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Thinking Styles: their relationships with modes of thinking and academic performance

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ABSTRACT *This study aimed at investigating the nature of thinking styles as described in the theory of mental self-government. Two-hundred-and-twelve US university students responded to the Thinking Styles Inventory and the Styles of Learning and Thinking. Results from convergent statistical analysis procedures indicated that thinking styles and modes of thinking share certain common variance in the data. It was evident that the more creativity-generating and more complex thinking styles are significantly related to a holistic mode of thinking, and that the more norm-conforming and more simplistic thinking styles are significantly related to an analytic mode of thinking. Furthermore, multiple-regression analyses showed that both thinking styles and modes of thinking statistically contributed to students' self-reported grade point averages beyond what was explained by their self-rated ability scores. These findings are discussed in terms of practical implications for educators.*

Research (e.g. Sternberg & Williams, 1997) has indicated that academic abilities and traditional achievement tests can account for only a minimal amount of individual-differences variation in academic achievement. Indeed, the impact of non-academically related factors on academic achievement has also been investigated by many researchers. These factors vary from learning motivation (e.g. Horn *et al.*, 1993, Dev, 1997), to self-esteem (e.g. Overwalle *et al.*, 1995, Leondari *et al.*, 1998), and to home and family support (e.g. Cutrona *et al.*, 1994, Chen *et al.*, 1996).

Style, as an individual-difference variable in academic achievement, also has been studied extensively. This research suggested that students' styles of learning and thinking do make a difference in academic achievement (e.g. Kim & Michael, 1995; Saracho, 1993). In the study of styles, many theoretical models have been postulated since the late 1950s and early 1960s. In the 1980s and 1990s, some scholars conceptually integrated these stylistic models. For example, Curry (1983) proposed a three-layer 'onion' model of style measures. Riding & Cheema (1991) contended that the style-based work be organised along two style-dimensions and one family of learning

strategies (also see Riding & Rayner, 1998). Grigorenko & Sternberg (1995) have classified the various theories of styles into three traditions. The present study is contextualised in Grigorenko & Sternberg's conceptualisation of work on styles.

According to Grigorenko & Sternberg (1995), existing models and theories on styles can be classified into three traditions to the study of styles: cognition-, personality- and activity-centred. Styles in the cognition-centred tradition most closely resemble abilities. Also, like abilities, these styles have often been measured by tests of maximal performance with 'right' and 'wrong' answers. Within this tradition, Witkin's (1964) field dependence-independence and Kagan's (1966) reflection-impulsivity models have generated the most interest. Styles in the personality-centred tradition are viewed as closer to personality traits. Moreover, styles in this tradition are measured via typical, rather than maximal performance tests. Models of styles in this tradition are best represented by Gregorc's (1979) four main types of styles, and Myers & McCaulley's (1988) work based on Jung's (1923) theory of types. The activity-centred tradition emphasises the notion of styles as mediators of various forms of activities that tend to arise from some aspects of cognition and personality. One major group of work in this tradition is represented by similar theories of deep- and surface-learning approaches proposed separately by Marton (1976), Biggs (1979), and Entwistle (1981).

Apart from containing a variety of theories of styles, the style literature also finds itself containing different style labels, such as learning styles, cognitive styles, and thinking styles. These styles, although different, have one thing in common. That is, styles are not abilities, but rather they are individuals' preferred ways of processing information and of using the abilities that they have.

The year 1988 saw the publication of Sternberg's theory of mental self-government—a theory of thinking styles that seems to fit in the definitions of all three traditions (also see Sternberg, 1997). Sternberg used the metaphor 'mental self-government' to portray the way human mind works. Just as there are many ways of governing our society, there are many ways of governing or managing our daily activities. These different ways of governing or managing our activities are what Sternberg (1988, 1997) called 'thinking styles'. This theory postulated 13 thinking styles that fall along five dimensions. These are functions (including the legislative, executive, and judicial thinking styles), forms (including the hierarchical, oligarchic, monarchic, and anarchic thinking styles), levels (including the global and local thinking styles), scopes (including the internal and external thinking styles) and leanings (including the liberal and conservative thinking styles) of the mental self-government. In the Appendix, each thinking style is briefly described.

Although they fall along five dimensions, these thinking styles can be broadly categorised into two types. The first type of thinking styles (e.g. legislative, judicial, global, liberal) implies ways of doing things that are creativity-generating and more complex (referred to as 'Type I' thinking styles hereafter). The second type of thinking styles (e.g. executive, local, conservative) implies ways of doing things that are more norm-favouring and more simplistic (referred to as 'Type II' thinking styles hereafter).

