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Comparison Between the Thinking Styles of Students in a Science School and a Mainstream School

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This study investigated the thinking styles of high achievers and normal achievers and examined whether the thinking styles based on Sternberg's (1988, 1997) theory of mental self-government could predict their achievement in science. The sample consisted of 145 high achievers in Year 7 classes from a Science school and 242 normal achievers in Year 7 classes from a mainstream school in Brunei Darussalam. In this study, the Sternberg-Wagner Thinking Styles Inventory (Sternberg, 1997) was used. Results showed that there were statistically significant differences in thinking styles between high achievers and normal achievers. On analysis using the standard multiple regression procedures, it was found that the subscales of thinking styles could be significant predictors of achievement in science. Furthermore, there were also significant differences in the thinking styles between male and male and between female and female students from the two different types of schools. The paper concluded with the implications of the study.

Key words: Thinking styles; High achievers; Normal achievers; Science

Introduction

Recognising the importance of science and technology as the driving force to move the country forward, a Science College was set up in 1982 in Brunei Darussalam with the main purpose of immersing young talented individuals into the field of science and technology. Unlike mainstream schools, the school is well equipped, has a smaller number of students in each class and has a highly qualified professional teaching staff. Enrolment is very selective and limited only to high achievers who obtain 5 Grade A's in Science, Mathematics, General Studies, English language and Malay language in the Primary School Assessment, a public examination for 11 year-olds. Those admitted will continue their secondary education for up to seven years, sitting for their General Certificate of Education (GCE) Ordinary level and Advanced level examinations in Year 11 and Year 13 respectively. Over the years, the school has consistently produced students demonstrating outstanding academic achievements so much so that students from this school are over-represented among the recipients of scholarships awarded by the State Government to further their studies overseas at post-secondary and university levels. Because of the competitive admission criteria and the notable features of the school, the Science College is in essence an elite school catering for the *crème de la crème* or high achieving students.

Astonishingly, despite its academic success, this unique educational institution remains largely outside the gauge of educational researchers. Nevertheless, a few studies have been conducted on these high achieving students as interest began to mount over the last few years. Yong (2005) investigated Year 11 students' perceptions of the classroom learning environment and teacher interactions in biology classes; Dhindsa and Fauziah (2006) evaluated Years 7 and 8 students' science skills; and Yong (2010) investigated Year 9 students' verbal, abstract and spatial reasoning abilities.

Elsewhere, numerous comparative studies had been conducted on students in the elite schools and they appeared to have different attributes to their counterparts in the mainstream schools. Studies have shown that an inherent trait, and perhaps the most important that distinguishes students in the elite schools is their high achieving potentials due to their exceptionally high cognitive abilities (Colangelo, Kerr, Christensen & Maxey, 1993; Toomela, Kikas & Mottus, 2006; Vlahovic-Stetic, Vidovic & Arambasic, 1999). Another reason for the high academic success of elite schools is largely due to the presence of a disproportionately large number of high achievers who

have a high level of motivation to continue their education (Kozochkina, 2009). Furthermore, high achievers have been reported to have significant differences in intellectual ability, verbal ability, attribution of failure to stable factors and mood, academic self-concepts, attainment value, rehearsal, time management and effort management than low achievers (Lau & Chan, 2001). Another characteristic about students' interaction with their teachers in the classroom, as Willson (1999) observed, is that high achievers were found to initiate interactions to volunteer answers, whereas the low achievers interacted purely for the purpose of help-seeking. Stoynoff (1997) studied factors associated with international students' academic achievement and found that high achievers not only had good English language proficiency but also spent more time studying, remained up-to-date in their courses, were better at test taking skills, and were better able to select the main ideas from spoken and written discourse. In assessing the career aspirations of high-achieving secondary school students, Zaitun (2003) reported that they are well motivated, ambitious and have a strong desire to be successful in their future professions. Adams (1996) reported that high achieving students display positive behaviour and hence, receive more teacher attention than other students during lessons.

