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Cognitive Style and Creative Quality: Influence on Academic Achievement of University Students in Indonesia

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ABSTRACT

Reasoning is a process to solve the problem. This process needs cognitive functions in thinking, learning, and making decision. Cognitive style is a term to explain human natural preferences in gathering and processing information. Humans appears to reason using two cognitive processing styles; the first system is called as intuitive thinking style that is spontaneous, effortless, and without conscious search, whereas the second system is called as reflective or analytical thinking that works in a deliberate, analytical, procedural, and controllable process. In human context, sometimes people encounter difficult problem or unknown situation that have to be coped by ideas that are both novel and adaptive to the task constraints. People who solve the problem successfully are called creative. Creativity is the base to enhance competitiveness among students that might result in good academic performance. The present study examined cognitive style and creative quality in affecting academic achievement of university students in Indonesia. The result showed that students who used analytical thinking tended to have higher academic success, especially in life science majors. Moreover, it was found that students would need to materialize their creative potential to reach greater academic achievement in demanding classes; for instance, the final year of undergraduate program.

1. Introduction

Reasoning is a process to solve the problem. This process needs cognitive functions that help us to think, learn, and make decision (Sadler-Smith and Badger 1998). It exploits what already known packed with adaptable knowledge to come to conclusion that is reliable, novel, and refutable for inconsistency (Johnson-Laird 2010). However, in yielding those kind of conclusions, human reasoning has its frailties as another premises counteracts. In performing such task, human have access to two distinct cognitive styles (Kahneman and Frederick 2001; Franco and Meadows 2007; Ahmed *et al.* 2012; Stanovich and West 2000). The first style is a system that is spontaneous, associative, emotionally charged, without conscious search, and effortless (Kahneman 2003); the second system works in a deliberate, analytical, procedural, and controllable process (Alter *et al.* 2007; Sarmanny-Schuller and Kuracka 2012). The first system is called as intuitive thinking, whereas the second system is reflective, rational, or analytical thinking styles. The first system may result in error due to aging, stressful situation, and biased premises, whereas the second system can occasionally correct the output of the first system (Alter *et al.* 2007). There is individual difference in using any of the two systems in making judgments that leads to different styles of cognitive functions in solving everyday life problem (Frederick 2005).

Cognitive style is closely related to learning activity. For instance, category learning is known as a way in assembling information to learn something. There are two kinds of category learning, that is, rule-based and information-integration tasks. Rule-based tasks have clue as indicator of the tasks; this clue then can be used to recover the rule that is easy to describe verbally. On the other hand, information-integration tasks are those in which their logical form cannot easily be extracted, so people need to integrate any knowledge they could gather to reach conclusion. Rule-based task relies on working memory, in contrast to information-integration task that relies on procedural memory (Zeithamova 2008). Zhang (2002) reported a statistically significant correlation of thinking styles in affecting grade point average of students. However, other works (Riding and Pearson 1994; Sadler-

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Smith 1997) found a low correlation between cognitive style and academic performance in terms of intelligence.

In human context, sometimes people encounter difficult problem or unknown situation that has to be coped by ideas that are both novel and adaptive to the task constraints (Goel *et al.* 2000). People who solve the problem successfully are called creative. There were many definitions of creativity varied by field. In the field of educational research, creativity refers to acquisition of knowledge and performance (Surkova 2012). Previous researches assessing the association of creativity to academic achievement (Riaz 1989) and performance in professional life (Scager *et al.* 2012) found a positive correlation between creativity scores and academic achievement, especially in the academically superior students. Moreover, creativity was the base of innovation that underlain the enhancing competitiveness among students (Chen and Chen 2012a) that might result in good academic performance.

The aim of this research is to determine cognitive style and creative quality of university students in Indonesia and examine the covariations between different cognitive styles and different creative qualities in affecting their academic achievement.

2. Materials and Methods

2.1. Time and place

The research was held on September 2013 until April 2014 in Bogor Agricultural University (IPB), Bogor and University of Indonesia (UI), Depok, West Java, Indonesia. Data were analyzed in Division of Animal Biosystematics and Ecology, Department of Biology, IPB.

2.2. Sampling

The subjects of this research were undergraduate (1–4 years of tertiary study) and graduate (more than 5 years of study) students of IPB and UI who are academically active until July 2014, had received their grade point average, and had never taken similar test. The total number of subjects used in this research is 234 individuals consisted of 133 IPB students and 101 students of UI from various majors. We specified the various majors into four groups based on an assessment system in Next Generation Science Standard adopted in the United States of America (Pellegrino *et al.* 2013); they were engineering and application sciences, life sciences (LS), physical sciences, and social sciences.

2.3. Informed consent

Subjects signed an informed consent before taking the test. Before the signing, the interviewer (NHW) stated the purpose of the research, researchers' contact address, and agreement form. After participating the test, the interviewer gave subjects a gift worth around IDR 1000.

