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Building a test to assess creative and critical thinking simultaneously

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Abstract

The Malaysia Education Master Plan 2006-2010 expresses the importance of critical and creative thinking, by stating that one of its major goals in producing first class human resources in Malaysia is to arm the students with creative and critical thinking abilities. As a consequence, educational transformation has been initiated, and creative and critical thinking teaching and learning strategies have been implemented at the Malaysian schools. Therefore, it was anticipated that by the year 2010, students under the new school system will exhibit higher levels of thinking styles, especially creative and critical thinking styles. An attempt was initiated to build an instrument to collect and provide data concerning the two thinking styles of the students. The instrument Yanpiaw Creative-Critical Thinking Styles Test or YCREATIVE-CRITICALS, consists of 34 items, will be used to measure creative and critical thinking style of the students simultaneously. This article reports the building of the test and its validity and reliability construction.

Keywords: Thinking test; creative thinking; critical thinking; thinking style.

1. Introduction

Creative and critical thinking are both essential for students in all aspects of educational studies. The Malaysia Education Master Plan 2006-2010 expressed the importance of both of the thinking, by stating that one of the goals of the Education Master Plan in producing first class human resources in Malaysia is to arm students with creative and critical thinking abilities (Ministry of Education Malaysia, 2006, p53). As a consequence, creative and critical thinking teaching and learning strategies have been implemented at the Malaysian schools. School based and less exam oriented curriculum that emphasizes on all-round skills, focus on thinking skills, cognitive, psychomotor and affective development have been introduced into the schooling system (Suresh, 2009).

However, without knowing students' thinking styles, it's difficult for a teacher to provide teaching strategies and materials that best accommodate students' learning and thinking styles. Matching teaching style to learning and thinking styles will increase academic achievement and make the teaching and learning process an enjoyable experience (Kitchens, Barber & Barber, 1991). Therefore an attempt was initiated beginning 2007 to build an instrument to collect and provide data concerning the two thinking styles of the students. The instrument named

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"Yanpiaw Creative-Critical Thinking Styles Test" or YCREATIVE-CRITICALS will be used to measure the creative and critical thinking style of the students simultaneously.

2. Indicators of creative and critical thinking styles

The items of the YCREATIVE-CRITICALS instrument were developed based on creative thinking and critical thinking theories and research evidences. Creative thinking traits (which form the creative thinking style) were derived from three main perspectives: (1) creative thinking as a person (2) creative thinking as a product, and (3) creative thinking as a process, based on research evidences that have been documented by scholars (Maisel, 2007; Weisberg, 2006; Karwowski, 2006; Clapham, 2004; Simonton, 2003; Schultz, Tannenbaum & Lauterborn, 1996; Isaksen, Dorval & Treffinger, 1994; Davis, 1992; Khatena, 1992; Besemer & O'Quin, 1987; Davis & Rimm, 1980; Torrance, 1979; Plass, Michael & Michael, 1974; Schaefer, 1971; Wallas, 1926).

For examples, the traits of the creative person have been studied and conceptualized at great length by a variety of researchers (Maisel, 2007; Simonton, 2003; Davis, 1992; Khatena, 1992; David and Rimm, 1980; Schaefer, 1971). The list of creative personality attributes they have identified includes such attitudes as imaginative, curiosity, openness, objectivity, flexibility, fluency, sensitiveness to sensory stimulation, humor, intellectual playfulness, indifference towards conformity, willingness to try new ideas, synthesizing skills, and an ability to work intensively for long periods of time.

Besides that, creative product could ultimately be judged by the levels of creative thinking presented in the product (Karwowski, 2006; Simonton, 2003; Dacey, 1989; Besemer & O'Quin, 1987; Taylor, 1964; Gamble, 1959; Lehman, 1953). It includes: (1) expressive creative thinking, which is illustrated in brainstorming, (2) productive creative thinking, which is judged by the number of products, (3) inventive creative thinking, which couples efficiency and ingenuity with available materials and ideas, and (4) innovative creative thinking, which rearranges the field as cubism in visual art (for instance, the esthetical values in Pablo Picasso's cubism painting).