Research also indicates that there are differences in learning strategies used by high achievers and low achievers. Holschuh (2000) compared the learning strategies between low, average and high achieving biology students and found that high achieving students tend to pay more attention to reading for understanding and to compare class notes with their textbook. In investigating the strategies that students used while studying or taking tests in mathematics, Hong, Sas and Sas (2006) reported that the difference between high achievers and low achievers is that the former used deep-level strategies such as understanding and solving problems in preparing their tests. In terms of reading comprehension, high achievers were found to extensively employ metacognitive components (such as planning, awareness of error) and cognitive components of strategic behaviours (in choosing between main and trivial information and analysing and combining activities) while low achievers were found to employ these strategies at a much lower level (Dermitzaki, Andreou & Paraskeva, 2008). Lau (2011) studied high achievers of secondary school students and observed that they have better reading motivation, used more reading strategies and have better reading performance than low achievers. Lin and Chiu (2010) reported that high and

low achievers use different learning models to learn chemistry concepts; high achievers used a scientific model while low achievers used a character-symbol model and this enabled the former to grasp deep understanding of scientific terminologies and the latter to grasp superficial meanings of scientific terminologies after instruction.

Another factor which has a strong influence on student achievement is thinking styles. Indeed, interests in thinking styles initially began with the work of an American psychologist named Robert Sternberg (1988) in which he put forward the theory of "mental self-government." In this theory, he proposed that just as there are many ways of governing society, there are also many ways of governing or managing one's daily activities. He called these different ways of governing or managing activities "thinking styles." Furthermore, a style of thinking is defined as a preferred way of thinking. It is not ability, but rather "a favoured way of expressing or using one or more abilities" (Grigorenko & Sternberg, 1997, p. 297). In other words, "thinking styles refer to what a person prefers to do and how he/she likes to do it" (Betoret, 2007, p. 220). Based on the theory of self-government, Sternberg (1988, 1994) proposed 13 thinking styles grouped together within 5 parts or dimensions: function (legislative, executive, and judicial), form (monarchic, hierarchic, oligarchic, anarchic); level (global and local); scope (internal, external); and leaning (liberal, conservative). The summary is presented in Table 1, and for a more detailed discussion, see Sternberg and Grigorenko (1993).

Another unique characteristic of thinking styles is that they are adaptive for a given task, for example, a student's preferred styles in one subject in the curriculum may be different in another subject; may undergo developmental changes at different levels of education and are not, in any absolute sense, "good" or "bad" (Sternberg & Grigorenko, 1995). Moreover, as explained by Sternberg (1997), two or more people with the same level of abilities may have very different styles of thinking. The theory of mental self-government provides an important insight into individuals' preferred ways of thinking in different activities (Grigorenko & Sternberg, 1997).

Zhang (2003, 2004a) further conceptualised the 13 thinking styles into three types. She proposed that Type 1 thinking style includes legislative, judicial, hierarchical, global and liberal styles, and people with this style of thinking tend to be more creativity-generating and that they prefer tasks that demand higher levels of cognitive complexity. In other words, they manifest positive

attributes such as a deep approach to learning, high cognitive developmental levels, holistic modes of thinking, and an open personality. Type 2 thinking style includes executive, monarchic, local, and conservative styles, and they tend to be norm-favouring, and prefer tasks that demand lower levels of cognitive complexity. Those with Type 2 thinking style manifest negative attributes such as low self-esteem, low cognitive developmental levels, analytic modes of thinking, and neuroticism. Type 3 thinking styles include anarchic, oligarchic, internal and external styles and people with this type of thinking may display the characteristics of either Type 1 or Type 2 thinking styles or both.

To date, much of the studies on thinking styles have been carried out on gifted students rather than high-achieving students. Studies of gifted students based on Sternberg's (1988, 1994) theory of mental self-government have generated some important findings. In the first instance, Sternberg and Grigorenko (1993) studied high school students ranging in age between 13 and 16 years in the United States and observed that gifted children were more legislative, judicial and liberal than non-gifted children when carrying out their tasks. In Korea, Park, Park and Choe (2005) reported that not only gifted students have higher scores in scientific giftedness, they were also found to prefer the legislative, judicial, anarchic, global, external and liberal thinking styles whereas non-gifted students preferred executive, oligarchic and conservative styles. In a separate study in Korea, Kim, Seo, Kim and Lee (2007) investigated gifted Information Technology (IT) students' thinking styles and found that they tended toward legislative, judicial, global, internal and liberal thinking styles, and these findings are in congruence with those reported by Yun (2005) and Lim (2006) in separate studies of gifted IT students in Korea. One conclusion that can be deduced from these studies is that the thinking styles of gifted students are very similar irrespective of their learning areas.