2.4. Academic achievement

Academic achievement was described according to the latest *Indeks Prestasi Kumulatif* (IPK). In each university, IPK is calculated as the ratio of the score gotten in every subject matter weighted with the total number of class credit she/he took. The IPK scales from 0 to 4. It is assessed at the end of each semester. In both universities, it is used to determine the number of credit she/he could take in next semester and whether she/he could pass through to the higher grade relative to some threshold (UI 2004a, 2007; IPB 2013).

2.5. Cognitive style

Cognitive style was determined by using cognitive reflection test (CRT; Frederick 2005). The Indonesian version of CRT (available on request to the authors) was used to determine which cognitive style each subject adopts. The test administered directly, so the subject's natural mindset would not be distracted. Test duration was without limit, and subjects had to do the test themselves. There were three questions and the correct answers were summed for the CRT scoring. The minimal CRT score 0 indicates that the individual is intuitive, and the maximal 3 reflective or analytic (Frederick 2005).

2.6. Creative quality

Creative personality scale (CPS) for the adjective check list (Gough 1979) is a commonly used self-report personality inventory test for creativity (Le Roux 2001). This is from Gough (1979) whom simplified the 300 words of adjective check list into 30 for which each of it have high relationship with creativity categories (Baron and Welsh 1952; Domino 1970). Present research used the Indonesian version of CPS (available on request to the authors) consists of 18 adjectives representing positive indications of creative individual and 12 negative ones. Subjects were asked to check all adjectives that they think match to them. Creative qualities were assessed by summing positive and negative checks, whereas non-checked adjectives were given zero value. Final score ranges from −12 to 18. The median score is three, so one who scores higher than three is categorized as more creative than average and one who scores lower than three is categorized as less creative (Oldham and Cummings 1996).

2.7. Statistical analysis

Statistical analysis was performed using linear model (Venables and Ripley 1999) with cognitive style and creative quality as factors that assumed to affect academic performance. It was performed in base statistical package implemented in R program version 2.11.0 (R Core Team 2014).

3. Results

3.1. IPK

The pooled mean of the students' academic achievement was 3.25 (Table 1); nevertheless, UI students had IPK significantly higher than IPB students on average, for LS and for final year (4th year of study) undergraduate. The pooled means were very much

Table 1. Means of IPK, CRT, and CPS scores

	Pooled	IPB	UI	Differences between universities	
				Subtraction	*p* Value*
IPK					
Pooled	3.25	3.19	3.34	0.146	**0.002**
Major					
EAS	3.27	3.27	3.27	0.001	0.992
SS	3.34	3.24	3.37	0.131	0.199
LS	3.20	3.16	3.42	0.254	**0.001**
PS	3.33	3.82	3.25	–	–
Year of study					
1	3.18	3.18	–	–	–
2	3.32	3.35	3.32	–	–
3	3.30	3.29	3.31	0.019	0.902
4	3.19	3.00	3.36	0.356	**0.000**
5	3.46	3.51	3.37	0.136	0.290
6	3.34	3.50	3.02	–	–
7	3.68	3.73	3.51	–	–
CRT score					
Pooled	0.85	0.49	1.34	0.848	**0.000**
CPS score					
Pooled	3.15	3.19	3.09	0.099	0.824

CPS = Creative personality scale; CRT = cognitive reflection test; EAS = engineering and application sciences; IPB = Bogor Agricultural University; IPK = *Indeks Prestasi Kumulatif*; LS = life sciences; PS = physical sciences; SS = social sciences; UI = University of Indonesia.
Endash (–) represents either minimum or no data collected.
* Probability that IPB-UI differences is not zero are given as bold printed.

higher than thresholds that are 2.00 to pass through the next semester (undergraduate); 2.75 (Master, UI) or 3.00 (Master, IPB); and 2.75 (Doctoral, UI) or 3.25 (Doctoral, IPB), respectively.

3.2. Cognitive style

Present study found that the pooled mean of CRT score was 0.85 (Table 1), which means most of the students could not answer all the test questions correctly, and only small proportion answered some or all the three. There were 53.8% of students who scored 0; 21.2% scored 1; 11.4% scored 2; and 13.6% scored 3 in CRT. This fact could be inferred as evidence that they adopted intuitive thinking as their cognitive thinking style. They typically made non-reflective or wrong answers based on wrongly applied logical form. As in IPK, UI students had higher CRT score than IPB students, meaning that they were slightly more analytical than IPB students.