In addition, the creative thinking process involves the ability to produce original ideas, to perceive new and unsuspected relationships, or to establish a unique and improved order among seemingly unrelated factors. In other words, creative thinking does not involve just one kind of behavior. The traits of creative process were documented in Simonton (2003), Downing (1997), Dacey (1989), Torrance (1979), Mackinnon (1978), Osborn (1963), Guilford (1950), Dewey (1930) and Wallach (1926).

On the other hand, the traits of critical thinking have also been described in various perspectives by scholars. For instances, Beyer (1995) offered the simplest definition of critical thinking: "Critical thinking means making reasoned judgments on statements, news ideas, arguments, research, etc". Other scholars (Paul & Elder, 2005; Giancarlo, Blohm & Urdan, 2004; Silverman & Smith, 2002; Scriven & Paul, 1996; Angelo, 1995; Rudinow & Barry, 1994; Wilson, 1988; Primack, 1986; Glaser, 1985; Modjeski & Michael, 1983) viewed critical thinking as the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.

From the educational perspective, Bloom (1956) stated that the process of critical thinking involves evaluation of ideas, solutions, arguments and evidences. In Bloom's Taxonomy of Higher Thinking, the evaluation skill is the highest level of effective learning and thinking processes. Besides that, writers such as Facione (1998), Ennis (1986), Garrison (1992), Henri (1991), Missimer (1990), and Watson & Glaser (1980) have focused their attentions upon the requirements of formal logical systems of critical thinking. For examples, Watson and Glaser (1980) characterized critical thinking as a composite of attitudes, knowledge, and skills. The composites included the attitudes of inquiry that involved an ability to recognize the existing of problems and an acceptance of the general need for evidence in support of what is asserted to be true, the knowledge of the nature of valid inferences, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined, and the skills in employing and applying the above attitudes and knowledge.

Similarly, Ennis (1986) identified twelve abilities of critical thinking. According to Ennis, the twelve abilities indicate ways of avoiding making mistake in evaluating when selecting the only right answer. By using the terms "meaningful", "clear", "consistent", "logical", "precise", "following rule", "accurate", "justified", "relevant", "assumption" and "true", one can think more precisely and critically in the evaluation process of critical thinking. Besides that, Silverman & Smiths (2002) and Wade (1995) provided examples of critical thinking, involves the

abilities of asking question, defining problem, examining evidence, analyzing assumptions and biases, avoiding emotional reasoning, avoiding oversimplification, considering other interpretations, and tolerating ambiguity.

3. Creative and critical thinking traits

Based on the theories and researches evidences documented by scholars, creative and critical thinking traits were identified and referred as the conceptual framework in building the YCREATIVE-CRITICALS test.

The traits of creative thinking style included: Generate unique ideas; produce ideas that other could not think of; shift from normal perspective to take a different point of view; view things other than normal ways; imaginative; aesthetic orientation; understand the beauty of art; potential for generating further ideas and changes; able to produce an abundance of ideas in a fixed time; the tendency to view a problem instantly from a variety of perspectives; do not get stuck by assuming the rules which do not apply to a problem; likely to bend the rules; need some breathing space for incubation in the middle of creative process; able to resist the tendency to leap to conclusion prematurely; able to keep open and to make the mental leap beyond the limit freely; able to capture the essence of a given information, to produce imaginative, abstract but appropriate title; able to communicate clearly and powerfully through storytelling; like to fantasize (fantasy provides an almost inexhaustible supply of analogies that useful in stating and solving problems creatively); like daydreaming and emotional; the tendency to combine two elements into one; the tendency to present and recognize idea or objects in unusual visual (other than static, upright, straight on view, the usual and common perspective given by the majority of people); able to visualize beyond exteriors and pay extension to the internal, dynamic working of things; ability to extending and breaking the boundaries of the problem; and good sense of humor (humor is basically creative because it involves unusual and surprise).