What is the nature of thinking styles as defined by the theory of mental self-government? Several measures have been developed to examine these thinking styles (see Sternberg, 1997). These measures have been used to study a few different populations such as secondary school students, pre-service and in-service teachers of primary and secondary schools, and university students in different cultures, including Hong Kong, mainland China, and the United States. Apart from obtaining satisfactory reliability and

validity data on these measures, we have also obtained a few interesting findings that have implications for teaching and learning.

First, we found that thinking styles vary depending on both students' and teachers' characteristics. For instance, secondary school students from higher socio-economic status (SES) families obtained significantly higher scores on the legislative thinking style than did students from lower SES families (e.g. Sternberg & Grigorenko, 1995). University students majoring in natural science and technology reported a thinking style that is significantly more global than did students majoring in social sciences and humanities (Zhang & Sachs, 1997). Students who reported more extracurricular experience scored significantly higher on such scales as the legislative, hierarchical, and liberal thinking styles, whereas students who reported less extracurricular experience scored significantly higher on such scales as the executive, local, and conservative thinking styles (Zhang, 1999). Teachers who have taught for a longer duration were more conservative, executive, and local in their thinking styles than those teachers who have taught for a shorter duration (Sternberg & Grigorenko, 1995). Sternberg & Grigorenko also found that teachers tended to evaluate favorably those students who have thinking styles similar to their own.

Secondly, we found that thinking styles contribute to students' academic performance over and above what can be explained by both objectively-tested abilities and self-rated abilities. For example, in a study of secondary school students, Grigorenko & Sternberg (1997) found that the judicial, legislative, and legislative thinking styles are associated with better academic achievement, whereas the executive thinking style is associated with lower achievement. On the other hand, in a study of Hong Kong university students, Zhang & Sternberg (1998) found that the executive, local, and conservative thinking styles significantly positively predicted students' achievement in their advanced levels tests.

Another source of variation in thinking styles has been related to students' self-esteem. In their study of 794 university students from Hong Kong, Zhang & Sternberg (2001) found that those students who scored significantly higher on Type I thinking styles reported significantly higher self-esteem. By contrast, students who scored significantly higher on Type II thinking styles reported significantly lower self-esteem.

The thinking style construct as defined in the theory of mental self-government also has been tested against constructs from two of the three traditions to the study of styles. The first is the activity-centred tradition. From this tradition, Bigg's (1987) theory of student learning approaches has been selected. Studies (Zhang, 2000a; Zhang & Sternberg, 2000) indicated that students who scored significantly higher on Type I thinking styles also reported a deep approach to learning. In a similar vein, students who scored significantly higher on Type II thinking styles reported a surface approach to learning.

The second type of theories against which the theory of mental self-government has been tested is from the personality-centered tradition. For example, Sternberg (1994a) examined the correlations between thinking styles and the Myers-Briggs Type Indicator (MBTI; Myers & McCaulley, 1988) and Gregorc's (1982) measure of mind styles. For the MBTI, 30 of 128 correlations were statistically significant, whereas for Gregorc's measure, 22 of 52 were significant. These correlations are well above the levels that would be expected by chance and suggest significant overlap between thinking styles and personality types. Recently, Zhang (2000b) studied the relationships of thinking styles to the six personality types defined by Holland (1973, 1994). Factor analysis of

the thinking styles and personality types scales resulted in two factors, each containing particular thinking styles and personality types, suggesting an overlap between the two constructs.

However, the thinking styles in Sternberg's theory have yet to be tested against a theory from the third tradition to the study of styles, that is, the cognition-centred tradition. The present study examines the relationships of thinking styles to the construct assessed by the Style of Learning and Thinking (SOLAT, Torrance *et al.*, 1988). Although the SOLAT was originally designed to measure brain dominance, findings from the past 20 years have suggested that the two hemispheres are more dynamic than static and that they are more interactive than were once believed to be (e.g. Banich, 1998; Banich & Heller, 1998; Beeman & Chiarello, 1998). Thus, the terms 'brain dominance' or 'hemispheric specificity' no longer seem to be appropriate. Indeed, more recent research using the SOLAT has been using the term 'hemispheric style' or 'hemispheric thinking style' (e.g. Albaili, 1993, 1996; Hassan & Abed, 1999). The present study casts the SOLAT in yet a different light, that is, in the light of modes of thinking that, I believe, is more accurate in describing what the inventory really measures. An individual with an analytic mode of thinking (originally left-brained dominance) tends to process information in a piecemeal, analytical, and sequential manner (which happens to be a good way for processing verbal information, see Banich & Heller, 1998; Reuter-Lorenz & Miller, 1998). An individual with a holistic mode of thinking (originally right-brained dominance) tends to process information in an intuitive, gestalt-type, synthesised manner (which happens to be good for processing spatial information). An individual with an integrative mode of thinking (originally whole-brained dominance) tends to process information in an interactive and dynamic way. It should be emphasised, however, although each individual has a dominant mode of thinking, one may use predominantly any one of the other two modes of thinking, depending on the tasks being dealt with.