When gifted students were classified according to Zhang's (2003) thinking type model, they appeared to belong to the Type 1 thinking styles. Similar observation was reported by Alborzi and Ostovar (2007) when they examined the thinking styles of junior high school students in Iran and found that gifted students scored significantly higher than non-gifted students on Type 1 and Type 3 thinking styles, while non-gifted students have statistically significant higher scores on Type 2 thinking styles. Research on thinking styles have now become fully established in the educational realm. Evidence emerging

from over a decade of research "has clearly and consistently indicated that thinking styles have a significant predictive power for students' academic performance" (Zhang, 2004a, p.560). It is based on this premise that the present study was undertaken. The purpose of the present study was to explore high achieving and normal achieving secondary students' thinking styles based on the theory of mental self-government (Sternberg, 1988). The study addressed the following research questions:

1. What is the relationship between students' thinking styles and their achievement in science?
2. Are the thinking styles of high achievers in Science school different from normal achievers in mainstream school?
3. Are there any significant differences in thinking styles between male students in Science school and male students in mainstream school?
4. Are there any significant differences in thinking styles between female students in Science school and female students in mainstream school?

Method

Sample

The sample of the study was Year 7 students from a Science school and a mainstream secondary school in Brunei Darussalam. The study was part of a bigger longitudinal study on thinking styles of secondary students starting from students in Year 7, the first year of secondary education. The present study reports only on students in Year 7 between these two types of schools. Of the 142 students who took part from the Science school, 70 were male (49.3%) and 75 were female (50.7%). There were 242 students from the mainstream school; 120 were male (49.6%) and 122 were female (50.4%). The average age of the students was 12.6 years, ranging from 12 to 13 years.

Questionnaire

The questionnaire consisted of two parts: Part 1 seeks to find out students' demographic information such as gender, age, grade level and marks that they obtained in their last science test.

Part 2 consisted of the Sternberg-Wagner Thinking Styles Inventory (Sternberg, 1997). The original version consisted of 104 items, of which only

78 items were chosen after the structure of the language of the items was carefully considered. Many of the items have also been simplified, considering that English is the second language for the majority of these students. The 78 items were categorised into 13 characteristics or scales with six items in each scale. The items were arranged in a cyclic order in the questionnaire. The students were asked to indicate the extent to which the statements described the way they like or prefer to accomplish tasks. The response options were on a 7-point Likert scale with (1) Not at all like me, (2) Not very much like me, (3) Slightly like me, (4) Somewhat like me, (5) Like me, (6) Very much like me and (7) Extremely like me. The thirteen thinking styles are categorised into five dimensions with several characteristics or scales in each dimension (refer to Table 1 for details).

Table 1
Sternberg's Thinking Styles Adapted from Betoret (2007), Dai & Feldhusen (1999) and Zhang (2001)

Thinking styles	Key characteristics	Tasks preferred	Sample item
Functions Legislative	Like doing things in their own way. They prefer to work on tasks that require creative strategies *(Being creative).*	Like doing science project, writing, poetry stories or music, and creating original artworks.	When making decisions, I tend to rely on my own ideas and ways of doing things.
Executive	Like to be told what they should do or how they should do it. They prefer to work on tasks with clear instructions and structures *(Being conforming).*	Like to solve problems, write papers on assigned topics, do artwork from models, build from designs, learn assigned information.	I am careful to use the proper method to solve every problem.