The critical thinking traits included: Searching for meaningful, clear, consistent, logical, precise, accurate, justify, relevant and true in every things; avoid making mistake; follow some rules and criteria in the thinking process; think more precisely and critically in the process of thinking; avoid emotional reasoning; evaluate the degree of truth or false of things before making decision; like to evaluate the logic, validity, and the relevance of data; in evaluation of idea, believe that there is only one way of being right; evaluate carefully before any action taken; distinguish between observation and inference; trying to remain to the main points; respect clarity and precision; like to ask question: searching for the degree of truth; the ability of asking question, defining problem, examining evidence, analyzing assumptions and biases; always looking for the best way to solve a problem; good at reasoning; do not believe in illusion or magic; believe that things can't change overnight; argumentative and like to criticize fact; high judgment skills; like to discuss about political issues; establish clear criteria for evaluating ideas, issues, or positions.

4. Building the YCREATIVE-CRITICALS test

Concerning with developing an instrument for measuring human thinking, Treffinger (1986) pointed out that there is no single, uniformly accepted theory of thinking, and there is also no single assessment instrument that is universally accepted, while Starko (2004) stated that the use of a typical thinking instrument is depended on the need and the purpose of its developer, and varying theories and definitions of creative thinking will support differing types of assessment. According to some thinking test developers (Torrance, 1984; Watson-Glaser, 1980; Taylor & Getzels, 1975), the general criteria for selecting specific thinking test are: (1) It must have relevance to thinking theory, (2) It must have relevance to creative and critical thinking behavior in the real world, (3) it must simply a different aspect of thinking behavior, (4) it must be attractive to the respondent, (5) it must be built so that a person can respond in terms of his/her experiences whatever these may have been, (6) it must yield data that can be scored reliably for meaningful aspects of thinking, and finally, (7) the testing materials, instructions for administration, time limits, and scoring procedures must be clearly and relevantly stated.

Besides the criteria as have been mentioned above, the items of the YCREATIVE-CRITICALS test was built on the rationales that the both creative and critical thinking styles can be identified, quantified, and represented by scores (Starko, 2004), both thinking styles are opposed to one another and they are not correlated (Baker, Rudd & Pomeroy, 2001; Toren, 1993), and both thinking styles are not incompatible. Some scholars (for example: Yang & Lin, 2004; Beyer, 1987) suggested that there was an overlapping between creative thinking and critical thinking in

certain traits (for examples: discerning imagining, visualizing, predicting, anticipating, recognizing cause and effect). Hence, to increase the validity and reliability of the YCREATIVE-CRITICALS test, these overlapping traits were not included in the test. Figure 1 presents the scoring indicator of the YCREATIVE-CRITICALS test.