The SOLAT is selected for two reasons. First, the inventory is clearly cognition-centred, measuring people's preferred ways of processing information—analytic, holistic, and integrative, which is suitable for the purpose of this study. Secondly, the SOLAT is one of the major inventories that have resulted in findings that have direct implications for curricula, instructions, and assessment formats. In general, research on the relationship between hemispheric styles as measured by the SOLAT and achievement indicates that school curricula favour students with a left hemispheric style (e.g. Bracken *et al.*, 1979; Stellern *et al.*, 1985).

The major goal of the present study was to examine the nature of thinking styles as defined in the theory of mental self-government. This goal was achieved by two procedures. First, the Thinking Styles Inventory (TSI; Sternberg & Wagner, 1992) was tested against the SOLAT. This aimed at identifying if thinking styles and modes of thinking share common variation. Two hypotheses were made about the relationships between thinking styles and modes of thinking. First, students who score higher on Type I thinking styles will also score higher on the holistic mode of thinking, but will score lower on the analytic mode of thinking. Secondly, students who score higher on Type II thinking styles will also score higher on the analytic mode of thinking, but will score lower on the holistic mode of thinking.

These two hypotheses are based on the nature of the two types of thinking styles and of the two modes of thinking. Type I thinking styles and the holistic mode of thinking should be positively correlated because both can be used to deal with tasks that require more creative, abstract, non-traditional, and complex thinking. Type II thinking

styles and the analytic mode of thinking should be positively correlated because both can be used to deal with tasks that require concrete, conventional, and simplistic thinking.

The second procedure to examine the nature of thinking styles was to test both the TSI and the SOLAT against academic performance. This procedure aimed at finding out if thinking styles and modes of thinking contribute to students' academic achievement in a predictable way. According to studies documented in the literature, both thinking styles (e.g. Bishop-Clark, 1995; Grigorenko & Sternberg, 1997; Zhang & Sternberg, 1998) and modes of thinking (e.g. Kim & Michael, 1995; Okabayashi & Torrance, 1984) have a significant impact on academic performance. Furthermore, previous research (e.g. Armstrong, 2000; Riding, 1996) has also shown that the effect of styles on an individual's performance depends on the nature of the tasks and the methods of assessment used. In the present study, the research participants were studying in a wide variety of disciplines from arts to sciences and the achievement scores used were self-reported cumulative GPAs. Students from different disciplines may be assessed differently and they might have dealt with very different tasks in obtaining their GPAs. In fact, even within the same discipline, different tasks and different methods of assessment may have been used for different courses. These different tasks and methods of assessment may require different thinking styles and modes of thinking. Because the nature of the tasks and methods of assessment to which the research participants were exposed are unknown, no specific hypothesis was made as for how exactly the thinking styles and modes of thinking will contribute to students' GPAs. However, it is hypothesized that (Hypothesis 3) Type I thinking styles and the holistic mode of thinking will contribute to students' GPAs in the same way and that Type II thinking styles and the analytic mode of thinking will contribute to students' GPAs in the same way. The first half of hypothesis 3 is based on hypothesis 1, that is, Type I thinking styles and the holistic mode of thinking will be positively correlated. The second half of hypothesis 3 is based on hypothesis 2, that is, Type II thinking styles and the analytic mode of thinking will be positively correlated.

Methods

Participants

Students from three research universities in the United States (one from California, one from Iowa, and one from Texas) participated in the study. Among the 212 participants, 85 were male students and 126 were female students (one participant did not indicate gender). The ages of participants ranged from 17 to 50, with a mean age of 22 years. The participants were studying in a variety of academic fields, including arts, business, education, medicine, science, and social sciences. There were 83 freshmen, 15 sophomores, 33 juniors, 56 seniors, and 23 graduate students (two participants did not report their academic year).

Measures

All participants responded to the Thinking Styles Inventory (TSI; Sternberg & Wagner, 1992) and the Style of Learning and Thinking (SOLAT; Torrance *et al.*, 1988). On a 10-point scale, participants also rated themselves about their abilities. The three kinds of abilities rated are analytical, creative, and practical (Sternberg,

1985). Participants' self-reported cumulative grade point averages (GPAs) were also obtained.

The TSI is a self-report inventory consisting 65 statements, each five assessing one of the 13 thinking styles. Participants rate themselves on a 7-point scale, with 1 representing that the statement does not characterise them at all and 7 representing that the statement describes them extremely well. In the present study, the participants responded to 35 items from seven scales. The four forms (hierarchical, oligarchic, anarchic, and monarchic), and two scopes (internal and external) of thinking styles were not included since no relationship was expected between these thinking styles and the SOLAT scales.