Table 2 explained the influence of different cognitive styles on IPK because it modulates the knowledge acquired through learning. In general, it showed that an increase in CRT score significantly raised IPK (linear model, slope = 0.077, p value = 0.005). However, UI and IPB showed different stories. Although pooled sample of both universities got significant correlation between CRT and IPK, CRT of UI students did not affect their IPK except in students majoring LS; in fact, most of the sample of UI students had high IPK. Interestingly, in IPB, the significant correlation was contributed by LS students too. This can partly be explained by the bigger proportion of LS students in IPB sample; nevertheless, the agriculture domain of IPB is part of LS. Apart from different results showed by various majors, in IPB, it was the 4th year students who showed significant correlation between CRT score and IPK, whereas other years did not. In this final year of undergraduate, variation in IPK was the widest when compared with lower classes.

3.3. Creative quality

From both universities, this research got a minimum CPS score −5 and maximum 15. The pooled mean was 3.25 (Table 1), nearly the same as expected median for Gough's CPS. Both universities also had mean of CPS nearly the same as median CPS, and did not differ from each other. This means that the creativity scores were normally distributed between students in both universities. Creative personality is thought to enhance student's innovation and therefore academic performance (Chen and Chen 2012b); in present research, we split the students as less creative (with CPS score less than 3) or more creative (with CPS score 3 or more), and looked on how was her/his IPK.

3.3.1. Effects of different creative quality on IPK

Table 3 described the influence of different creative quality on IPK. About 40% of UI students were more creative than their peers and the data seems to point that they need to be more creative to reach higher IPK (slope = 0.016, p value = 0.016). As with thinking style, students of IPB performed differently as the less creative of them could also get high IPK. In both universities and within their respective major, less creative students performed the same as more creative ones. In spite of major, it is worth of note that final year undergraduate students of IPB got higher IPK when they were more creative (slope = 0.032, p value = 0.043), whereas the same phenomenon was observed for the 1st year student of graduate course in UI (slope = 0.077, p value = 0.004).

Table 2. Mean of IPK* for different CRT score

	CRT score				Regression	
	0	1	2	3	Slope	Pr (>|t|)†
Pooled	3.18 (*124*)	3.29 (*50*)	3.34 (*27*)	3.41 (*32*)	0.077	**0.001**
IPB						
Pooled	3.12 (*87*)	3.25 (*31*)	3.44 (*8*)	3.52 (*6*)	0.138	0.005
Major						
EAS	3.16 (*11*)	3.56 (*4*)	–	3.26 (*1*)	0.115	0.621
SS	3.23 (*9*)	3.30 (*5*)	3.11 (*1*)	–	0.002	0.990
LS	3.10 (*67*)	3.15 (*21*)	3.49 (*7*)	3.57 (*5*)	0.151	**0.008**
PS	3.82 (*1*)	–	–	–	–	–
Year of study						
1	3.10 (*39*)	3.34 (*17*)	3.08 (*2*)	3.53 (*3*)	0.143	0.056
2	3.35 (*1*)	–	–	–	–	–
3	3.29 (*10*)	–	–	–	–	–
4	2.86 (*24*)	3.08 (*11*)	3.52 (*2*)	3.51 (*3*)	0.238	**0.001**
5	3.52 (*9*)	3.32 (*2*)	3.58 (*4*)		0.019	0.828
6	3.50 (*2*)	–	–	–	–	–
7	3.81 (*2*)	3.58 (*1*)	–	–	−0.23	0.612
UI						
Pooled	3.31 (*37*)	3.36 (*19*)	3.30 (*19*)	3.38 (*26*)	0.016	0.389
Major						
EAS	3.15 (*7*)	3.40 (*10*)	3.26 (*6*)	3.24 (*12*)	0.000	0.986
SS	3.40 (*23*)	3.21 (*5*)	3.29 (*8*)	3.48 (*8*)	0.005	0.871
LS	3.22 (*5*)	3.46 (*4*)	3.36 (*3*)	3.67 (*4*)	0.129	**0.003**
PS	3.10 (*2*)	–	3.37 (*2*)	3.27 (*2*)	0.070	0.516
Year of study						
2	3.27 (*10*)	3.44 (*4*)	3.26 (*4*)	3.57 (*1*)	0.043	0.485
3	3.38 (*11*)	3.24 (*3*)	3.31 (*3*)	3.24 (*8*)	−0.041	0.236
4	3.29 (*13*)	3.40 (*10*)	3.29 (*11*)	3.43 (*14*)	0.033	0.217
5	3.31 (*3*)	3.34 (*1*)	3.49 (*1*)	3.43 (*2*)	0.046	0.604
6	–	3.02 (*1*)	–	–	–	–
7	–	–	–	3.51 (*1*)	–	–

CRT = cognitive reflection test; EAS = engineering and application sciences; IPB = Bogor Agricultural University; IPK = *Indeks Prestasi Kumulatif*; LS = life sciences; PS = physical sciences; SS = social sciences; UI = University of Indonesia.
Endash (−) represents no data collected.
* Number in parenthesis represents number of observation.
† Probability that the estimated regression slope is not zero is given in bold.