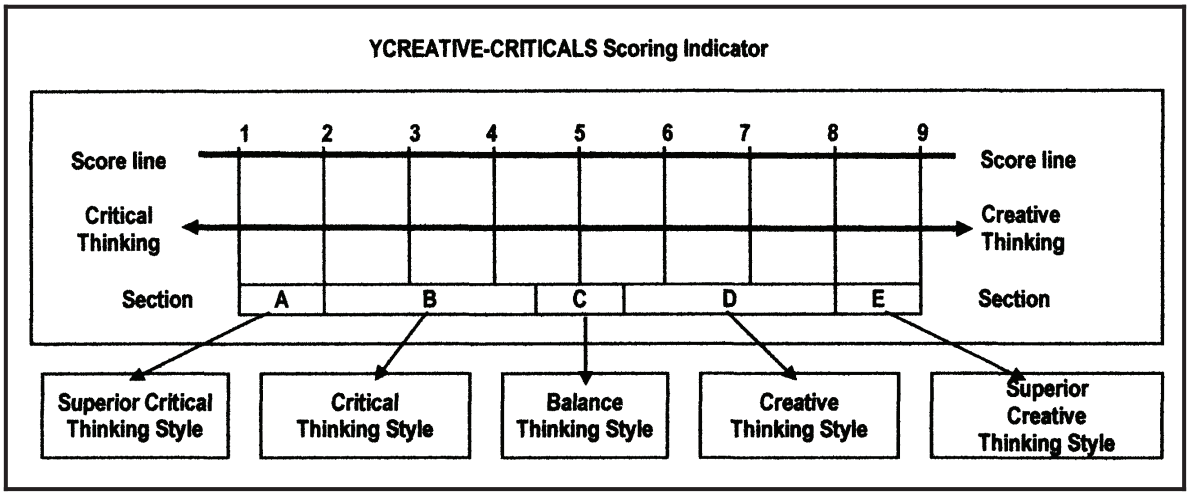

Figure 1: The scoring indicator of the YCREATIVE-CRITICALS test

5. Reliability and validity of the YCREATIVE-CRITICALS test

The items of the YCREATIVE-CRITICALS test were established on the rationale that both thinking styles can be identified, quantified, and represented by scores. In order for these assumptions to be met, the instrument used for measurement must meet the tests of validity and reliability (Starko, 2004).

5.1. Reliability

Test-retest reliability of the YCREATIVE-CRITICALS was conducted in two studies. Chua, Komari, Amirruddin and Rorlinda (2007) tested 281 students of a teacher training programme and retested the same students three months later on the YCREATIVE-CRITICALS. The product-moment reliability coefficients were .90 (total score), .81 (critical thinking style), and .85 (creative thinking style), all of them were at the level of significance $p< .01$. The second test was conducted on 23 form sixth students (18 years old) from the Seri Serdang Secondary School in a range of six months. The product-moment reliability coefficients were .91 (creative thinking style) and .87 (critical thinking style), both at the level of significance $p< .01$.

5.2. Validity

The validity of the YCREATIVE-CRITICALS test will be presented in terms of content, construct, concurrent and predictive validity.

5.2.1. Content Validity

The items of the YCREATIVE-CRITICALS test were constructed by attempting to transform the theories and research findings regarding creative thinking and critical thinking into a multiple-choice test format, with each choice representing either a critical thinking style or a creative thinking style. The original test consisted of 40 items, and six of them were deleted on the basis of item analysis data, leaving 34 items.

5.2.2. Construct Validity

Like content validity, construct validity asks whether the task on an instrument match generally accepted characteristics of the construct being measured. In determining construct validity, the test developer examines scores on instruments attempting to measure the same variable as well as scores on measures of different but related variables (Starko, 2004). The construct validity study for the YCREATIVE-CRITICALS was conducted on a group of 102 semester three students (55 males and 47 females), enrolled in a diploma in education programme at the Special Teacher Training Institute, Kuala Lumpur. The study identified correlation analyses between the YCREATIVE-CRITICALS test and two thinking skill instruments. The two instruments are:

1. The Torrance Test of Creative Thinking (TTCT, Torrance, 1982). The TTCT test is the most well known creative thinking test. It has been translated and used in more than 25 different languages (Khatena, 1992: 244). It was used to obtain data of creative thinking skills of the subjects. It consisted of 3 sub-tests: Picture Construction, Picture Completion and Lines Activity. These sub-tests were scored for five components of creative thinking based on Torrance's definition of creative thinking. The five components are (1) fluency, (2) originality, (3) elaboration, (4) abstractness of titles, and (5) resistance to premature closure.

2. The Watson-Glaser Critical Thinking Appraisal (WGCTA, Watson & Glaser, 1980). The WGCTA test is one of the most prominent critical thinking tests (Fulton, 1989). It was used to obtain data about critical thinking skills of the subjects. It consisted of 80 items. The items are scored for five components of critical thinking based on Watson and Glaser' critical thinking definition. The five components of critical thinking are (1) inference, (2) recognition of assumptions, (3) deduction, (4) interpretation, and (5) evaluation of arguments.

It was hypothesised that if the instruments reliably measure similar thinking style, one would expect positive relationships, despite the different contents and responses required. From the data in the Table 1, the results of the Pearson correlations clearly indicated certain trends, i.e. the scores of creative thinking style of the YCREATIVE-CRITICALS test was correlated positively with the TTCT index ($r = .51$, $p < .05$) and its four components, on the other hand, the scores of critical thinking style of the YCREATIVE-CRITICALS was correlated positively with the WGCTA index ($r = .53$, $p < .01$) and its four components.