Previous research indicated that the Thinking Styles Inventory is a reliable and valid measure for assessing the thinking styles proposed in the theory of mental self-government among students and teachers in Hong Kong, mainland China, as well as in the United States. The internal-consistency reliabilities of the scales are generally satisfactory, ranging from the high 0.50s to the low 0.80s (see Zhang, 2000a,b; Zhang & Sternberg, 2001 for details). Factor analyses were generally, although not completely, supportive of the structure of the theory. For example, in Sternberg's (1994a) and Zhang's (1999) studies, five factors were identified, with each factor roughly corresponding to each of the five dimensions of thinking styles. However, in Zhang & Sachs's (1997) study, three factors were readily interpretable. In addition, external validity also has been obtained for the TSI, as discussed earlier in the literature review on the studies testing relationships of thinking styles to learning approaches (Zhang, 2000a; Zhang & Sternberg, 2000), self-esteem (Zhang & Sternberg, 2001), and to personality styles (Sternberg, 1994a; Zhang, 2000b).

The Style of Learning and Thinking is also a self-report inventory. It is composed of 28 items, each allowing the respondents to choose one of the two statements or both. One of the statements is assumed to be characterized by the analytic mode of thinking, and the other, by the holistic mode of thinking. Choosing both statements results in scoring on the integrative mode of thinking scale. An example follows:

- (a) I am good at using logic in solving problems.
- (b) I am good at using feelings and intuitions in solving problems.

Choosing (a) is scored on the analytic mode of thinking scale; (b) is scored on the holistic mode of thinking scale; and choosing both (a) and (b) is scored on the integrative mode of thinking scale.

Data for reliability and validity of the SOLAT have been delineated in the SOLAT Administrator's Manual (Torrance, 1988). Cronbach's alphas were 0.77 and 0.74 for the analytic and holistic scales, respectively. Reliability for the integrative scale was not reported. In the present study, the Cronbach's alphas are 0.75 for the analytic scale, 0.73 for the holistic scale, and 0.83 for the integrative scale.

No study has been found that reported the validity of the SOLAT. However, as Torrance (1988) pointed out, its validity can be primarily drawn upon the validity evidence accumulated for a few earlier versions of the SOLAT (see Torrance, 1988, for details). It was suggested that, while creative problem-solving and creative thinking require both analytic and holistic modes of thinking, the essence of creative behaviour calls for the holistic mode of thinking.

Data Analysis

A preliminary test was conducted for identifying gender difference in any of the

thinking style and mode of thinking scales. Since gender difference was identified in two of the thinking styles ($M_{\text{male}} = 5.33$, $M_{\text{female}} = 4.88$, $t_{208} = 3.16$, $P < 0.01$ for the legislative style; $M_{\text{male}} = 4.94$, $M_{\text{female}} = 4.51$, $t_{208} = 2.48$, $P < 0.05$ for the liberal style), the remaining statistical analyses were conducted both separately for males and females, and jointly for both genders.

To explore the relationships between thinking styles and modes of thinking, four statistical procedures were performed. First, an exploratory factor analysis with a varimax rotation was conducted for all scales in the two inventories. Secondly, a zero-order correlation matrix was computed, with scales from the TSI being one set of variables and scales from the SOLAT being a second set of variables. Thirdly, analysis of variance (multivariate followed by univariate) was conducted to examine the participants' differences in thinking styles based on their responses to the SOLAT. Participants were assigned to high, medium, and low groups on all three of the SOLAT scales—analytic, holistic, and integrative scales. Cut-off scores are based upon an exploration of score distributions. The Kolmogorov–Smirnov test was conducted to examine the normality of the data. Since the significance level of the test is greater than 0.05 for all three scales, normality was assumed for all three scales. Thereafter, scores in the lowest quartile are designated as low, the middle two quartiles as medium, and the highest quartile as high. Fourthly, stepwise multiple-regression procedures were conducted, using the thinking styles and modes of thinking scales as predictors separately for students' accumulative GPAs, after their self-rated ability scores were being controlled.

Results

Although there is gender difference in two of the thinking styles scales, results from the analyses aimed at identifying the relationships between thinking styles and modes of thinking did not indicate any gender difference. Therefore, the data reported below are gender-combined results.

Factor Analysis

The factor analysis conducted on all scales from the two inventories resulted in a three-factor solution based on visual inspection of eigenvalues with the scree test (Cattell, 1966). The first two factors were, as expected, loaded by scales from both inventories. The first factor (accounting for 29% of the variance in the data) was dominated by the holistic mode of thinking scale, as well as by the legislative, judicial, global and liberal thinking styles (all being Type I thinking styles). All factor loadings are positive. The second factor (accounting for 25% of the variance in the data) loaded negatively on the holistic mode of thinking but positively on the analytic mode of thinking, as well as the executive, local, conservative thinking styles (all being Type II thinking styles). The factor loadings in the first two factors suggested relationships between the modes of thinking and thinking styles in the expected directions (see hypotheses 1 and 2). The third factor, however, was dominated only by scales from the SOLAT, these are the analytic and integrative modes of thinking. In all, these three factors accounted for 71% of the variance in the data. Detailed statistical results are summarized in Table I.

