis (Wong, 2002; Kaplan and Saccuzzo, 2005; Rosnaini, 2006). Every item was plotted by taking its discrimination index as x-value and the difficulty index as y-value. Moreover, two horizontal lines marking the optimum range for difficulty index of 0.30 to 0.90 and a vertical line marking the minimum acceptable discrimination index of 0.15 were drawn on the graph.

Based on Figure 1, 18 items (Q2, Q4, Q5, Q6, Q7, Q8, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q20, Q21 and Q22) fall within the minimum acceptable set limits. Those items were within the boundaries of the horizontal (0.30-0.90) and the vertical (0.15) line. Therefore, 4 items (Q1,Q3, Q9 and Q19) which were outside those boundaries, as shown on the graph, needed to be taken out, leaving the test with 18 items.

Reliability

Table 3 shows the reliability or internal consistency values of the CTS instrument. Since the data of the CTS test were dichotomous, the reliability was assessed by computing Kuder-Richardson 20 (KR-20) correlation. According to Patock (2008), Kaplan and Saccuzzo (2005) and Wong (2002), a value of 0.70 or higher can be accepted for this type of study. The KR-20 values for the CTS test were found to be higher than 0.70. The CTS test with values of 0.73 and 0.77 for first and second versions respectively, has acceptable internal consistency respectively.

Table 4 shows the final composition of the instrument for the actual research. There are two parts in the instrument. Part A is for obtaining demographic data (such as gender, academic major, academic year); Part B consists of 18 multiple-choice questions that included analysis, evaluation, deduction and induction subscales.

5. DISCUSSIONS

Items discriminant and difficulty analyses were conducted on part B of the instrument. Items in the second version of part B were improved to have reasonable levels of item difficulty and item discriminant indices. These analyses ensured that the items had acceptable levels of difficulty with high discriminant capabilities. Items in this instrument had a good spread of easy and difficult questions with p values ranging between 0.30 and 0.90 (Wong, 2002; Rosnaini, 2006; Patock, 2008).

The rpbis values greater than 0.15 indicated that the items were able to discriminate between good and poor students Varma (2008). Finally, the KR-20 values for the second version were improved to be an acceptable 0.77.

6. CONCLUSION

This paper reported a pilot study of a research to find out the validity and reliability of the instrument to measure CTS at Universiti Putra Malaysia. The result of the pilot study showed that the instrument needed to be modified to ensure that only good quality items were being included in the test. Moreover, all parts of the modified CTS instrument were found to be suitable, valid and reliable in obtaining data for the actual research.

Table-1. Item Discrimination Index for CTS Test

Item	Point Biserial correlation (rpbis)	Item	Point Biserial correlation (rpbis)
Q1	0.66	Q12	0.52
Q2	0.56	Q13	0.30
Q3	0.62	Q14	0.35
Q4	0.36	Q15	0.47
Q5	0.45	Q16	0.27
Q6	0.39	Q17	0.34
Q7	0.55	Q18	0.32
Q8	0.46	Q19	0.11
Q9	0.62	Q20	0.23
Q10	0.53	Q21	0.96
Q11	0.30	Q22	0.27

Table-2. Item Difficulty Index for CTS Test

Item	p	Item	p
Q1	0.96	Q12	0.86
Q2	0.89	Q13	0.71
Q3	0.94	Q14	0.74
Q4	0.75	Q15	0.83
Q5	0.81	Q16	0.69
Q6	0.77	Q17	0.74
Q7	0.88	Q18	0.72
Q8	0.82	Q19	0.57
Q9	0.94	Q20	0.66
Q10	0.87	Q21	0.57
Q11	0.71	Q22	0.69