Table 1.Correlations between the scores of the YCREATIVE-CRITICALS with the TTCT and the WGCTA Tests

Correlation	Yanpiaw Creative-Critical Styles (YCREATIVE-CRITICALS)	
	Creative Thinking Style	Critical Thinking Style
Torrance Test of Creative Thinking (TTCT)		
Fluency	.55*	-33
Originality	.56**	-.25
Elaboration	.63*	-.51*
Abstractness of Titles	.31	-.45*
Resistance to Premature Closure	.44*	-.06
Creative Thinking Index	.51*	-.37
Watson-Glaser Critical Thinking Appraisal (WGCTA)		
Inference	-.36	.59**
Recognition of Assumptions	.02	.26
Deduction	-.12	.70**
Interpretation	-.44*	.55*
Evaluation of Arguments	.05	.45*
Critical Thinking Index	-.29	.53**

Note: *p< .05; **p< .01

The results suggest that the YCREATIVE-CRITICALS reliably measure certain similar creative and critical thinking skills, as measured by the TTCT and WGCTA. However, the relative low correlation between the Abstractness of Titles score of the TTCT and the creative thinking style score of the YCREATIVE-CRITICALS ($r = .31$, $p > .05$) might suggests that the two tests assess different components of creative thinking via different test contents. Similarly, the relative low correlation between the Recognition of Assumptions score of the WGCTA and

the critical thinking style score of the YCREATIVE-CRITICALS (r= .26, p> .05) suggests that the two tests measure different aspects of critical thinking. Please note that the YCREATIVE-CRITICALS was used to measure thinking style, while the TTCT and the WGCTA were used to measure thinking skills of the respondents.

5.2.3. Concurrent Validity

Concurrent validity examines whether an instrument correlates with current measures. Since the theories behind the items of the YCREATIVE-CRITICALS are related to thinking and learning style, it seemed reasonable to test its validity with other learning and thinking style instruments. In this case, according to the Split Brain Theory which was derived from the split brain experiment evidences (Sperry, 1975), creative, artistic and imaginative abilities are the functions of the right brain. On the other hand, verbal, language, along with logical and critical reasoning abilities are functions of the human left brain. The instruments are:

1. The Styles of Learning and Thinking test (SOLAT, Torrance, 1988). The SOLAT test (consists of 28 items) was used to obtain data of the learning and thinking styles of the subjects. Each item of the test provides the subject with two choices – one representing a specialised function of the left cerebral hemisphere, and the other representing a parallel specialised function of the right hemisphere. The subjects are asked to indicate which of the two specific brain learning styles best describes their own typical behaviours.

2. The Yanpiaw Brain Style test (YBRAINS, Chua, 2001). The YBRAINS test was used to obtain data of the brain styles of the subjects. It consists of 40 items. Each item of the test provides the subjects with two choices – one representing a specialised function of the left brain, and the other representing a parallel function of the right brain. The subjects were asked to indicate which of the two specific brain functions best described their own typical behaviours. The responses of the subjects are categorised into three brain styles based on a 9-point index: (1) Left brain style: 1.0 – 4.4 points; (2) whole brain style: 4.5 – 5.5 points; and (3) right brain style: 5.6 – 9.0 points.

The results of the two concurrent validity studies are presented in Table 2 and Table 3. The subjects of the first study were 102 student teachers (average age = 19.23 years old) enrolled in a teacher training programme (Table 2), while the subjects of the second study were 84 form five students (17 years old) from the Petaling Jaya Catholic Secondary School and 68 from four students (16 years old) from the Klang High School. Both schools located at the Selangor State (Table 3).

As shown in Table 2, the scores of creative thinking style of the YCREATIVE-CRITICALS are positively and significantly correlated with the right style of the SOLAT (r= .61, p< .01) and the YBRAINS (r= .67, p< .01). On the other hand, the scores of critical thinking style of the YCREATIVE-CRITICALS are positively and significantly correlated with the left style of the SOLAT (r= .54, p< .05) and the YBRAINS (r= .56, p< .01).