TABLE I. Varimax-rotated three-factor model for Thinking Styles Inventory and Style of Learning and Thinking ($n = 212$)

Scales	Factor I	Factor II	Factor III
SOLAT			
Analytic	-0.30	0.44	0.70
Holistic	0.41	-0.56	0.39
Integrative			0.97
TSI			
Legislative	0.80		
Executive		0.88	
Judicial	0.76	0.31	
Global	0.61		
Local	0.21	0.71	
Liberal	0.89		
Conservative		0.88	
% Variance	29.29	25.45	16.70
Cumulative variance	29.29	54.74	71.43
Eigenvalues	2.93	2.55	1.67

TSI and SOLAT Scale Correlations

Fourteen correlation coefficients resulted from the two modes of thinking (analytic and holistic) and seven thinking styles. Twelve of the 14 correlation coefficients are statistically significant. Furthermore, all these correlations are in the expected directions (see hypotheses 1 and 2). For example, the analytic mode of thinking is significantly positively correlated with Type II thinking styles, but significantly negatively correlated with Type I thinking styles. By the same token, the holistic mode of thinking is significantly positively correlated with the more creativity-generating thinking styles, but significantly negatively correlated with the thinking styles that are more norm-favoring and more simplistic. The correlation coefficients among the scales in the two inventories are summarized in Table II.

Analysis of Variance: Thinking styles by modes of thinking

A separate one-way MANOVA was conducted for each of the three modes of thinking scales to identify possible significant differences in thinking styles among the high,

TABLE II. Pearson Correlation Matrix for the Thinking Styles Inventory and the Style of Learning and Thinking ($n = 212$)

Scale	Analytic	Holistic	Integrative
Legislative	-0.22**	0.29**	0.04
Executive	0.26**	-0.32**	-0.08
Judicial	-0.07	0.14*	0.01
Global	-0.20**	0.10	-0.12
Local	0.27**	-0.21**	0.00
Liberal	-0.25**	0.34**	0.03
Conservative	0.31**	-0.37**	-0.09

* $P < 0.05$; ** $P < 0.01$.

medium, and low modes of thinking groups. Statistically significant differences in thinking styles were identified for the analytic ($F_{14,388} = 3.11$, Wilks' Lambda = 0.81, $P = 0.00$) and holistic ($F_{14,388} = 3.96$, Wilks' Lambda = 0.77, $P = 0.00$) modes of thinking. Univariate analysis of variance followed by *post hoc* tests using Tukey's Honestly Significant Differences suggested statistically significant differences in six thinking styles by the analytic mode of thinking groups (judicial style, non-significant) and in six thinking styles by the holistic mode of thinking groups (global style, non-significant).

Specifically, with respect to the analytic mode of thinking, participants in the higher analytic mode of thinking groups tended to score significantly lower on the legislative, global, and liberal thinking styles, but significantly higher on the executive, local, and conservative thinking styles than did their counterparts. On the contrary, participants in the lower analytic mode of thinking groups tended to score significantly higher on the legislative, global, and liberal thinking styles, but significantly lower on the executive, local, and conservative thinking styles than did their counterparts. All these group differences in thinking styles were anticipated by hypotheses 1 and 2.

Regarding the holistic mode of thinking groups, participants in the higher scale groups tended to score significantly higher on the legislative and liberal thinking styles, but significantly lower on the executive, local, and conservative thinking styles than did their counterparts. By contrast, participants in the lower holistic mode of thinking groups tended to score significantly lower on the legislative and liberal thinking styles scales, but significantly higher on the executive, local, and conservative thinking styles scales than did their counterparts. These results, again, suggested relationships between thinking styles and modes of thinking in ways as predicted by hypotheses 1 and 2.

Yet, the group differences in the judicial thinking style (by the holistic mode of thinking) were not fully anticipated. While the highest mean score for the judicial style was obtained by the high holistic mode of thinking group, as expected, the lowest mean score for the judicial style was obtained by the medium holistic mode of thinking group, but not by the lowest group. Yet, it should be noted that the mean difference between the medium and low holistic groups is not statistically significant. Therefore, the group differences in the judicial style did not lend full support to hypothesis 1. The mean differences for the analytic and holistic modes of thinking groups are summarized in Table III.

Thinking Styles, Modes of Thinking, Achievement, and Self-rated Abilities

Summary statistics from stepwise multiple-regression procedures are presented in Table IV. Three of the seven thinking styles statistically contributed to students' accumulative GPAs beyond what can be explained by students' self-rated abilities. These thinking styles are the liberal, global, and conservative thinking styles. The three thinking styles explained 10% of the variance in the data over and above what is contributed by self-rated abilities. The signs of the beta weights indicate that the liberal and global thinking styles negatively contributed to achievement, and that the conservative thinking style positively contributed to achievement.