Thinking styles	Key characteristics	Tasks preferred	Sample item
Judicial	Prefer tasks that enable them to analyse, judge, and evaluate things and ideas *(Being analytical).*	Like to critique work of others, write critical essays, give feedback and advice.	When discussing or writing down ideas, I like judging other peoples' ways of doing things.
Forms Monarchic	Prefer to work on tasks that allow complete focus on one thing at a time *(Dealing with one task at a time).*	Like to immerse self in a single project, whether art, science, history	I like to concentrate on one task at a time.
Oligarchic	Prefer to work on multiple tasks in the service of multiple objectives, without setting priorities *(Dealing with multiple non-prioritised tasks).*	Like to devote sufficient time to reading comprehension items so may not finish standardised verbal ability test.	When I have several tasks to do, I usually start working on them all at once.
Hierarchical	Like to prioritise tasks and distribute attention to them according to their value *(Dealing with multiple prioritised tasks).*	Like to budget time for doing homework so that more time and energy is devoted to important assignments.	I like to set priorities for the things I need to do before I start doing them.
Anarchic	Prefer to work on tasks without norms and instructions. They like flexibility about what, where, and how to work *(Dealing with tasks at random).*	Write an essay in stream of consciousness form in conversation, jump from one point to another, start things but don't finish them.	When I have many things to do, I do whatever occurs to me first.

Thinking styles	Key characteristics	Tasks preferred	Sample item
Levels Local	Local people prefer to work with details. They tend to notice the trees more than the forest *(Focus on concrete ideas).*	Write an essay describing the details of a work of art and how they interact.	I prefer to deal with specific problems rather than general questions.
Global	Prefer to deal with wide and frequently abstract questions. They tend to see the forest more than the trees *(Focus on abstract ideas).*	Write an essay on the global message and meaning of a work of art.	I like situations and tasks in which I am not concerned with details.
Scopes Internal	Are usually introverted, reserved people with fewer social connections than others, as a result, prefer to work alone *(Enjoy working independently).*	Prefer to do science or social studies projects on their own.	I like to control all phases of a project, without having to consult others.
External	Tend to be extroverted, open, and with greater social and interpersonal inclinations *(Enjoy working in groups).*	Prefer to do science or social studies project with other members of a group.	When starting a task, I like to brainstorm ideas with friends or peers.
Leanings Liberal	Prefer to work on tasks that involve novelty and ambiguity *(Use new ways to deal with tasks).*	Prefer to figure out how to operate new equipment even if it is not the recommended way, prefer open-classroom setting.	I enjoy working on projects that allow me to try new ways of doing things.

Thinking styles	Key characteristics	Tasks preferred	Sample item
Conservative	Prefer to work on traditional tasks that must follow similar rules and procedures to those previously used *(Use traditional ways to deal with tasks).*	Prefer to operate new equipment in traditional way, prefer traditional classroom setting.	I like to do things in ways that have been used in the past.

Data Collection

The questionnaires were given to the Heads of the Science Department of the schools who distributed them to their respective teachers responsible for teaching science to Year 7 students. Students were given 15 to 20 minutes to complete the questionnaires during one of their science lessons.

Data Analysis

Data were analysed using the SPSS statistical computer package (Statistical Package for the Social Sciences, 1997). Several procedures, including reliability analysis, frequency, mean, and standard regression coefficients were performed to summarise the data. The classification of students into five thinking style dimensions followed the same procedure as those described by Richmond, Krank and Cummings (2006). In this method, a student's highest scores for a given dimension were chosen to represent that dimension. For example if respondent's scores were Judicial = 4.5, Legislative = 6.2 and Executive = 3.1, they would be categorised as a *Legislative* thinker. The process was performed on all five Thinking Style Dimensions.

Achievement in Science

Students' achievements in science were determined by the marks that they obtained from their class tests. This is based on the first monthly test given by teachers after they have completed a science topic at the end of January of that year when the study was conducted. The test items were short structured questions which required only straight recall answers prepared by teachers

based on past exam papers. The tests conducted by the two schools were almost similar in nature.

Results and Discussion

Reliability and Discriminant Validity of the Instrument

Cronbach's alpha coefficients and mean partial correlation coefficients were calculated to estimate the internal consistency and discriminant validity of the items in each scale of the thinking style instrument. Values obtained for alpha coefficients ranged from 0.51 to 0.73 which indicated that each scale displayed adequate internal consistency. These values are similar to those reported by Grigorenko and Sternberg (1997) which ranged from 0.55 to 0.83 and those obtained by Bernardo, Zhang and Callueng (2002) which ranged from 0.50 to 0.81. Values obtained for discriminant validity ranged from 0.08 to 0.11 which suggested that each scale is relatively distinctive of other scales though there was a small degree of overlapping occurring between each scale. Based on these data, the reliability and validity of instruments were considered adequate and suitable for the purpose of the study.