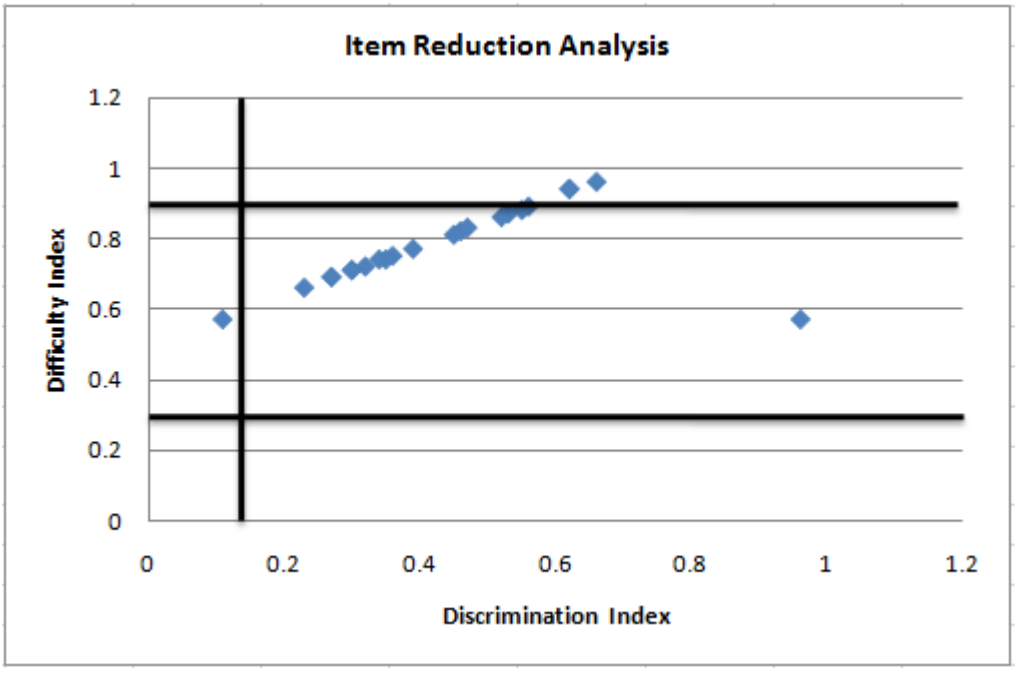
Table-3. Reliability for CTS Test

Mean	Mean	Std. Dev.	Variance	Total Items	KR-20
First vision					
	3.298	0.826	0.682	22	0.73
Second Version					
	4.109	0.969	0.940	18	0.77

Table-4. Questions of critical thinking skills subscales

Part	CTS	Questions
Part A	Gender	1
	Academic major	2
	Academic year	3
Part B	Analysis	1-3
	Evaluation	4-6
	Deduction	7-13
	Induction	14-18

Figure-1. Item Reduction Analysis CTS Test



7. ACKNOWLEDGEMENTS

I would like to profess my gratitude to Professor Dr. Kamariah Abu Bakar and Dr. Nor Hyati Alwi my supervisors, who had always been a source of guidance with their immense knowledge and experience.

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About Authors

Kamariah Abu Bakar She has dedicated about 36 years of her life pursuing Science Education as a teacher and a teacher educator. She has been actively involved in the field of IT in education. Her research interests are web-based learning and instruction as well as the use of multimedia in education. Besides teaching Information Technology in Education to undergraduate students as well as Computer Assisted Learning to postgraduate students since 1995, she also has a wide experience in student supervision, research and consultancy, and administration.

Ibrahim Ghadi *completed* his high school in 2000. He holds a Bachelor of Arts Degree in Geography from Yarmouk University-Jordan and Master of Science in Curriculum & Instruction specializing in Science Education from Muta University-Jordan. Currently, he is a PhD candidate in Curriculum and Instruction at University Putra Malaysia.

Nor Hayati Alwi holds a Bachelor of Science Degree In Biology from Indiana State University, USA and Master of Science in Curriculum & Instruction specializing in Science Education from University of Wisconsin, USA. She also holds Diploma of Education from Universiti Teknologi Malaysia and a PhD Degree in Science Education from Universiti Kebangsaan Malaysia. She was a Biology teacher for 8 years at Junior MARA Science College and the Science Matriculation Center of Universiti Kebangsaan Malaysia. She was appointed as a lecturer at Universiti Putra Malaysia in 2002. Currently, she is involved in teaching, research and consultation in the fields of Science Education, Curriculum & Instruction, and Human Development. She has produced one Science Education Theory and Model, and three Science Instructional theories and models from her PhD thesis. These theories and models are capable of becoming the basis of science curriculum development and planning with the aim to produce a good science person via the national science education system. She is well-versed in "Grounded Theory Research Method". Her interests and expertise in all those fields motivate her to be involved in community services for students, parents and local women's organizations.

Othman Talib completed his first degree in Chemistry with UKM in 1986. He was then appointed as a Chemist (temporary basis). A year later, he was appointed as a Chemistry teacher at the Matriculation Centre, Universiti Putra Malaysia (UPM). He completed his Master in Pedagogy with UPM in 1999 and then in February 2000, was appointed as a lecturer with the Faculty of Educational Studies, UPM. He pursued his study at the University of Adelaide, Australia and obtained his Doctor of Education degree in 2007.