Results from the regression using the modes of thinking scales as the predictor indicated that the analytic mode of thinking explained 4% of the variance in the data over and above what has been explained by students' self-rated ability scores. Furthermore, the analytic mode of thinking positively contributed to students' academic achievement ($\beta = 0.22$, $F_{4,205} = 4.06$, $P < 0.01$).

TABLE III. Mean scores for Thinking Styles Inventory Scales based on mode of thinking groups ($n = 212$)

MOT scales	Analytic						Holistic						
	Leg	Exe	Global	Local	Lib	Con	Leg	Exe	Jud	Local	Lib	Con	
MOT groups													
Low	5.46 ^H	4.20 ^{LL}	4.38 ^H	4.18 ^{LL}	5.12 ^H	3.98 ^{LL}	4.80 ^L	5.17 ^H	4.58	4.87 ^{HH}	4.40 ^L	5.00 ^H	
(N)	(44)	(44)	(42)	(44)	(44)	(44)	(43)	(43)	(43)	(43)	(43)	(42)	
Medium	5.06	4.80 ^H	4.26	4.57 ^H	4.70	4.60 ^H	4.97	4.81	4.55 ^L	4.46 ^L	4.48	4.68	
(N)	(114)	(113)	(112)	(113)	(114)	(113)	(122)	(121)	(122)	(121)	(122)	(122)	
High	4.75 ^L	5.02 ^H	3.95 ^L	4.96 ^H	4.28 ^L	5.01 ^H	5.57 ^H	4.12 ^L	4.96 ^H	4.32 ^L	5.47 ^H	3.90 ^L	
(N)	(53)	(53)	(53)	(52)	(53)	(53)	(46)	(46)	(47)	(45)	(46)	(46)	

Note: MOT = mode of thinking; Leg = legislative; Exe = executive; Jud = judicial; Lib = Liberal, Con = Conservative,

^Ldenotes a mean significantly lower than that of one group; ^{LL}denotes a mean significantly lower than those of two groups; ^Hdenotes a mean significantly higher than that of one group; ^{HH}denotes a mean significantly higher than those of two groups.

TABLE IV. Summary of stepwise multiple regressions of TSI scales as predictors of GPAs, controlling for self-rated abilities ($n = 212$)

Variables	Variable summary	Model summary	
	β weights	R	F value
<i>In the equation</i>			
Analytical ability	0.17	0.08 ^a	$F_{1,199} = 1.25$
Creative ability	-0.07	0.15 ^b	$F_{2,198} = 2.36$
Practical ability	-0.08	0.16 ^c	$F_{3,197} = 1.80$
Liberal	-0.13		
Global	-0.19**	0.33 ^c	$F_{5,195} = 4.68**$
Conservative	0.15**	0.37 ^f	$F_{6,194} = 4.69**$
<i>Not in the equation</i>			
Legislative	-0.10 ^f		
Executive	-0.11 ^f		
Judicial	0.09 ^f		
Local	0.02 ^f		

* $P < 0.05$; ** $P < 0.01$.

^a Predictors in the model: (constant), analytic ability,

^b Predictors in the model: (constant), analytic ability, creative ability,

^c Predictors in the model: (constant), analytic ability, creative ability, practical ability,

^d Predictors in the model: (constant), analytic ability, creative ability, practical ability, liberal style.

^e Predictors in the model: (constant), analytic ability, creative ability, practical ability, liberal style, global style.

^f Predictors in the model: (constant), analytic ability, creative ability, practical ability, liberal style, global style, conservative style.

Discussion, Conclusions, and Implications

The goal of the present study was to investigate the nature of thinking styles. This goal has been achieved by testing the relationships among thinking styles, modes of thinking, and academic performance. Findings from this research indicated that thinking styles and modes of thinking share certain common variance in the data. Results from the first three statistical procedures (factor analysis, scale correlation, and analysis of variance) consistently supported the predictions (hypotheses 1 and 2) on the relationships between thinking styles and modes of thinking. Results indicated that participants' use of the more creativity-generating and more complex thinking styles was significantly positively related to the use of the holistic mode of thinking, but significantly negatively related to the use of the analytic mode of thinking. In a similar vein, participants' use of the more norm-favoring and more simplistic thinking styles was significantly positively related to the use of the analytic mode of thinking, but significantly negatively related to the use of the holistic mode of thinking.