Achievements in Science

The results in Table 2 show that high achieving students in the Science school performed much better in science than normal achieving students in the mainstream school. This was reflected in the overall mean scores, and the mean difference was significant (p<0.000; ES = 0.93).

Table 2
Achievement in Science between Students in the Science School and Mainstream School

School	Mean	SD	*t*-value	*p*	ES
Science	81.98	8.98	7.087	0.000	0.93
Mainstream	68.73	19.56			

Science school=145; mainstream school=242; SD=standard deviation; ES=effect size

Relationships between Thinking Styles and Achievement in Science

The relationships between thinking styles and achievement were examined using standard multiple regression procedure, with the students' achievement as the dependent variable and their thinking styles as their independent variables. The summary statistics of the analysis are shown in Table 3. Results show that of the 13 thinking style characteristics, four thinking styles contributed statistically. They were the monarchic and local thinking styles which contributed positively, and the hierarchical and global thinking styles which contributed negatively to achievement in science. This means that the preference for dealing one task at a time and focusing on concrete ideas will more likely increase their conceptual understanding whilst dealing with multiple prioritised tasks, and focusing on abstract ideas will more likely decrease their conceptual understanding, and ultimately their achievement in science. This suggests that all four thinking styles contributed to the prediction of achievement scores albeit in different directions. They explained 16% of the total variance (R^2) for student achievement.

Table 3
Relationships between Thinking Styles Characteristics and Achievement in Science in terms of Standard Multiple Regression Coefficients (ß)

Dimension	Characteristic	ß
Functions	Legislative	0.045
	Executive	0.168
	Judicial	0.077
Forms	Monarchic	0.186*
	Oligarchic	-0.101
	Hierarchical	-0.317**
	Anarchic	-0.077
Levels	Local	0.162*
	Global	-0.168*
Scopes	Internal	-0.052
	External	0.049
Leanings	Liberal	0.136
	Conservative	0.028
Multiple *R*	0.400***	
R^2	0.160	

*P<0.05; **p<0.01; ***p<0.001; N=406

Thinking Styles between High Achievers and Normal Achievers

Based on the scale mean scores of the 13 characteristics, results show that students in both types of schools tended to prefer executive, monarchic, local, external and liberal thinking styles (Table 4). According to Zhang's (2003) thinking type model, it appears that both high achievers and normal achievers leaned predominantly toward Type 2 thinking styles that include executive, monarchic and local thinking styles except for leaning dimension with which they seemed to prefer the liberal instead of the conservative learning styles. Accordingly, Bruneian students, regardless of whether they are high achieving or normal achieving, seemed to orientate toward the characteristics of Type 2 thinking styles. This can be translated to imply that Bruneian secondary students tended to be norm-favouring or preferred tasks which demanded lower level of cognitive complexity. In other words, they preferred tasks that have clear instructions and structures, tasks that allow complete focus on one thing at a time, tasks that focus on concrete ideas, and tasks that they can do cooperatively in group. Oddly, they also seemed to prefer tasks that gave them new ways of solving the tasks which is a liberal thinking characterised by Type 1 thinking style.

Table 4
Scale Means, Standard Deviations, t-values and Effect Sizes for Students' Thinking Style Characteristics in Science School and Mainstream School

Characteristic	Science school		Mainstream school			
	Mean	SD	Mean	SD	*t*-value	ES
Legislative	27.87	5.96	24.36	7.07	5.225***	0.54
Executive	28.28	5.44	25.40	7.02	4.494***	0.46
Judicial	27.28	5.33	23.71	6.55	5.836***	0.60
Monarchic	29.33	5.62	26.21	6.68	4.919***	0.51
Oligarchic	22.40	6.19	20.66	6.32	2.660**	0.28
Hierarchical	26.98	6.16	24.65	6.76	3.464**	0.36
Anarchic	27.59	5.42	24.87	6.10	4.551***	0.47
Local	25.41	4.97	23.05	6.81	3.927***	0.40
Global	22.77	4.90	20.79	5.90	3.544***	0.37
Internal	22.42	6.35	22.23	6.44	0.281	-
External	30.21	6.04	26.25	6.67	5.605***	0.62
Liberal	29.28	5.77	26.25	6.67	4.698***	0.49
Conservative	25.74	6.12	24.03	6.50	2.597**	0.27