Table 3. Mean of IPK* for different creative quality

	Creative quality		Pooled	Regression	
	Less creative	More creative		Slope	Pr (>|t|)†
University					
Pooled	3.24 (138)	3.28 (95)	3.25	0.010	0.164
UI	3.29 (60)	3.41 (41)	3.34	0.016	**0.016**
IPB	3.20 (78)	3.18 (54)	3.19	0.007	0.565
IPB					
Major					
EAS	3.25 (11)	3.32 (5)	3.27	0.022	0.441
SS	3.15 (5)	3.29 (10)	3.24	−0.015	0.663
LS	3.18 (61)	3.14 (39)	3.16	0.006	0.654
PS	3.82 (1)	–	3.82	–	–
Year of study					
1	3.24 (32)	3.13 (29)	3.18	−0.015	0.450
2	3.35 (1)	–	3.35	–	–
3	3.18 (8)	3.73 (2)	3.29	0.098	0.298
4	2.93 (23)	3.09 (17)	3.00	0.032	**0.043**
5	3.58 (13)	3.03 (2)	3.51	−0.030	0.295
6	3.15 (1)	3.84 (1)	3.50	–	–
7	–	3.73 (3)	3.73	–	–
UI					
Major					
EAS	3.28 (26)	3.25 (9)	3.27	0.002	0.874
SS	3.30 (20)	3.44 (24)	3.73	0.019	0.085
LS	3.38 (9)	3.47 (7)	3.42	0.012	0.572
PS	3.16 (5)	3.66 (1)	3.25	0.034	0.539
Year of study					
2	3.27 (9)	3.36 (10)	3.32	0.018	0.256
3	3.24 (13)	3.39 (12)	3.31	0.016	0.210
4	3.32 (34)	3.45 (14)	3.36	0.009	0.401
5	3.23 (4)	3.56 (3)	3.37	0.077	**0.004**
6	–	3.02 (1)	3.02	–	–
7	–	3.51 (1)	3.51	–	–

EAS = engineering and application sciences; IPB = Bogor Agricultural University; IPK = *Indeks Prestasi Kumulatif*; LS = life sciences; PS = physical sciences; SS = social sciences; UI = University of Indonesia.
Endash (−) represents no data collected.
* Number in parenthesis represents number of observation.
† Probability that the estimated regression slope is not zero is given in bold.

4. Discussion

Prior research performed by Frederick (2005) assessed CRT in some universities in USA and found Massachusetts Institute of Technology students had the highest mean of CRT score at 2.18, which can be said as adopting analytical thinking style. However, a pooled sample of 3428 American students and laymen had mean CRT score at 1.24. University of Michigan at Dearborn got mean CRT at 0.83 that is similar with Indonesian students with mean CRT 0.85; and both samples had similar proportion of each CRT score. The data by Frederick (2005) had CRT score ranged from 0.57 to 2.18 from 8 universities; they seemed to point that certain university attracted students with analytical cognitive style, whereas others got intuitive ones. In Indonesia, there is no extensive research on CRT score of different universities and with only two universities, present research cannot conclude the same pointer.

In our sample, students who used analytical thinking (CRT = 3) had high IPK. In this case, cognitive style may be considered as a factor in determining academic success of the students. Interestingly, the significant correlation of CRT and IPK appeared in students in their demanding class; for instance, the final year of undergraduate. If academic achievement is a consequence of learning (Diseth and Martinsen 2003) and learning itself provides knowledge that will be modulated by cognitive styles, it can be inferred that, compared with the unsuccessful ones, the successful students had developed their analytical competency. However, this analytical competency would only be achieved gradually and requires extensive practice (Zeithamova 2008). When did these final year students get their analytical competency? This is an open question for future research.

In complement to cognitive style, present research also described creative quality of the students. Creativity often defined as development of original ideas, underlies problem solving, and relates to independence (Sheldon 1995; Runco 2004; Chen and Chen 2012b). Thus creativity might play crucial role in academic achievement when students are in a condition that needs independency and innovation. In other words, students who performed independent project that pursue innovation need to be creative. Our result showed that more creative students got greater academic achievement in higher level of study. Indeed, this higher level students had the responsibility to do independent academic tasks (final project or independent assignments; UI 2004b; IPB 2013) that require the above creativity quality. The other way around, Jabeen and Khan (2013) reported that one's academic achievement is considered as more likely a factor in determining one's creativity. In fact, our result can also be inferred in support of this perspective. So it was unclear to conclude the pattern of relationship between creativity and academic achievement. As with analytical competency, one way to answer this problem is to find out when do students develop their creative quality.

Conflicts of interest

The authors declares that there is no conflict of interest.

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