The relationships between thinking styles and modes of thinking were further revealed by the way each of the two constructs contributed to academic achievement. First, both constructs seem to play an important role in students' academic achievement since both statistically predicted students' accumulative GPAs over and above what can be predicted by students' self-rated abilities. More importantly, thinking styles and modes of thinking contributed to achievement in a similar manner, as predicted. It seemed that performing tasks according to rules and procedures (conservative thinking

style), and processing information in a more piecemeal fashion pay off in school whereas performing tasks in a more norm-challenging way (liberal style) and paying more attention to larger issues (global style) are not academically rewarded.

Although no prediction was made regarding the relationship between thinking styles and the integrative mode of thinking, all statistical procedures used in this investigation were used to explore if there is any relationship between the two. Across all statistical procedures, the integrative mode of thinking appeared to be independent of thinking styles. Furthermore, no statistical impact was found in the integrative mode of thinking on students' academic achievement. This absence of relationship between the integrative mode of thinking and thinking styles might be explained by the fact that this sample of participants did not indicate much of an endorsement of the integrative mode of thinking. The cut-off score for the high integrative group (11.25) is actually lower than the cut-off score for the low analytic (14.5) and holistic (15.5) groups.

The relationships of thinking styles to the analytic and holistic modes of thinking could be explained in at least two ways. It could be that participants who are used to employing the analytic mode of thinking (i.e. processing information in a piecemeal and logical manner) became more executive, local, and conservative in their thinking styles, whereas participants who are used to employing the holistic mode of thinking (i.e. processing information in a synthesized and intuitive manner) became more legislative, judicial, global, and liberal in their thinking styles. It also could be that participants who are more executive, local, and conservative (i.e. dealing with learning tasks in a more norm-favoring and simplistic manner) in their thinking styles became more analytic in processing information, whereas those who are more legislative, judicial, global, and liberal (i.e. dealing with learning tasks in a more creative and complex manner) in their thinking styles became more holistic in processing information. Either way, the two constructs overlap to some extent. Thus, the difference between the two constructs seems to be in degree, but not in kind.

For the statistical contributions made by the thinking styles (liberal, global, and conservative) and the analytic mode of thinking to students' academic achievement, support can be found in the literature in terms of both conceptual argument and empirical findings. Using the terminologies 'brain dominance' and 'cognitive style', Grow & Johnson (1983) once reasoned that many students demonstrate dominance by one hemisphere of the brain. They went on saying that 'In some youngsters, this asymmetry results in an individual cognitive style sufficient to affect school achievement' (pp. 34–35; also see Wittrock, 1978). Empirically, many studies have found that thinking styles (e.g. Grigorenko & Sternberg, 1997; Zhang & Sternberg, 1998) and modes of thinking (e.g. Kim & Michael, 1995; Okabayashi & Torrance, 1984) contribute to students' academic achievement. The present study went a step further than previous research in that it has shown that both particular thinking styles and mode of thinking contribute to academic achievement beyond what can be explained by students' self-rated abilities. Unfortunately, this study also confirmed findings from previous studies regarding such a phenomenon, that is, educational institutions tend to favour students who are more conforming in their thinking styles and who are more analytic in their mode of thinking, but to penalise those students who are more norm-challenging and those who focus more on the larger pictures of issues.

It should be noted, however, that there was a major limitation to the present study. That is, the academic achievement scores used were self-reported cumulative GPAs of students from a wide variety of academic disciplines. Also, there was a lack of information about the methods in which the research participants were assessed in

gaining their GPAs. All this might have affected the findings regarding the relationships of academic performance to the thinking styles and to the modes of thinking. To be more specific, the effect of certain thinking styles and/or modes of thinking might have been overshadowed by that of other thinking styles and/or modes of thinking that are required by assessment methods predominantly employed among the various disciplines in which the research participants were studying. In order to identify exactly how each thinking style or mode of thinking contributes to academic performance, future studies should consider using discipline- or even course-specific academic scores, rather than using those from an amalgam of achievement scores in different courses of different disciplines.

Nevertheless, the present study has made a major contribution to the styles literature. That is, it is the pioneer study that has empirically examined the nature of thinking styles against a construct from the cognition-centred approach to the study of styles. The present findings also have two practical implications for educators.

First, educators could use the relationships found between thinking styles and modes of thinking in their efforts of cultivating creativity among students. Much research has suggested that creativity is highly associated with the use of the holistic mode of thinking (e.g. Harnad, 1972; Tan-Willman, 1981; Okabayashi & Torrance, 1984; Kim & Michael, 1995). For example, Harnad (1972) concluded that highly creative mathematicians habitually employ the holistic mode of thinking. Tan-Willman (1981) observed that intellectually gifted students (who are characterised by their creativity) also tended to use the holistic mode of thinking. Given that there are significant relationships between the holistic mode of thinking and the legislative, judicial, global, and liberal thinking styles, educators should feel confident that they could cultivate creativity not only by encouraging holistic information processing, but also by allowing for the use of Type I thinking styles. There are a variety of methods for inducing the use of Type I thinking styles. For example, teachers could model creative thinking during their instructions. Teachers could also assess for creative thinking. Also for example, university/school counselors can use the knowledge of thinking styles in challenging students to think more creatively and come up with more effective solutions to their problems.