$^{**}P < 0.01$; $^{***}P < 0.001$; science school=145; mainstream school=242;
SD=standard deviation; ES=effect size

The results in Table 4 also show that there were statistically significant differences in thinking styles between these two groups of students. Of the 13 thinking style characteristics, high achieving students showed a higher tendency than normal achieving students in all the thinking styles except for internal style. Specifically, in the function dimension, high achieving students tended to be more conforming, more creative and more analytical than normal achieving students. In form, high achieving students seemed to prefer to deal with tasks in all the different ways whether one at a time, many at a time, at random or according to priority; in level, they seemed to prefer to focus both on concrete and abstract concepts; in scope, they seemed to enjoy more on group work; and in leaning, they seemed to prefer using both new ways and traditional ways of carrying out a task than the normal achieving students.

Thinking Styles between High Achieving and Normal Achieving Male Students

The results showed that both high achieving and normal achieving male students tended predominantly toward Type 2 thinking styles (Table 5). There were also significant statistical differences between the thinking styles of these two groups of male students. Of the 13 thinking style characteristics, high achieving male students from the Science school showed a higher tendency than normal achieving students from the mainstream school in legislative, judicial, monarchic, anarchic, global, external and liberal thinking styles. The findings seemed to suggest that high achieving male students tended to be more conforming, more creative, more analytical, prefer to deal with tasks one at a time and according to priority, enjoy group work and prefer using new ways of carrying out a task than the normal achieving male students.

Table 5
Scale Means, Standard Deviations, t-values and Effect Sizes for Male Students' Thinking Style Characteristics in Science School and Mainstream School

Characteristic	Science school (Male)		Mainstream school (Male)		*t*-value	ES
	Mean	SD	Mean	SD		
Legislative	27.27	6.10	24.81	6.86	2.543*	0.38
Executive	27.29	5.86	25.66	6.56	1.766	-
Judicial	26.31	5.28	23.83	6.13	2.943**	0.53
Monarchic	28.61	5.68	25.97	6.44	2.948**	0.44
Oligarchic	21.86	6.48	21.39	5.73	0.498	-
Hierarchical	25.81	6.42	24.87	6.49	0.978	-
Anarchic	26.77	5.68	24.59	5.33	2.610**	0.40
Local	24.87	5.34	23.52	6.34	1.564	-
Global	22.86	5.11	21.03	5.41	2.321*	0.35
Internal	21.99	6.68	23.34	6.10	-1.385	-
External	28.67	6.45	26.30	6.69	2.405*	0.36
Liberal	28.83	6.59	26.19	6.02	2.740**	0.42
Conservative	24.81	6.37	24.65	6.16	0.176	-

*$P < 0.05$; **$P < 0.01$; science school=70; mainstream school=120;
SD=standard deviation; ES=effect size

Table 6
Scale Means, Standard Deviations, t-values and Effect Sizes for Female Students' Thinking Style Characteristics in Science School and Mainstream School

Characteristic	Science school (Female)		Mainstream school (Female)		*t*-value	ES
	Mean	SD	Mean	SD		
Legislative	28.41	5.81	23.88	7.26	4.823***	0.69
Executive	29.20	4.88	25.16	7.47	4.594***	0.65
Judicial	28.17	5.25	23.59	6.97	5.237***	0.75
Monarchic	30.00	5.52	26.45	6.92	3.970***	0.57
Oligarchic	22.91	5.91	19.93	6.79	3.234**	0.47
Hierarchical	28.06	5.74	24.44	7.05	3.938***	0.57
Anarchic	28.35	5.09	25.14	6.77	3.776***	0.54
Local	25.92	4.58	22.59	7.22	3.960***	0.56
Global	22.68	4.73	20.56	6.36	2.674**	0.38
Internal	22.83	6.05	21.16	6.60	1.818	-
External	31.65	5.28	26.24	8.42	5.501***	0.79
Liberal	29.71	4.88	26.31	7.29	3.885***	0.56
Conservative	26.61	5.79	23.41	6.79	3.504**	0.51