The data in Table 3 indicated that the scores of the right brain style of the subjects were positively and significantly correlated with creative thinking style scores (Form five students: r= .56, p< .05; form four students: r= .68, p< .01), while the left brain style of the subjects were positively and significantly correlated with critical thinking style scores (Form five students: r= .65, p< .01; form four students: r= .71, p< .01).

Table 2. Correlation between the scores of the YCREATIVE-CRITICALS and the scores of the SOLAT and the YBRAINS

Correlation	Yanpiaw Creative-Critical Styles (YCREATIVE-CRITICALS)	
	Creative Thinking Style	Critical Thinking Style
	r	r
Styles of Learning and Thinking (SOLAT)		
Left Brain Style	-.36	.54*
Right Brain Style	.61**	-.32
Yanpiaw Brain Style (YBRAINS)		
Left Brain Style	-.35	. 56**
Right Brain Style	.67**	-.55*

Note: *: p< .05; **: p< .01

Table 3. Correlations between the scores of the YCREATIVE-CRITICALS and the scores of the YBRAINS

Correlation	Yanpiaw Creative-Critical Styles (YCREATIVE-CRITICALS)		
	Creative Thinking Style	Critical Thinking Style	
	r	r	r
Styles of Learning and Thinking (SOLAT)			
Form Five Students (n=84)			
Left Brain Style	-.12	.65**	
Right Brain Style	.56*	-.20	
Form Four Student (n=68)			
Left Brain Style	-.34	.71**	
Right Brain Style	.68**	-.33	

Note: *: p< .05; **: p< .01

5.2.4. Predictive Validity

Predictive validity examines whether scores on a measure predict its traits or performance at a later time. It asks not how a measure correlates with other measures today but how they may relate to activities tomorrow (Starko, 2004). It seemed reasonable to predict that arts major subjects will score higher on the creative thinking style of the YCREATIVE-CRITICALS test. On the contrary, mathematics major subjects will score higher on the critical thinking style. Table 4 depicts the results of a predictive study. The subjects of the study were 72 mathematics major and 79 fine arts undergraduate students from a local university.

The data in Table 4 indicate that the fine arts major subjects scored higher on the creative thinking style [Mean score: creative thinking style, M=18.77; critical thinking Style, M =14.77]. On the other hand, the mathematics major subjects scored higher on the critical thinking style [Mean score: critical thinking style, M=18.50; creative thinking style, M =15.11]. The results justify the ability of the scores of the YCREATIVE-CRITICALS test in predicting thinking styles of the respondents. Moreover, referring to the YCREATIVE-CRITICALS scoring indicator (Figure 1), mathematics major students possessed critical thinking style (score=5.87, i.e. in the range of 5.5 to 8.0) while on the other hand, the fine arts student demonstrated creative thinking style (score=4.21, i.e. in the range of 2.0-4.5).

Table 4. Mean and Standard Deviation Scores of the Mathematics Major and Fine Arts Major on the YCREATIVE-CRITICALS test

YCREATIVE-CRITICALS	Mathematics Major		Fine Arts Major	
	M	*SD*	*M*	*SD*
Critical Thinking Style	18.50	3.25	14.77	4.33
Creative Thinking Style	15.11	4.20	18.77	3.81
YCREATIVE-CRITICALS score	5.87	0.94	4.21	0.86

6. Conclusion

The reliability and validity studies indicated the ability of the YCREATIVE-CRITICALS scores to represent the styles of creative thinking and critical thinking of its respondent. Although the purpose of establishing this instrument was mainly for assessing the Malaysian students' thinking styles, the instrument could be used as an alternative measure to other thinking tests, in understand human behaviours from different perspectives. Since human thinking is a universal behaviour, the usage of the test may not limited only to the Malaysian secondary school students, however, reliability measures should be carried out before it could be used generally.

Since the test is limited to the age of sixteen and above, there is a need to develop two alternative forms of the YCREATIVE-CRITICALS test, for secondary lower and primary school students.

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