Secondly, educators should start giving more serious consideration to the fact that repeated studies have found that both school and university curricula around the world tend to penalize creative thinking. Creative thinking, though, is critical to students' future career success. If we want to produce students who are going to be capable of adapting themselves to the ever-changing world, we must start cultivating students' creative thinking during their educational career. Otherwise, we could produce a generation of students who would be overwhelmed by their future world of work.

What can we do to change the present situation? It was noted earlier that Sternberg (1997) has argued that thinking styles are socialized (also see Saracho, 1993). By the same token, modes of thinking have also been contended to be socialised (e.g. Kinsbourne, 1982; Gadzella & Kneipp, 1990; Petty & Haltman, 1991). If both thinking styles and modes of thinking can be socialised, then both can be modified.

For teachers, there are at least three ways of modifying students' thinking styles and modes of thinking. First, teachers could re-examine and redesign their instructional models. The new instructional models should be such that they allow multiple thinking styles and that they put together the specialised functions of both modes of thinking. In our earlier writings (e.g. Sternberg, 1994b; Zhang, 1999), we have argued that the least that teachers could do to allow for multiple thinking styles is to use diverse instructional methods and multiple assessment methods. Being allowed for the use of different

thinking styles would give students an equal opportunity to benefit from teachers' instructions and to experience academic success, no matter what the students' predominant thinking styles are. By the same token, many scholars have argued for a curriculum that also should allow the use of holistic mode of thinking apart from the analytic mode of thinking. For example, Torrance (1981) proposed a curriculum that is characterised by students' involvement and participation in an innovative learning.

Secondly, teachers could also encourage the use of Type I thinking styles and the holistic mode of thinking by providing students with opportunities for participating in extracurricular activities. Numerous studies, including studies using the theory of mental self-government, have indicated that rich student extracurricular experiences are associated with the use of creativity-generating thinking styles and with more advanced cognitive development (e.g. Gordon, 1990; Batchelder & Root, 1994; Petersen *et al.*, 1995; Hattie *et al.*, 1997; Zhang, 1999).

Thirdly, there is also an indirect way of allowing students to use multiple thinking styles and to be engaged in both modes of thinking. That is, teachers themselves should be allowed to use creativity-generating thinking styles and holistic mode of thinking in their teaching and interaction with students in general. Research on teachers has indicated that teachers' thinking styles as manifested in teaching are consistent with the ideology of their schools (e.g. Sternberg & Grigorenko, 1995), and that teaching styles and teaching approaches vary depending on their perceptions about their work environments (e.g. Prosser & Trigwell, 1997; Zhang, 2001). If teachers work in an environment in which they are given much flexibility and autonomy, teachers will work in an innovative manner. Thus, teachers could become role models for students in using Type I thinking styles. It follows that students would become more risk-taking both in performing their learning tasks and in dealing with other issues outside the classroom.

To conclude, the various findings in the present investigation substantiate that thinking styles and modes of thinking are, to some extent, similar. However, since this is the first study that examines thinking styles against modes of thinking, further investigation is required to specify adequately the relationship between the two. Moreover, the finding about the relationship between the two constructs and academic achievement can be regarded as another call for the nurturing of creativity-generating thinking styles and of a holistic mode of thinking among university students.

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Appendix: Sample items from the Thinking Styles Inventory

Sample items	Scale Type	Key Characteristic
<ul style="list-style-type: none"> • I like tasks that allow me to do things my own way. • I like situations in which it is clear what role I must play or in what way I should participate. • I like to evaluate and compare different points of view on issues that interest me. • I like to complete what I am doing before starting something else. • When undertaking some task, I like first to come up with a list of things that the task will require me to do and to assign an order of priority to the items on the list. • I usually know what things need to be done, but I sometimes have trouble deciding in what order to do them. • When working on a written project, I usually let my mind wander and my pen follow-up on whatever thoughts cross my mind. • Usually when I make a decision, I don't pay much attention to details. • I like problems that require engagement with details. • I like to be alone when working on a problem. • I like to work with others rather than by myself. • I like to do things in new ways, even if I am not sure they are the best ways. • In my work, I like to keep close to what has been done before. 	<p>Legislative Executive Judicial Monarchic Hierarchical Oligarchic Anarchic Global Local Internal External Liberal Conservative</p>	<p>Being creative Being conforming Being analytical Dealing with one task at a time Dealing with multiple prioritised tasks Dealing with multiple non-prioritised tasks Dealing with tasks at random Focusing on abstract ideas Focusing on concrete ideas Enjoying working independently Enjoying working in groups Using new ways to deal with tasks Using traditional ways to deal with tasks</p>

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