**$P < 0.01$; ***$P < 0.001$; science school=75; mainstream school=122;
SD=standard deviation; ES=effect size

Thinking Styles between High Achieving and Normal Achieving Female Students

Like their male counterparts, both high achieving and normal achieving female students tended to lean predominantly toward Type 2 thinking styles. However, unlike their male counterparts, the difference between high achieving and normal achieving female students was greater in terms of the number of thinking styles that are statistically significant (Table 6). Of the 13 thinking style characteristics, high achieving female students showed a higher tendency than normal achieving female students in all the thinking styles except for internal style. Specifically, in the function dimension, high achieving female students tended to be more conforming, more creative and more analytical than normal achieving female students. In form, they seemed to prefer to deal with tasks in all the different ways whether one at a time, many at a time, at random or according to priority; in level, they seemed to

prefer to focus both on concrete and abstract concepts; in scope, they seemed to enjoyed more on group work; and in leaning, they seemed to prefer using both new ways and traditional ways of carrying out a task than the normal achieving female students.

Conclusion

The thinking style inventory based on the Stenberg's theory of mental self-government is a valid and reliable instrument for use in research study in Brunei Darussalam. The Cronbach's alpha and discriminant validity coefficients obtained were within the range of acceptable values. This instrument has also been widely used in many countries such as Hong Kong and China (Zhang (2001, 2004b, 2008a, 2008b,) the Philippines (Bernardo, Zhang & Callueng, 2002), Spain (Betoret, 2007; Cano-Garcia & Hughes, 2000; Liminana, Berna & Lopez, 2009), South Africa (Cilliers & Sternberg, 2001; Murphy & Janeke, 2009), the USA (Grigorenko & Sternberg, 1997; Richmond, Krank & Cummings, 2006), South Korea (Kim, Seo, Kim, & Lee, 2007; Lim, 2006; Park, Park, & Choe, 2005; Yun, 2005), Turkey (Balkis & Isiker, 2005) and in Iran (Alborzi & Ostovar, 2007). It would seem therefore that the thinking style instrument is highly adaptable for students in different educational settings.

In achievement, high achieving students from the Science school seemed to outperform normal achieving students from the mainstream school by a margin of 13 percentage point. Results also show that there were significant relationships between students' thinking styles and achievement when examined using the standard multiple regression procedure. Of the four thinking styles which contributed statistically, the monarchic and local thinking styles were found to contribute positively, while the hierarchical and global thinking styles were found to contribute negatively to achievement in science. Overall, thinking styles accounted for about 16% of the variance for student achievement.

Another interesting finding of this study was that secondary Year 7 students in Brunei tended to prefer the executive, monarchic, local, external and liberal thinking styles or the Type 2 thinking model irrespective of whether they were high achieving or normal achieving. A possible explanation for this observation is that a majority of Bruneian students at Year 7 exhibit largely concrete operational stage based on Piaget's cognitive

developmental theory. This is in spite of the fact that they were on average 12.6 years of age and should be theoretically in the formal operational stage which occurs approximately from age 12. Students' preference for tasks that focus on concrete ideas indicates that many may have not entered the next or higher stage of cognitive development. Other studies on gifted students where the samples were drawn from much older students showed that the students exhibit Type 1 thinking styles and preferred to focus on tasks involving abstract ideas. In the bigger longitudinal study, it would be interesting to find out if the older students will exhibit Type 1 thinking styles as reported elsewhere.

Another possible explanation for this tendency perhaps lies with the educational system and cultural expectations. In a comparative study of students' thinking styles of different countries, Zhang (2001) came to the conclusion that in order "to succeed academically in their respective cultures, students need to have a preference for certain thinking styles because each culture has its own values and each educational system has a different reward system…" (p. 632). Based on Zhang's (2001) thinking model, Bruneian students tended to prefer ways of doing things that are norm-favouring or tasks that demand lower levels of cognitive complexity. This manifestation reflects the nature and demand of the educational system which places great emphasis on examinations. Under this system, teachers resort to teaching students for the examinations because they are under constant pressure to produce results. In order to meet that expectation, teachers will attempt to cover the syllabuses quickly so that they will have ample time of a few months to drill their students to practice past examination questions. Therefore, the form of teaching approach is teacher-centred and assessment-driven with very few opportunities for students to engage in exploratory activities. Zhang (2004b) reported that when teachers use a knowledge transmission/teacher-focused teaching approach, they tended to use Type 2 teaching styles. It seems that the reason for Bruneian students to orientate toward Type 2 thinking styles is because it fits well with what the contextual demands, and in this case, with the ways science is taught and assessed.

Results of the study also showed statistically significant relationships between different thinking styles and student achievement. More specifically, it appears that preference for a monarchic (being conforming), a local (focusing on concrete ideas) and a liberal (using new ways to deal with tasks) thinking style tended to positively contribute to secondary students'

achievement in science. In contrast, the use of an oligarchic (dealing with multiple non-prioritised tasks) and a global (focusing on abstract ideas) thinking style tended to put students in a disadvantage position in science achievement.

In terms of school type, high achieving students from the Science school have significantly higher tendency than normal achieving students from the mainstream school in all the 13 thinking styles except in internal thinking styles although both groups of students tended toward Type 2 thinking style. The same was also true when comparisons were made between high achieving male and normal achieving male students and between high achieving female and normal achieving female students albeit in different degrees. It can be reasonably assumed that high achieving students tended to prefer tasks that are more challenging in terms of cognitive complexity than normal achieving students.

Implications

The implications of the study are follows:

1. As students will be more successful if they are given tasks that match with their thinking styles (Sternberg & Grigorenko, 1997) teachers should design teaching and learning methods that are best suited for the individual style of each student. Bruneian secondary students in Year 7, regardless of whether they are high achieving or normal achieving, seemed to prefer the Type 2 thinking styles which are characterised by the executive, monarchic and local thinking styles in the way they carry out their tasks. Based on this thinking style preference, it is suggested that expository method of teaching and tasks that are related to problem-solving where clear instructions and structures, tasks like projects where they can focus on one thing at a time and tasks that require detail and precision will be more suitable for the students.

2. Since high achieving students leaned toward all the thinking styles, except the internal thinking style, higher than those of normal achieving students, they should be given tasks that are more creative, more analytical and more challenging like projects in which they can choose the topics they want to investigate and design the methods to solve problems on their own under the advice and guided support of teachers. Whilst normal achieving students should also be given tasks that are creative, analytical and challenging, they should, however, be introduced in stages so that the tasks would not be too overwhelming for them.

3. Teachers should also use other teaching and learning programmes that reflect the diverse thinking style characteristics of the learners in both types of schools. More importantly, as these students gradually advance to higher levels and enter the formal operational stage, teachers should offer a curriculum and instructional method that are appropriate to the level of their cognitive developmental stage. The new educational system in Brunei introduced in 2008 which emphasises course work as part of students' assessment will give teachers the opportunity to make changes their teaching and learning strategies. Teachers should introduce tasks that are cognitively more demanding like problem solving and those that involve analysis, synthesis and application in order to develop creative and analytical thinking skills, thus placing less emphasis on teacher-centred and examination-oriented instruction.

4. Students' thinking styles should be included in the teacher education programme. Such knowledge will enable teachers to develop effective teaching methods and pedagogical strategies to respond to the diverse thinking styles of students in science classrooms.

Limitations of the Study

The limitations of the study are as follows:

1. In this study the grades obtained by students were used as a measure of achievement. As the grades were based on one class test, they did not necessarily represent a precise indication of level of proficiency of the students. It is recommended that the academic performance of participants be based on results obtained from several tests or end-of-year examinations. A better alternative would be to develop a test which has a high test validity and to use it as a standardised test for students in different schools.

2. More studies should be carried out before the results can be generalised for other schools. It is recommended that a similar study be conducted using the same research design with a larger sample of participants randomly drawn from all the secondary schools. This will generate more credible results and obtain better and wider representation of different categories of thinking styles.

In conclusion this exploratory study has generated some interesting findings with regard to high achieving and normal achieving students' thinking styles. Nevertheless, more studies need to be conducted on students

at different levels of their secondary education. This will undoubtedly provide researchers and teachers with a better understanding of Bruneian students' thinking styles as they advance to higher levels of education and such knowledge will enable classroom practitioners to offer appropriate teaching methods for effective learning of science.

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